U.S. Department of Energy
Office of Environmental Management

Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage and Disposal of Radioactive and Hazardous Waste

Volume I of V

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FINAL
WASTE MANAGEMENT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
for
Managing Treatment, Storage, and Disposal of
Radioactive and Hazardous Waste

Volume I of V

Chapters 1-15

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Office of Environmental Management
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Abstract:

The Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) examines the potential environmental and cost impacts of strategic management alternatives for managing five types of radioactive and hazardous wastes that have resulted and will continue to result from nuclear defense and research activities at a variety of sites around the United States. The five waste types are low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. The WM PEIS provides information on the impacts of various siting alternatives which the Department of Energy (DOE) will use to decide at which sites to locate additional treatment, storage, and disposal capacity for each waste type. This information includes the cumulative impacts of combining future siting configurations for the five waste types and the collective impacts of other past, present, and reasonably foreseeable future activities.

The selected waste management facilities being considered for these different waste types are treatment and disposal facilities for low-level mixed waste; treatment and disposal facilities for low-level waste; treatment and storage facilities for transuranic waste in the event that treatment is required before disposal; storage facilities for treated (vitrified) high-level waste canisters; and treatment of nonwastewater hazardous waste by DOE and commercial vendors. In addition to the no action alternative, which includes only existing or approved waste management facilities, the alternatives for each of the waste type configurations include decentralized, regionalized, and centralized alternatives for using existing and operating new waste management facilities. However, the siting, construction and operations of any new facility at a selected site will not be decided until completion of a sitewide or project-specific environmental impact review.

Reader's Guide

What is the purpose of this environmental impact statement?

The purpose of all environmental impact statements is to inform the public and decision makers of the potential impacts of proposed Federal actions and to identify which of these impacts might be significant to human health or the environment. In brief, the **Waste Management Programmatic Environmental Impact Statement (WM PEIS)** evaluates the possible impacts of several strategic waste management alternatives being considered by the U.S. Department of Energy (DOE).

How is it organized?

Chapter 1 of Volume I describes how the WM PEIS is organized. Recognizing that the public has varying levels of interest, the WM PEIS is separated into distinct levels that increase in complexity from the Summary to the technical reports. These levels are shown in the box at right.

VOLUME V contains an indexed compilation of the public's comments on the draft WM PEIS and DOE's responses to them. All comments received during the public comment period were carefully considered.

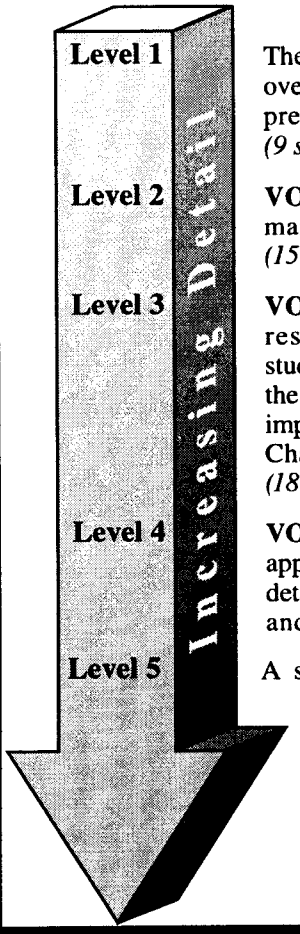
How can I tell where the final document has been changed?

All text changes that have occurred since publication of the Draft WM PEIS are indicated with shading for tables and marginal rules for text. One exception is Appendix I, which is completely new.

What if I don't understand a term or an abbreviation?

The glossary in Chapter 14 of Volume I contains definitions of technical and less commonly used words. Some definitions can also be found in the main text of the document. Acronym lists spelling out the abbreviations used in the WM PEIS and its appendices are provided in the front of the document (the Summary and Volume I) and before each appendix.

Levels of Detail in the WM PEIS



The **SUMMARY** contains an overview of all of the material presented in the WM PEIS. *(9 sections)*

VOLUME I contains the main text of the document. *(15 chapters)*

VOLUME II presents the results of the analytical studies, by site, that constitute the basis of the environmental impact discussions provided in Chapters 6–10 of Volume I. *(18 chapters)*

VOLUMES III AND IV are appendices that provide more detail concerning the analyses and results. *(9 appendices)*

A series of **TECHNICAL REPORTS** (available in the DOE reading rooms listed in Chapter 1 of Volume I) contains detailed information of interest to technical experts. *(32 reports)*

Where can I find out what proposed Federal actions are evaluated in the WM PEIS?

DOE evaluates several possible alternatives for treatment, storage, or disposal of five types of waste generated from nuclear weapons production and related activities. The alternatives considered for each waste type are introduced in Chapter 1 of Volume I, and summarized in Section 1 of the Summary. Chapter 2 of Volume I discusses why DOE needs to make waste management decisions.

Where does DOE define the five waste types?

Definitions for the waste types are found in Section 1.5 of Volume I and Section 1.3 of the Summary.

Where are the waste management alternatives described?

Chapter 3 of Volume I and Section 2 of the Summary describe the alternatives for each type of waste and the methods used to develop the alternatives.

How did DOE decide which of its sites to include in the various alternatives?

Chapter 1 of Volume I introduces the basic rationale for identifying 17 DOE sites as the "major" sites in the waste management complex. Chapters 6–10 of Volume I present the rationale for determining which of these sites are included in each alternative for each waste type. Sections 2 and 4–8 of the Summary also contain this information.

Does DOE have preferred alternatives? Where can I find them discussed?

Yes, DOE has preferred alternatives for each of the five waste types. These alternatives are described in Chapter 3 of Volume I and in Section 2 of the Summary. The criteria used to select the preferred alternatives are presented in Chapter 1 of Volume I and Section 2 of the Summary.

How can I find out quickly and easily which alternatives were considered for each waste type?

An "At a Glance" page for each waste type summarizes the waste management alternatives (including DOE's preferred alternative) considered for that waste type. The data and assumptions used to compare the alternatives and the highlights of what was learned are also provided. The "At a Glance" pages can be found at the beginning of each waste type section in the Summary (Sections 4–8).

Where can I find more details about the possible impacts at a site?

More detailed information about possible impacts is provided in Volume II, where site-specific modeling results for health risks, air quality, water resources, socioeconomic impacts, and costs are presented. Also note that the maps in Appendix C (Volume III) depict minority and low-income population distributions for the major waste management sites. The table at the end of this guide shows where to find all of this information for each of the major sites.

What can DOE do about the possible impacts at a site?

Chapter 12 of Volume I describes the "mitigation measures" that DOE can use to reduce or eliminate potential impacts wherever appropriate. These measures are described on both a programmatic and a site level.

Where can I find information about a site near me?

The WM PEIS is a *programmatic* (i.e., Department-wide) study to evaluate strategies for managing waste. It is not a site-specific review. However, two chapters of Volume I are organized by site: Chapter 4, *Affected Environment*, and Chapter 11, *Cumulative Impacts*. Refer to the table at the end of this guide to find the sections of these chapters that discuss the site you are interested in.

Chapters 6–10 provide information in tables organized by site. A foldout table is included at the end of each of these chapters to use as a handy reference while you are reading the chapter. The foldout tables provide the waste management activities analyzed for each site under each alternative.

At the end of the Summary, a profile of each "major" site summarizes the amount of each type of waste at the site and the waste management alternatives considered for the site. The possible human health and environmental impacts of the preferred alternatives at the site are also briefly identified.

Reader's Guide

Guide to Finding Site Information in the WM PEIS

	Topic and WM PEIS Volume Number				
	Affected Environment	**Cumulative Impacts**	**Site Data Tables**	**Distribution of Minority Populations (and Tribal Lands)**	**Distribution of Low-Income Populations**
DOE Site	**Volume I**	**Volume I**	**Volume II**	**Volume III**	**Volume III**
ANL-E	Section 4.4.1	Section 11.3	Chapter II.2	Figure C.4-7	Figure C.4-24
BNL	Section 4.4.2	Section 11.4	Chapter II.3	Figure C.4-8	Figure C.4-25
FEMP	Section 4.4.3	Section 11.5	Chapter II.4	Figure C.4-9	Figure C.4-26
Hanford	Section 4.4.4	Section 11.6	Chapter II.5	Figure C.4-10a,b	Figure C.4-27
INEL	Section 4.4.5	Section 11.7	Chapter II.6	Figure C.4-11a,b	Figure C.4-28
LANL	Section 4.4.7	Section 11.9	Chapter II.7	Figure C.4-13a,b	Figure C.4-30
LLNL	Section 4.4.6	Section 11.8	Chapter II.8	Figure C.4-12	Figure C.4-29
NTS	Section 4.4.8	Section 11.10	Chapter II.9	Figure C.4-14	Figure C.4-31
ORR	Section 4.4.9	Section 11.11	Chapter II.10	Figure C.4-15	Figure C.4-32
Pantex	Section 4.4.11	Section 11.13	Chapter II.12	Figure C.4-17	Figure C.4-34
PGDP	Section 4.4.10	Section 11.12	Chapter II.11	Figure C.4-16	Figure C.4-33
PORTS	Section 4.4.12	Section 11.14	Chapter II.13	Figure C.4-18	Figure C.4-35
RFETS	Section 4.4.13	Section 11.15	Chapter II.14	Figure C.4-19	Figure C.4-36
SNL-NM	Section 4.4.14	Section 11.16	Chapter II.15	Figure C.4-20a,b	Figure C.4-37
SRS	Section 4.4.15	Section 11.17	Chapter II.16	Figure C.4-21	Figure C.4-38
WIPP	Section 4.4.16	Section 11.18	Chapter II.17	Figure C.4-22	Figure C.4-39
WVDP	Section 4.4.17	Section 11.19	Chapter II.18	Figure C.4-23a,b	Figure C.4-40

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Acronyms and Abbreviations

AI	Atomics International
Ames	Ames Laboratory
AMRC	Albany Metallurgical Research Center
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
ARAM	Automated Remedial Action Methodology
ARARs	Applicable or Relevant and Appropriate Requirements
AEA	Atomic Energy Act
BEA	Bureau of Economic Analysis
BCL	Battelle Columbus Laboratory
BEMR	Baseline Environmental Management Report
Bettis	Bettis Atomic Power Laboratory
BGV	below-ground vault
BNL	Brookhaven National Laboratory
BRC	Below Regulatory Concern
CAA	Clean Air Act
CEER	Center for Energy and Environmental Research
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH	Contact-handled
Charleston	Charleston Naval Shipyard
CISS	Colonie Interim Storage Site
CWA	Clean Water Act
CY	Calendar Year
D&D	Decontamination and Decommissioning
DNFSB	Defense Nuclear Facilities Safety Board
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DP	Defense Programs
DUST	Disposal Unit Source Term
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
EDE	Effective Dose Equivalent
EH	DOE Office of Environment, Safety, and Health
EIS	Environmental Impact Statement
EM	Office of Environmental Management
EMAB	Environmental Management Advisory Board
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration

ETEC	Energy Technology Engineering Center
et seq.	and that which follows
FEMA	U.S. Federal Emergency Management Agency
FEMP	Fernald Environmental Management Project
Fermi	Fermi National Accelerator Laboratory
FFCAct	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
FR	Federal Register
FTE	Full-time Equivalent
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	Fiscal Year
GA	General Atomics
GCR	General Conformity Rule
GE	General Electric Vallecitos Nuclear Center
GJPO	Grand Junction Projects Office
GTCC	Greater-Than-Class C
Hallam	Hallam Nuclear Power Facility
Hanford	Hanford Site
HAPs	Hazardous Air Pollutants
HEPA	High Efficiency Particulate Air
HHS	U.S. Department of Health and Human Services
HLW	High-Level Waste
HW	Hazardous Waste
ICF	Inertial Confinement Fusion
ICPP	Idaho Chemical Processing Plant
IDHL	Immediately Dangerous to Life and Health
INEL	Idaho National Engineering Laboratory
IP	Implementation Plan
ITRI	Inhalation Toxicology Research Institute
K-25	Oak Ridge K-25 Site
KAFB	Kirtland Air Force Base
KAPL	Knolls Atomic Power Laboratory
KAPL-K	Knolls Atomic Power Laboratory-Kesselring
KAPL-N	Knolls Atomic Power Laboratory-Niskayuna
KAPL-W	Knolls Atomic Power Laboratory-Windsor
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LDRs	Land Disposal Restrictions
LEHR	Laboratory for Energy-Related Health Research
LLMW	Low-Level Mixed Waste

LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level Waste
m^3	cubic meter (1 cubic meter is equal to 35.314 cubic feet, or 264,173 gallons)
Mare Is	Mare Island Naval Shipyard
MISS	Maywood Interim Storage Site
MCL	Maximum Contaminant Level
MEI	Maximally Exposed Individual
MEPAS	Multimedia Environmental Pollutant Assessment System
Middlesex	Middlesex Sampling Plant
Mound	Mound Plant
MWIR	Mixed Waste Inventory Report
NAAQS	National Ambient Air Quality Standards
nCi/g	nanocuries per gram
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NOI	Notice of Intent
Norfolk	Norfolk Naval Shipyard
NRC	U.S. Nuclear Regulatory Commission
NRF	Naval Reactor Facility
NRHP	National Register of Historic Places
NHL	National Historic Landmark
NTS	Nevada Test Site
NWPA	Nuclear Waste Policy Act
ODS	Ozone-Depleting Substance
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Act
Paducah	Paducah Gaseous Diffusion Plant
PA/SI	Preliminary Assessment and Site Investigation
Palos	Palos Forest
Pantex	Pantex Plant
PCBs	Polychlorinated Biphenyls
PEIS	Programmatic Environmental Impact Statement
Pearl H	Pearl Harbor Naval Shipyard
PGDP	Paducah Gaseous Diffusion Plant
Pinellas	Pinellas Plant
PM_{10}	Particulate matter of aerodynamic diameter equal to or less than 10 micrometers
PNNL	Batelle Pacific Northwest National Laboratory
PORTS	Portsmouth Gaseous Diffusion Plant
Ports Nav	Portsmouth Naval Shipyard
PPPL	Princeton Plasma Physics Laboratory

PSD	Prevention of Significant Deterioration
Puget So	Puget Sound Naval Shipyard
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RH	Remote-handled
RI/FS	Remedial Investigation/Feasibility Study
RIMS	Regional Input-Output Modeling System
RMI	RMI Titanium Company
ROD	Record of Decision
ROI	Region of Influence
Salton Sea	Salton Sea Test Base
SARA	Superfund Amendment Reauthorization Act
SARs	Safety Analysis Reports
SDWA	Safe Drinking Water Act
SIW	Sanitary and Industrial Waste
SLAC	Stanford Linear Accelerator Center
SMAC	Shipment/Mobility Accountability Collection
SNF	Spent Nuclear Fuel
SNM	Special Nuclear Material
SNL-CA	Sandia National Laboratories (California)
SNL-NM	Sandia National Laboratories (New Mexico)
SRS	Savannah River Site
STPs	Site Treatment Plans
TAPs	Toxic Air Pollutants
TBE	Teledyne Brown Engineering
TCLP	Toxicity Characteristic Leaching Procedure
TEDE	Total Effective Dose Equivalent
TRUW	Transuranic Waste
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage, and Disposal
U of MO	University of Missouri
UMTRA	Uranium Mill Tailings Remedial Action Project
USAMC	U.S. Army Material Command
USC	U.S. Code
VOCs	Volatile Organic Compounds
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WIPP LWA	Waste Isolation Pilot Plant Land Withdrawal Act
WIPP-WAC	Waste Isolation Pilot Plant Waste Acceptance Criteria
WM PEIS	Waste Management Programmatic Environmental Impact Statement

WNYNSC	Western New York Nuclear Service Center
WSSR	Weldon Spring Remedial Action Project
WVDP	West Valley Demonstration Project
Y-12	Oak Ridge Y-12 Plant

CHAPTER 1
Introduction and Background

This chapter describes the U.S. Department of Energy's (DOE's) past and ongoing activities that generate and have resulted in the accumulation of wastes, and provides information about the statutory and regulatory framework under which DOE must operate to manage five types of waste. These waste types are defined, the involved DOE sites are identified, and the decisions that DOE must make with respect to managing those wastes are described. This chapter also includes a discussion of the relationship of this decision-making process to other DOE National Environmental Policy Act (NEPA) documents and programs.

1.1 Purpose of the Waste Management Programmatic Environmental Impact Statement

This Waste Management Programmatic Environmental Impact Statement (WM PEIS) is a nationwide study examining the environmental impacts of managing more than 2 million cubic meters of radioactive and hazardous wastes from past and future DOE activities. The WM PEIS will assist the U.S. Department of Energy (DOE) in improving the efficiency and reliability of managing its current and anticipated volumes of radioactive and hazardous wastes, will help DOE continue to comply with applicable laws and regulations, and will promote the protection of workers, public health and safety, and the environment (DOE, 1994b). The WM PEIS allows the public and DOE decision makers to make comparisons of the impacts from various potential configurations for the management of DOE wastes. The goal is a nationwide strategy to treat wastes in a safe, responsible, and efficient manner that minimizes impacts. Nevertheless, there will always be legitimate questions regarding waste management activities at certain sites. DOE understands and appreciates these concerns and will carefully consider them in making these strategic decisions.

Wastes analyzed in the WM PEIS result primarily from nuclear weapons production and related activities.[1] Wastes produced from nuclear weapons production and related activities are categorized into five waste types. These are: low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), high-level waste (HLW), and hazardous waste (HW). More information on the scope of this document and its relationship to other actions and programs can be found in Sections 1.7 and 1.8.

[1] Environmental restoration (ER), another activity resulting in waste generation, is reviewed but not analyzed in the WM PEIS.

Definitions of Wastes Analyzed in the WM PEIS:

- **Low-level mixed waste.** Waste that contains both hazardous waste under the Resource Conservation and Recovery Act (RCRA) and source, special nuclear, or by-product material subject to the Atomic Energy Act (AEA) of 1954 (42 USC 2011, *et seq.*).
- **Low-level waste.** Waste that contains radioactivity and is not classified as HLW, TRUW, or spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section 11(e)(2) of the Atomic Energy Act). Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW, provided that the concentration of transuranic is less than 100 nCi/g.

Terms of Radioactivity

The spontaneous decay of unstable nuclei in the atom causes the release of particles or electromagnetic waves. These releases are measured in terms of the number of nuclear disintegrations per unit of time. The common unit for this is the "curie," which is 37 billion disintegrations per second. A ***nanocurie****, or one-billionth of a curie, designated as "nCi," is 37 disintegrations per second. The activity level of radiation, measured in curies, declines over time. The time it takes for the activity to drop to one-half of its starting value is known as the* ***half-life*** *of the material. DOE waste has half-lives as short as minutes in the case of some fission products (smaller atoms left over by the splitting of uranium and plutonium) to billions of years in the case of uranium-238 (one of two main isotopes of uranium).*

The dosage of radiation a person receives is measured in ***REMs*** *(roentgen equivalent man) and is typically stated in terms of thousandths of REMs (1/1,000 REM or millirem [mrem]).*

- **Transuranic wastes**. Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than 20 years, per gram of waste, and an atomic number greater than 92 except for (a) HLW, (b) waste that DOE has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency (EPA), does not need the degree of isolation required by 40 CFR 191, or (c) waste that the U.S. Nuclear Regulatory Commission (NRC) has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.
- **High-level waste**. The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the NRC, consistent with existing law, determines by rule requires permanent isolation.
- **Hazardous waste**. Under RCRA, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly

contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the AEA, are specifically excluded from the definition of solid waste.

Waste management is broadly defined as the treatment, storage, or disposal of waste. The activities associated with the management of the waste include:

- Pollution prevention
- Identifying and contracting with private vendors to manage waste
- Modifying existing waste management facilities or constructing new facilities at particular sites
- Operating modified or new waste management facilities at those sites
- Transporting wastes among sites as necessary
- Handling, surveillance, and maintenance

The WM PEIS will help DOE select a configuration for the following activities:

- Treatment and disposal of LLMW
- Treatment and disposal of LLW
- Treatment and storage of TRUW
- Storage of treated (vitrified) HLW in canisters
- Treatment of nonwastewater HW

The decision-making process will follow a "tiered" approach. First, DOE will make broad Departmentwide decisions, supported by this programmatic NEPA review, about which sites will manage which wastes. DOE will follow these broad decisions with an analysis of narrower proposals for the implementation of programmatic decisions in related NEPA reviews. Although DOE intends to identify a configuration (i.e., select sites for waste management activities as a result of this *programmatic* EIS), DOE will take a closer look (including site-specific design, location on the site, operating parameters for new facilities, and site-specific impacts) in *sitewide* or *project-level* NEPA reviews.

To assist DOE in making decisions regarding the sites at which it should locate waste management facilities, this PEIS considers four broad categories of alternatives for each waste type: the No Action Alternative, Decentralized Alternatives that would minimize the transportation of waste between sites, Regionalized Alternatives that would locate waste management facilities at several sites throughout the nation, and

Centralized Alternatives that would locate large waste management facilities at only one or two sites. For certain waste types, DOE considers more than one Regionalized or Centralized alternative in order to vary the number of sites analyzed for waste management facilities and the sites at which the facilities could be located. This variation among alternatives bounds potential impacts and allows the decision maker maximum flexibility to compare impacts of potential waste management configurations when considering alternatives.

1.2 The Legacy of Nuclear Weapons Production

Over the past 50 years, DOE and its predecessor agencies have been responsible for atomic energy and nuclear weapons research and production in the United States. In 1946, the AEA established the Atomic Energy Commission to administer and regulate the production and uses of atomic power. Soon after its inception, the Commission expanded its work from building a stockpile of nuclear weapons to peaceful uses of atomic energy and studies of the health and safety hazards of radioactive materials. In 1974, the Atomic Energy Commission was replaced by two new agencies: the NRC, which was charged with regulating the civilian uses of nuclear power, and the Energy Research and Development Administration, whose duties included the production of the nation's nuclear weapons and control of the nuclear weapons complex—a vast network of research, development, and manufacturing facilities, as well as testing sites. In 1977, the duties of the Energy Research and Development Administration were transferred to the newly created DOE.

At its peak, the nuclear weapons complex consisted of 16 major facilities, including large sites in Nevada, Idaho, Washington, and South Carolina. National laboratories in New Mexico and California designed weapons that were produced from components fabricated in plants located in Colorado, Florida, Missouri, Ohio, Tennessee, and Washington. Like most industrial and manufacturing operations, the production of nuclear weapons generated waste, pollution, and contamination. However, many of the problems posed by DOE's nuclear operations are unlike those associated with any other industry. Among these problems are unique radiation hazards; contaminated structures, such as nuclear reactors; and chemical plants that processed nuclear materials. By far, the largest contributor to the contamination problem which exists at these facilities resulted from producing the nuclear materials required for the weapons. This activity generated large quantities of wastes in plants designed and constructed in the 1940s and 1950s.

Nuclear weapons have played an important role in national security, and the nation continues to maintain an arsenal of nuclear weapons and some production capability. With the end of the Cold War and the

nuclear arms race, national priorities have shifted, and waste management and environmental restoration have become central to DOE's mission.

Thus, DOE is faced with an environmental legacy of the Cold War and must provide for the proper management of its wastes and for the environmental restoration of contaminated facilities and sites.[2] DOE faces the challenge of treating, storing, and disposing of its waste inventories, both hazardous (treatment only) and radioactive, that have resulted from its past nuclear energy and weapons research and production, as well as waste that may be generated in the future.

The DOE Office of the Assistant Secretary for Environmental Management was established in 1989, with responsibilities for a variety of waste management and environmental restoration activities. These activities include:

- Stabilizing and maintaining a large number of nuclear materials and facilities
- Managing a large amount and variety of wastes
- Providing safe storage for wastes while building and operating a variety of treatment facilities to prepare wastes for disposal
- Cleaning up areas of existing contamination and pollution—the environmental restoration portion of the environmental management program
- Managing a national program of technology development for environmental cleanup, waste management, and related activities
- Reducing waste through waste minimization and pollution prevention practices at each site
- Providing support for international nonproliferation policies

The DOE Environmental Management Program is continually working to accelerate cleanup schedules, increase efficiency, and foster cooperative relationships with its regulators and stakeholders. However, there is concern whether support can be sustained for a program that may last more than 70 years and cost more than $200 billion (DOE, 1996l). DOE has been challenged to accelerate reduction of this "cleanup mortgage" from the Cold War to reduce long-term economic and environmental liabilities. DOE is working on a 2006 Plan (previously the Ten Year Plan) to meet this challenge (see Section 1.8.2). The goal of this

[2] For an overview of DOE's approach to existing environmental, safety, and health issues throughout the nuclear weapons complex, see *Closing the Circle on the Splitting of the Atom—The Environmental Legacy of Nuclear Weapons Production in the United States and What the Department of Energy is Doing About It* (DOE, 1995a). In addition, DOE's *Baseline Environmental Management Report*, issued in June 1996, examines the costs associated with waste management and environmental restoration activities (DOE, 1996l).

plan is that, within the next decade, most DOE facilities will be able to treat and dispose of the backlog of wastes safely and to clean up their land and buildings. These steps would dramatically reduce long-term costs and open a large portion of the land and other resources controlled by DOE for other purposes.

1.3 How the WM PEIS Is Organized

Volume I of the WM PEIS contains the main text of the document. The remainder of this chapter describes the statutory and regulatory constraints under which DOE must operate in managing its waste, defines the five waste types that are analyzed in the WM PEIS, and discusses the waste management sites that are the focus of the document. The chapter also outlines the decisions that DOE expects to make on the basis of the WM PEIS and the relationship of the WM PEIS to other ongoing and planned DOE actions and programs.

Following this introductory chapter, the purpose and need for DOE action (Chapter 2), the alternatives (Chapter 3), the affected environment (Chapter 4), and the impact analysis methodologies (Chapter 5) are described and discussed. Chapters 6 through 10 analyze the health risk, environmental and socioeconomic impacts, and costs associated with each of the alternatives for each waste type. Chapter 11 examines the cumulative effects of the alternatives and other ongoing and proposed DOE activities. Chapter 12 discusses mitigation as well as unavoidable and irreversible impacts of the alternatives. A glossary is also provided in Volume I, Chapter 14.

Volume II consists of tables, organized by major site, that contain information regarding the potential impacts associated with all of the alternatives for the five waste types at those sites.

DOE has also prepared extensive appendices (Volumes III and IV) and technical reports that provide supporting data as well as in-depth descriptions and explanations of a variety of issues. A list of these background documents is provided in Chapter 15 at the end of this volume. Responses to public comments on the Draft WM PEIS are in Volume V.

1.4 Consultations, Laws, and Requirements

This section identifies and summarizes the major laws, regulations, executive orders, and DOE orders that may apply to the programmatic alternatives for WM.

Section 1.4.1 discusses the major Federal statutes that impose environmental requirements upon DOE. In addition, there may be other Federal, State, and local measures applicable to the Waste Management Program because Federal law delegates enforcement authority to State or local agencies. Section 1.4.2 addresses environmentally related presidential executive orders that clarify issues of national policy and set guidelines under which Federal agencies, including DOE, must act. DOE implements its responsibilities for protection of public health, safety, and the environment through a series of departmental orders that impose requirements on the operating contractors of DOE facilities. Section 1.4.3 discusses those DOE orders related to the environment, health, and safety. Hazardous and radioactive materials transportation regulations are summarized in Section 1.4.4. Section 1.4.5 describes DOE's relationship to agencies and organizations, including American Indian Tribes.

1.4.1 Federal Environmental Statutes and Regulations

Some laws require DOE to obtain permits from the EPA or States before constructing and operating waste management facilities that discharge effluent, emit air pollutants, or treat or dispose of toxic substances. Wherever new facilities are located as a result of the decisions made on the basis of the WM PEIS, existing permits will need to be amended or new permits obtained.

National Environmental Policy Act of 1969, as Amended (42 USC §§4321 *et seq.*). NEPA establishes a national policy that promotes awareness of the environmental consequences of the activity of humans on the environment and consideration of the environmental impacts during the planning and decision-making stages of a project. NEPA requires all agencies of the Federal government to prepare a detailed statement on the environmental effects of proposed major Federal actions that may significantly affect the quality of the human environment.

Key Statutes

National Environmental Policy Act (NEPA). *In addition to establishing a broad national policy on the environment, NEPA requires DOE and all other Federal agencies to consider the potential environmental consequences related to proposed actions and requires them to prepare detailed statements on the environmental effects of major actions, alternatives to the action, and measures to avoid or minimize adverse effects.*

Resource Conservation and Recovery Act (RCRA). *The statute outlines the framework for national programs to achieve environmentally sound management of HW from "cradle to grave" and requires agencies, including DOE, to follow specific regulations, procedures, and standards for managing HW, including the hazardous components of radioactive waste (mixed waste).*

Federal Facility Compliance Act (FFCAct). *An amendment to RCRA, the FFCAct waives immunity for DOE and other Federal agencies, allowing States and the EPA to impose fines and penalties for RCRA violations. DOE may avoid these penalties and fines if they are otherwise in compliance with approved site treatment plans.*

Atomic Energy Act (AEA). *The AEA provides the authority for DOE to develop procedures and standards to ensure proper and safe management of radioactive materials.*

Nuclear Waste Policy Act (NWPA). *This Act authorizes Federal agencies to develop a geologic repository for the permanent disposal of spent nuclear fuel and high-level radioactive waste. The Act specifies the process for selecting a repository site and constructing, operating, closing, and decommissioning the repository. The Act also establishes programmatic guidance for these activities.*

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). *Also known as "Superfund," CERCLA outlines the framework for liability, compensation, remediation, and emergency response for hazardous substances released into the environment and for the remediation of inactive hazardous waste disposal sites. CERCLA also provides the basis for requirements affecting DOE's environmental restoration activities.*

This PEIS has been prepared in accordance with the Council on Environmental Quality's (CEQ's) NEPA Implementing Regulations (40 CFR Parts 1500–1508) and DOE's Implementing Procedures (10 CFR Part 1021).

Both the CEQ and DOE regulations encourage the preparation of a programmatic EIS for broad Federal actions (40 CFR 1502.4 and 10 CFR 1021.330). An agency preparing an EIS may then "tier" from the broad, programmatic EIS to one of narrower scope in order to eliminate repetitive discussions and to focus on the issues ready for decision (40 CFR 1502.20; 10 CFR 1021.210). "Tiering" means that when a PEIS has been prepared, a subsequent NEPA document need only summarize or incorporate by reference the issues discussed in the broader statement.

This PEIS has been prepared to assist DOE in determining the sites at which it should either continue to operate certain waste management facilities or locate new facilities. Project-level environmental impact statements (EISs) or environmental assessments (EAs) will assess the environmental impacts of applying alternative treatment, storage, and disposal technologies, and the impacts of constructing and operating these facilities at specific locations on the selected sites.

The CEQ and DOE regulations require the preparation of EISs in two stages, draft and final (40 CFR 1502.9; 10 CFR 1021.313). The draft and final EISs must contain discussions of the purpose and need for the proposed action; reasonable alternatives to the proposed action, including the "No Action" Alternative; the environment potentially affected by the proposed action and the alternatives; and the environmental consequences of the proposed action and alternatives (40 CFR 1502.10 and 10 CFR 1021.310), including cumulative effects and recommended mitigation and monitoring. At the time the agency reaches a decision, but no sooner than 30 days after completing the Final EIS, the agency preparing the EIS must prepare one or more Records of Decision that state what the decisions are and identify the alternatives considered (40 CFR 1505.2; 10 CFR 1021.315).

Resource Conservation and Recovery Act (RCRA). DOE's management of wastes with hazardous constituents (LLMW, some TRUW, HLW, and HW) must comply with the RCRA (42 USC 6901 *et seq.*). RCRA was enacted to ensure the safe and environmentally responsible management of hazardous and nonhazardous solid waste, and to promote resource recovery techniques to minimize waste volumes. Regulations issued by EPA under RCRA set forth a comprehensive program to provide "cradle to grave" control of HW by requiring generators and transporters of HW, and owners and operators of treatment, storage, and disposal facilities, to meet specific standards and procedures. Hazardous waste is defined under RCRA as a waste that poses a potential hazard to human health or the environment when improperly treated, stored, or disposed.

The RCRA regulations include requirements for locating and operating treatment, storage, and disposal facilities. RCRA also required EPA to issue regulations containing land disposal restrictions (LDRs) that require the use of the best demonstrated available technologies to treat certain HW and waste containing certain hazardous constituents. The land disposal restrictions also prohibit storing waste that requires treatment except to facilitate proper recovery, treatment, or disposal. Much of DOE's waste that is currently stored, as well as some waste that it will generate in the future, is HW or contains hazardous constituents that are subject to RCRA and LDRs. DOE facilities that store, treat, or dispose of HW or waste containing

hazardous constituents subject to RCRA requirements must obtain a permit from EPA, or from States that are delegated permitting authority by EPA, before such facilities can be constructed and operated. States granted permitting authority by EPA can adopt more stringent requirements.

Federal Facility Compliance Act (FFCAct). The 1992 FFCAct (42 USC §6961) waives DOE's sovereign immunity by allowing States to impose fines and penalties for RCRA violations. The FFCAct also requires DOE to prepare plans for developing treatment capacity for its mixed wastes (waste containing both radioactive and hazardous components subject to RCRA requirements). The FFCAct subjects DOE to fines and penalties after October 6, 1995, for DOE's violations at sites of RCRA's LDRs for waste storage unless the site is otherwise in compliance with an approved STP and compliance order issued by the appropriate regulator. DOE expects and intends that the environmental impact analysis contained in the WM PEIS will also be used by regulators and other stakeholders involved in the FFCAct implementation process. Sixteen of the 17 major sites analyzed in the WM PEIS are required to prepare site treatment plans (STPs). Each of these sites has submitted an STP, and all but three (ANL-E, BNL, and LLNL) have been approved by the appropriate agency. Compliance orders or agreements have incorporated the approved STPs.

Atomic Energy Act (AEA). DOE must also comply with the AEA (42 USC §§2011 *et seq.*) in managing its radioactive wastes. One purpose of the Act is to ensure proper management—production, possession, and use—of radioactive materials. The AEA and other related legislation (including the Energy Reorganization Act of 1974 and the Department of Energy Organization Act of 1977) authorize DOE to develop generally applicable standards for protecting the environment from radioactive materials. Pursuant to the AEA, DOE has established a system of standards and requirements, issued as DOE Orders.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as Amended (42 USC §§9601 *et seq.*). The Comprehensive Environmental Response, Compensation, and Liability Act provides a statutory framework for the cleanup of waste sites containing hazardous substances and — as amended by the Superfund Amendments and Reauthorization Act (SARA) — provides an emergency response program in the event of a release (or threat of a release) of a hazardous substance to the environment. Using the Hazard Ranking System, Federal and private sites are ranked and may be included on the National Priorities List. The Act requires such Federal facilities having such sites to undertake investigations and remediation as necessary. The Act also includes requirements for reporting releases of certain hazardous substances in excess of specified amounts to State and Federal agencies.

Nuclear Waste Policy Act of 1982, as Amended (42 USC §§10101–10270). The Nuclear Waste Policy Act established a national policy for disposal of HLW and spent nuclear fuel (SNF) in a geologic repository and directed DOE to characterize the Yucca Mountain site in Nevada for suitability as the site of a first United States repository. The Act authorizes disposal of HLW and SNL in the first repository, subject to a limit on repository capacity and the payment of appropriate fees. The Act specifically instructs the NRC to limit the first geologic repository to 70,000 metric tons of heavy metal or a quantity of solidified HLW resulting from the reprocessing of such a quantity of SNF until such time as a second geologic repository is in operation. For planning purposes, DOE assumes that some or all of the Hanford Site HLW that satisfies the repository's acceptance criteria could be placed in the potential geologic repositories developed under the Nuclear Waste Policy Act.

Sufficient information is not available to determine at this time whether the Yucca Mountain site is a suitable candidate for geologic disposal of SNF and HLW. DOE, however, is in the early planning stages for a repository EIS. DOE has issued a formal notice of its intent to prepare this analysis. The repository EIS will evaluate potential environmental impacts using the best available information and data and would support the Secretary of Energy's final recommendation to the President, as required by the Nuclear Waste Policy Act. The repository EIS would examine the site-specific environmental impacts from construction, operation, and eventual closure of the repository, including potential post-closure radiological effects to the environment, and would assess the impacts of transporting SNF and HLW to a repository.

The Nuclear Waste Policy Act provides that any repository for the disposal of HLW resulting only from atomic energy defense activities shall be subject to licensing under Section 202 of the Energy Reorganization Act of 1974 (42 USC §5842). Further, Section 202 of the Energy Reorganization Act authorizes NRC licensing of facilities authorized for the express purpose of long-term storage of HLW that are not used for, or are not a part of, research and development activities. Therefore, to the extent that any decision requires defense HLW to be placed in a repository constructed under the Nuclear Waste Policy Act or a facility subject to licensing under Section 202 of the Energy Reorganization Act, such a repository or facility would be subject to licensing by the NRC. NRC's regulations governing the licensing of a geologic repository are contained in 10 CFR Part 60.

The Nuclear Waste Policy Act also directed EPA to promulgate waste standards pursuant to the Atomic Energy Act. EPA responded by issuing the "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Wastes" (final rule) in 40 CFR Part 191. The final

rule announcement (58 FR 66398) notes that 40 CFR 191 does not apply to the candidate Yucca Mountain site.

The final version of 40 CFR 191 consists of three subparts. Subpart A establishes dose limits for members of the public, including doses resulting from management and storage of SNF and HLW or TRUW at any disposal facility operated by DOE that is not regulated by NRC or by agreement States. Subpart B establishes containment requirements, assurance requirements, and individual protection requirements for disposal systems for SNF, HLW, and TRUW. This part specifies a 10,000-year design objective and discusses requirements for institutional controls; monitoring performance of a disposal system; designation by records, markers, and passive controls; and retrievability of wastes. Subpart C establishes groundwater protection standards for underground sources of drinking water for disposal systems for SNF, HLW, and TRUW.

The rule was developed primarily for mined geologic repositories. However, EPA states that "Although developed primarily through consideration of mined geologic repositories, 40 CFR 191... applies to disposal of the subject wastes by any method with three exceptions." The standards do not apply to ocean disposal or disposal that occurred before the 1985 standards. The groundwater protection requirements of Subpart C may not apply to disposal systems located within a quarter mile of an underground source of drinking water.

Occupational Safety and Health Act of 1970, as Amended (29 USC §§651 *et seq.*). The Occupational Safety and Health Act establishes standards to enhance safe and healthful working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration (OSHA), a U.S. Department of Labor agency. While OSHA and EPA both have a mandate to reduce exposures to toxic substances, OSHA's jurisdiction is limited to safety and health conditions that exist in the workplace environment. In general, under the Act, it is the duty of each employer to furnish all employees a place of employment free of recognized hazards likely to cause death or serious physical harm. Employees have a duty to comply with the occupational safety and health standards and all rules, regulations, and orders issued under the Act. OSHA regulations (published in Title 29 of the *Code of Federal Regulations*) establish specific standards telling employers what must be done to achieve a safe and healthful working environment. DOE emphasizes compliance with these regulations at its facilities and prescribes through DOE orders the standards that contractors shall meet, during their work at Government-owned, contractor-operated facilities (DOE Orders 5480.1B, 5483.1A).

DOE keeps and makes available the various records of illnesses, injuries, and work-related deaths as required by OSHA regulations.

Clean Air Act, as Amended (42 USC §§7401 *et seq.*). The Clean Air Act is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Section 118 of the Clean Air Act requires that each Federal agency, such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, comply with "all Federal, state, interstate, and local requirements" with regard to the control and abatement of air pollution.

The Act requires EPA to establish National Ambient Air Quality Standards as necessary to protect public health, with an adequate margin of safety, from any known or anticipated adverse effects of a regulated pollutant (42 USC §7409). The Act also requires establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 USC §7411) and requires specific emission increases to be evaluated so as to prevent a significant deterioration in air quality (42 USC §7470). Hazardous air pollutants, including radionuclides, are regulated separately (42 USC §7412). Air emissions are regulated by EPA in 40 CFR Parts 50 through 99. In particular, radionuclide emissions and hazardous air pollutants are regulated under the National Emission Standard for Hazardous Air Pollutants Program (see 40 CFR Part 61 and 40 CFR Part 63).

Safe Drinking Water Act, as Amended (42 USC §§300[F] *et seq.*). The primary objective of the Safe Drinking Water Act is to protect the quality of the public water supplies and all sources of drinking water. The implementing regulations, administered by EPA unless delegated to the States, establish standards applicable to public water systems. They promulgate maximum contaminant levels, including those for radioactivity, in public water systems. Safe Drinking Water Act requirements have been promulgated by EPA in 40 CFR Parts 100 through 149. Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program.

Clean Water Act, as Amended (33 USC §§1251 *et seq.*). The Clean Water Act, which amended the Federal Water Pollution Control Act, was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The Clean Water Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 313 of the Clean Water Act requires

all branches of the Federal government engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with Federal, State, interstate, and local requirements. In addition to setting water quality standards for the Nation's waterways, the Clean Water Act supplies guidelines and limitations for effluent discharges from point-source discharges and provides authority for EPA to implement the National Pollutant Discharge Elimination System permitting program. The National Pollutant Discharge Elimination System program is administered by the Water Management Division of EPA pursuant to regulations in 40 CFR Part 122 *et seq*.

Sections 401 and 405 of the Water Quality Act of 1987 added Section 402(p) to the Clean Water Act. Section 402(p) requires that the Environmental Protection Act establish regulations for issuing permits for stormwater discharges associated with industrial activity. Stormwater discharges associated with industrial activity are permitted through the National Pollutant Discharge Elimination System. General Permit requirements are published in 40 CFR Part 122.

Emergency Planning and Community Right-to-Know Act of 1986 (42 USC §§11001 *et seq*.) (also known as "SARA Title III"). Under Subtitle A of this Act, Federal facilities, including those owned by DOE, provide various information (such as inventories of specific chemicals used or stored and releases that occur from these sites) to the State Emergency Response Commission and to the Local Emergency Planning Committee to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. Implementation of the provisions of this Act began voluntarily in 1987, and inventory and annual emissions reporting began in 1988 based on 1987 activities and information. In 1993, Executive Order 12856 (see Section 1.4.2, below) directed compliance by Federal agencies. The requirements for this Act were promulgated by EPA in 40 CFR Parts 350–372.

Toxic Substances Control Act (15 USC §§2601 *et seq*.). The Toxic Substances Control Act provides EPA with the authority to require testing of chemical substances, both new and old, entering the environment, and regulates them where necessary. The law complements existing toxic substance laws such as §112 of the Clean Air Act and §307 of the Clean Water Act. The Act came about because there were no general Federal regulations for the potential environmental or health effects of the thousands of new chemicals developed each year before they were introduced into the public or commerce. The Act also regulates the treatment, storage, and disposal of certain toxic substances, specifically polychlorinated biphenyls, chlorofluorocarbons, asbestos, dioxins, certain metal-working fluids, and hexavalent chromium. The asbestos regulations under the Act were ultimately overturned. However, regulations pertaining to asbestos

removal, storage, and disposal are promulgated through the National Emission Standard for Hazardous Air Pollutants Program (40 CFR Part 61, Subpart M). For chlorofluorocarbons, Title VI of the Clean Air Act Amendments of 1990 requires a reduction of chlorofluorocarbons beginning in 1991 and prohibits production beginning in 2000.

Pollution Prevention Act of 1990 (42 USC §§13101 *et seq.*). The Pollution Prevention Act of 1990 establishes a national policy for waste management and pollution control that focuses first on source reduction, followed sequentially by environmentally safe recycling, treatment, and lastly, disposal. Disposal or releases to the environment should only occur as a last resort. In response, DOE has committed to participation in the Superfund Amendments and Reauthorization Act Section 313, U.S. Environmental Protection Agency 33/50 Pollution Prevention Program. The goal, for facilities already involved in Section 313 compliance, is to achieve a 33% reduction in the release of 17 priority chemicals by 1997, from a 1993 baseline. On August 3, 1993, Executive Order 12856 was issued, expanding the 33/50 program such that DOE must reduce its total releases of all toxic chemicals by 50% by December 31, 1999. The DOE is also requiring each DOE site to establish site-specific goals to reduce generation of all waste types.

National Historic Preservation Act, as Amended (16 USC §§470 *et seq.*). The National Historic Preservation Act provides that sites with significant national historic value be placed on the *National Register of Historic Places*. No permits or certifications are required under the Act. However, if a particular Federal activity may impact a historic property resource, consultation with the Advisory Council on Historic Preservation will generally result in a Memorandum of Agreement, including stipulations that must be followed to minimize adverse impacts. Coordination with the State Historic Preservation officer is also undertaken to ensure that potentially significant sites are properly identified and appropriate mitigative actions are implemented.

Archaeological Resource Protection Act, as Amended (16 USC §§470aa *et seq.*). This Act protects archaeological resources and sites on public and Indian lands. It requires a permit for any excavation or removal of archaeological resources from public or Indian lands. Excavations must be undertaken for the purpose of furthering archaeological knowledge in the public interest, and resources removed are to remain the property of the United States. Indian tribes must be notified of possible harm or destruction of sites having religious or cultural importance. For resources on Indian tribes, consent must be obtained from the Indian tribe owning the lands on which a resource is located before issuance of a permit, and the permit must contain terms or conditions requested by the tribe.

Native American Grave Protection and Repatriation Act of 1990 (25 USC §§3001 *et seq.*). This Act requires Federal agencies and federally funded museums to repatriate human remains, sacred objects, and objects of cultural patrimony to the culturally affiliated Native American groups. This includes repatriation of cultural items in collections, proof of consultation with appropriate Native American groups for excavation on Federal or tribal lands, and notification of the Federal land manager and appropriate Native American group when an inadvertent discovery is made on Federal or tribal land. Any cultural items excavated after November 16, 1990, pertaining to this Act are owned by lineal descendants.

American Indian Religious Freedom Act of 1978 (42 USC §1996). This Act reaffirms Native American religious freedom under the First Amendment and sets United States policy to protect and preserve the inherent and constitutional right of American Indians to believe, express, and exercise their traditional religions. This Act requires that Federal actions avoid interfering with access to sacred locations and traditional resources that are integral to the practice of religions.

Religious Freedom Restoration Act of 1993 (42 USC §§2000bb *et seq.*). This Act prohibits the Government, including Federal departments, from substantially burdening the exercise of religion unless the Government demonstrates a compelling governmental interest and the action furthers that interest and is the least restrictive means of furthering that interest.

Endangered Species Act, as Amended (16 USC §§1531 *et seq.*). The Endangered Species Act is intended to prevent the further decline of endangered and threatened species and to restore these species and their habitats. The Act is jointly administered by the U.S. Departments of Commerce and the Interior. Section 7 of the Act requires consultation with the U.S. Fish and Wildlife Service to determine whether endangered and threatened species or their critical habitats are known to be in the vicinity of the proposed action.

Migratory Bird Treaty Act, as Amended (16 USC §§703 *et seq.*). The Migratory Bird Treaty Act is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the harvest of migratory birds by specifying mode of harvest, hunting seasons, and bag limits. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill . . . any migratory bird." Although no permit for this project is required under the Act, DOE is required to consult with the U.S. Fish and Wildlife Service regarding impacts to migratory birds and to evaluate ways to avoid or minimize these effects in accordance with the U.S. Fish and Wildlife Service Mitigation Policy.

Bald and Golden Eagle Protection Act, as Amended (16 USC §§668–668d). The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere in the United States (Section 668, 688c). A permit must be obtained from the U.S. Department of the Interior to relocate a nest that interferes with resource development or recovery operations.

Wild and Scenic Rivers Act, as Amended (16 USC §§1271 *et seq.* 71:8301 *et seq.*). The Wild and Scenic Rivers Act protects certain selected rivers of the Nation, which possess outstanding scenic, recreational, geological, fish and wildlife, historical, cultural, or other similar values. These rivers are to be preserved in a free-flowing condition to protect water quality and other vital national conservation purposes. The purpose of the Act is to institute a national wild and scenic rivers system, to designate the initial rivers that are a part of that system, and to develop standards for the addition of new rivers in the future.

Noise Control Act of 1972, as Amended (42 USC §§4901 *et seq.*). Section 4 of the Noise Control Act of 1972, as amended, directs all Federal agencies to carry out "to the fullest extent within their authority" programs within their jurisdictions in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare.

In addition to these laws, the Nuclear Waste Policy Act (42 USC §§10101–10270) authorizes the development of a geologic repository for the permanent disposal of spent nuclear fuel and HLW. The West Valley Demonstration Project Act was enacted in 1980 and authorizes DOE (1) to develop a solidification process that can be used to prepare HLW for disposal and (2) to conduct a nuclear waste management project on the site of the Western New York Nuclear Service Center near West Valley, New York.

1.4.2 Executive Orders

Executive Order 12088, Federal Compliance With Pollution Control Standards (10/13/78). As amended by Executive Order 12580 (January 23, 1987), Federal Compliance with Pollution Control Standards, Executive Order 12088 directs Federal agencies, including DOE, to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Clean Air Act, the Noise Control Act, the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act (15 USC §§2601 *et seq.*), and the Resource Conservation and Recovery Act.

Executive Order 11593, National Historic Preservation (5/13/71). Executive Order 11593 directs Federal agencies, including DOE, to locate, inventory, and nominate properties under their jurisdiction or control to the *National Register of Historic Places* if those properties qualify. This process requires DOE to provide the Advisory Council on Historic Preservation the opportunity to comment on the possible impacts of the proposed activity on any potential eligible or listed resources.

Executive Order 11514, Protection and Enhancement of Environmental Quality. Executive Order 11514 directs Federal agencies to continually monitor and control their activities to protect and enhance the quality of the environment and to develop procedures to ensure that fullest practicable provision of timely public information and understanding of the Federal plans and programs with environmental impact to obtain the views of interested parties. The DOE has issued regulations (10 CFR Part 1021) and DOE Order 451.1 for compliance with this executive order.

Executive Order 11988, Floodplain Management. Executive Order 11988 directs Federal agencies to establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for any action undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable.

Executive Order 11990, Protection of Wetlands. Executive Order 11990 directs governmental agencies to avoid, to the extent practicable, any short- and long-term adverse impacts on wetlands wherever there is a practicable alternative.

Executive Order 12580, Superfund Implementation. Executive Order 12580 delegates to the heads of executive departments and agencies the responsibility for undertaking remedial actions for releases or threatened releases that are not on the National Priority List and removal actions at any facility under the jurisdiction or control of executive departments and agencies.

Executive Order 12856, Right to Know Laws and Pollution Prevention Requirements. This order directs all Federal agencies to reduce and report toxic chemicals entering any waste stream; improve emergency planning, response, and accident notification; and encourage clean technologies and testing of innovative prevention technologies. The Executive Order also provides that Federal agencies are persons for purposes of the Emergency Planning and Community Right-to-Know Act (SARA Title III), which obliges agencies to meet the requirements of the Act.

Executive Order 12898, Environmental Justice. This order directs Federal agencies to promote environmental justice by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. The order creates an Interagency Working Group on Environmental Justice and directs each Federal agency to develop strategies within prescribed time limits to identify and address environmental justice concerns. The order further directs each Federal agency to collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative or judicial action and to make such information publicly available.

Executive Order 12114, Environmental Effects Abroad of Major Federal Actions. This order declares that Federal agencies are required to prepare environmental analyses for "major Federal actions significantly affecting the environment of the global commons outside the jurisdiction of any nation (e.g., the ocean or Antarctica)." According to the Executive Order, major Federal actions significantly affecting the environment of foreign countries may also require environmental analyses under certain circumstances. The procedural requirements imposed by the Executive Order are analogous to those under the National Environmental Policy Act.

Executive Order 13007, Sacred Sites. Executive Order 13007 directs Executive agencies, to the extent permitted by law and not inconsistent with agency missions, to avoid adversely affecting sacred sites and to provide access to Native American religious practitioners for religious practices.

1.4.3 Department of Energy Regulations and Orders

Through the authority of the Atomic Energy Act, DOE is responsible for establishing a comprehensive health, safety, and environmental program for its facilities. The regulatory mechanisms through which DOE manages its facilities are the promulgation of regulations and the issuance of DOE orders.

The DOE regulations are generally found in Title 10 of the Code of Federal Regulations. These regulations address such areas as energy conservation, administrative requirements and procedures, nuclear safety, and

classified information. For purposes of this PEIS, relevant regulations include 10 CFR Part 820, Procedures for DOE Nuclear Activities; 10 CFR Part 830.120, Quality Assurance; 10 CFR Part 834, Radiation Protection of the Public and the Environment (proposed); 10 CFR Part 835, Occupational Radiation Protection; 10 CFR Part 1021, Compliance with the National Environmental Policy Act; and 10 CFR Part 1022, Compliance with Floodplains/Wetlands Environmental Review Requirements.

DOE orders generally set forth policy and the programs and internal procedures for implementing those policies. The following sections provide a brief discussion of selected orders.

DOE Order 151.1, Comprehensive Emergency Management System (9/25/95). This order describes the roles and responsibilities for the DOE Emergency Management System. One purpose of the order is to ensure that the DOE Emergency Management System is ready to respond promptly, efficiently, and effectively to any emergency involving DOE facilities, activities, or operations. The order requires emergency planning for DOE sites/facilities, including DOE transportation activities, in order to ensure personnel and resources are prepared to respond effectively to emergencies.

DOE Order 451.1, National Environmental Policy Act Compliance Program (9/11/95). This order sets forth DOE internal requirements and responsibilities for implementing the NEPA and associated regulations, including preparation of environmental impact assessments. It also directs Agency personnel to "incorporate NEPA values . . . to the extent practicable, in DOE documents prepared under [CERCLA]."

DOE Order 5820.2A, Radioactive Waste Management (9/26/88). DOE Order 5820.2A establishes policies and guidelines for management of radioactive waste and contaminated facilities. The generation, treatment, storage, transportation, and/or disposal of such wastes is to be accomplished in a manner that complies with all applicable Federal, state, and local environmental, safety, and health laws and regulations, as well as DOE requirements. The order contains materials pertaining to management of high-level waste, transuranic waste, low-level waste, and other types of radioactive waste, plus guidelines on decommissioning of radioactively contaminated facilities. DOE is currently in the process of updating this order.

10 CFR Part 835, Occupational Radiation Protection. This rule establishes radiation protection standards, limits, and program requirements for occupational exposure at DOE facilities and operations. Each activity must have a Radiation Protection Program. The order sets the goal of minimizing workplace

exposure and establishes maximum allowable exposures on the basis of national and international recommended standards. The rule also establishes policies on worker training, workplace monitoring and dosimetry, entry control, and other aspects of workplace radiation safety.

DOE Order 5400.5, Radiation Protection of the Public and the Environment (2/8/90). The purposes of DOE's program on radiation protection of the public and the environment are to: (1) establish dose limits for exposure of members of the public to radiation and implementation of the Department's "as low as reasonably achievable" (ALARA) policy; (2) manage radioactive materials in liquid waste discharges, in soil columns, and in selected solid waste containing radioactive materials, including a groundwater protection program for each DOE site; (3) establish requirements for decontamination, survey, and release of buildings, land, equipment, and personal property containing residual radioactive material and for the management, storage, and disposal of wastes generated by these activities; and (4) establish an "Environmental Radiation Protection Program and plan (including an effluent monitoring and environmental surveillance program) to set forth the programs, plans, and other processes to protect the public from exposures to radiation. DOE is in the process of codifying this policy; Proposed Rule 10 CFR 834 was issued for comment on March 25, 1993.

1.4.4 Hazardous and Radioactive Materials Transportation Regulations

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, NRC, EPA regulations, and the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171–178, 49 CFR Parts 383–397, 10 CFR Part 71, and 40 CFR Part 262 and 265, respectively.

U.S. Department of Transportation regulations contain requirements for identifying a material as hazardous or radioactive. These regulations interface with those of the NRC or EPA for identifying material, but the U.S. Department of Transportation hazardous material regulations govern the hazard communication (such as marking, hazard labeling, vehicle placarding, and emergency response telephone number) and shipping requirements (such as required entries on shipping papers or EPA waste manifests).

NRC regulations applicable to radioactive materials transportation are found in 10 CFR Part 71, which includes detailed packaging design requirements and package certification testing requirements. Complete

documentation of design and safety analysis and results of the required testing are submitted to the NRC to certify the package for use. This certification testing involves the following components: heat, physical drop onto an unyielding surface, water submersion, puncture by dropping package onto a rigid spike, and gas tightness. Some of the required tests simulate maximum reasonably foreseeable accident conditions.

EPA regulations pertaining to hazardous waste transportation are found in 40 CFR Part 262. These regulations deal with the use of the EPA waste manifest, which is the shipping paper for transporting RCRA hazardous waste.

1.4.5 Consultations With Other Agencies, Organizations, and American Indian Tribes

Section 102(2)(c)(v) of NEPA and 40 CFR 1503.1 require that Federal agencies (defined to include American Indian tribes) with jurisdiction or special expertise regarding any environmental impacts be consulted and involved in the National Environmental Policy process. 10 CFR 1502.25 requires consultation with agencies that have the authority to issue applicable permits, licenses, and other regulatory approvals, as well as those responsible for protecting significant resources (for example, endangered species, critical habitats, or cultural resources).

In addition to these provisions, DOE's NEPA regulation 10 CFR 1021.341(b) requires consultation with other agencies when necessary or appropriate. The PEIS Implementation Plan (DOE, 1994b) described the scoping process of the WM PEIS and the extent of EPA involvement in that process. Chapter 5 of the plan summarizes the roles and responsibilities of EPA and DOE with regard to technical coordination on issues of mutual concern. EPA participated by reviewing the Preliminary Draft and Final WM PEIS before they were issued to the public, helping DOE to define issues and concerns to address in the PEIS, and providing information in areas in which EPA has regulatory authority or technical expertise. EPA also participated in meetings involving review of the human health risk methodology. Moreover, during the course of developing the draft and final WM PEIS, DOE invited comment from and held discussions with certain groups with special interests, such as the Environmental Management Advisory Board (EMAB), the Site Specific Advisory Board (SSAB) representatives, and others.

As stated in a Presidential Memorandum (April 29, 1994), "The United States government has a unique legal relationship with Native American tribal governments as set forth in the constitution of the United

States, treaties, statutes, and court decisions." This memorandum directs each executive department to operate within a government-to-government relationship with Federally recognized tribal governments, consult with tribal governments, and assess the impact of Federal government plans, projects, programs, and activities on tribal trust resources. The importance of these relationships and consultations is echoed in the DOE American Indian policy, as implemented by DOE Order 1230.2, which emphasizes the importance of establishing a proactive approach to solicit input from tribal governments on Departmental policies and issues. It also encourages tribal governments and their members to participate fully in national and regional dialogues concerning Departmental programs. Consultation with Federally recognized tribes is also an integral part of compliance with a number of cultural resource statutes and their implementing regulations discussed in Section 1.4.1. DOE has initiated consultation with some of the tribal governments that have trust, treaty, and traditional lands near DOE facilities. In recent years, DOE has worked to build government-to-government relationships with tribes near Departmental sites.

DOE has received comments regarding tribal values and the requirement for government-to-government consultations, which have been considered in this Final WM PEIS. Many issues between DOE and the tribes are dealt with at the site level, such as local cultural resources, and ongoing and planned DOE activities. To facilitate discussion between DOE and the tribes, each local DOE office has a point of contact for tribal issues, including cultural resource and historic preservation issues.

The WM PEIS analysis focuses mainly on alternatives addressing national-level strategic issues. Follow-on project and site-specific NEPA reviews will be conducted that will more fully explore specific concerns related to the respective sites. During these reviews, local DOE offices will work with other agency and tribal representatives as well as members of the interested public to identify the locations of any necessary facilities and related activities such as transportation. It is during this next level of planning and project-level implementation that specific values and environmental impact analyses will be considered.

1.5 Waste Types

DOE is responsible for managing large inventories of LLMW, LLW, TRUW, HLW, and HW. DOE manages each of these waste types separately because they have different components, have different levels of radioactivity, and must meet different regulatory requirements. The definitions of these waste types have different bases: some are defined by source, some by physical or chemical characteristics, and some by

exception. Moreover, a given radionuclide can appear in more than one waste type but usually in different concentration.

LLMW and LLW are categorized either as alpha or nonalpha waste, depending on whether the waste contains concentrations of alpha particles at or above 10 nanocuries per gram. All TRUW is alpha waste. There are typically two categories of LLMW, LLW, and TRUW—"contact-handled" (CH) and "remote-handled" (RH). The categories differ because of the concentration of radioactive materials. Remote-handled waste typically requires additional shielding and containment to protect workers and the public.

Types of Radioactivity

The four principal types of radiation are: alpha particles, beta particles, gamma rays, and neutrons. ***Alpha radiation*** *can be stopped by a sheet of paper and will not penetrate skin, but it is harmful if ingested or inhaled.* ***Beta radiation*** *can pass through an inch of water or skin, but not through a thin sheet of aluminum, plywood, or steel.* ***Gamma rays*** *and* ***neutrons*** *are the most penetrating radiation and can pass through many materials, including the human body. Dense materials like lead are effective for stopping gamma rays, whereas hydrogenous materials like water are effective in slowing down and stopping neutrons.*

The following sections define and discuss each of the waste types considered in this PEIS. The environmental impacts associated with managing those wastes types under the four broad categories of alternatives are contained in the waste-type Chapters 6 through 10. Privatized management is also considered in this PEIS. Privatization means that the private sector would own (or control) the means for treatment, storage, or disposal of nuclear waste. Privatization is detailed in Section 1.7.4.

1.5.1 Low-Level Mixed Waste

LLMW contains both hazardous and low-level radioactive components. The hazardous component in LLMW is subject to RCRA, whereas the radioactive components are subject to the AEA (42 USC 2011 *et seq.*). LLMW is characterized as either CH or RH and as alpha or nonalpha. LLMW results from a variety of activities, including the processing of nuclear materials used in nuclear weapons production, and energy research and development activities. The WM PEIS evaluates approximately 82,000 cubic meters of LLMW currently stored and an estimated 137,000 cubic meters

Metric Units

Volumes in this document are given in the metric unit of cubic meters. One cubic meter is equal to approximately 35 cubic feet, or 264 gallons.

expected to be generated over the next 20 years (excluding LLMW that could be generated as a result of environmental restoration activities) for a total of approximately 219,000 cubic meters. Presently, commercial and DOE facilities are insufficient to treat DOE's inventory of LLMW. However, it is possible that some portion of the inventory could be treated at commercial facilities and that the capacity of such facilities could increase rapidly if specific DOE sites were to decide to use commercial facilities. This PEIS addresses the treatment and disposal of LLMW; storage of LLMW is not addressed because RCRA prohibits storage of untreated waste except to facilitate proper recovery, treatment, or disposal. Table 1.5–1 summarizes the range of decisions that DOE could make with respect to LLMW.

Contact- and Remote-Handled Wastes

*Radioactive waste is classified as "contact-handled" or "remote-handled." **Contact-handled** wastes are those wastes whose external surface dose rate does not exceed 200 millirem per hour.*

***Remote-handled** wastes are those wastes whose external surface dose rate exceeds 200 millirem per hour.*

LLMW, LLW, and TRUW are categorized as either contact-handled or remote-handled.

1.5.2 Low-Level Waste

LLW includes all radioactive waste that is not classified as HLW, spent nuclear fuel (fuel discharged from nuclear reactors), TRUW, uranium and thorium mill tailings, or waste from processed ore. LLW does not contain hazardous constituents regulated under RCRA. Most LLW consists of relatively large amounts of waste materials contaminated with small amounts of radionuclides, such as contaminated equipment (e.g., gloveboxes, ventilation ducts, shielding, and laboratory equipment), protective clothing, paper, rags, packing material, and solidified sludges. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranics is less than 100 nanocuries per gram of waste. Low-level waste is subject to the provisions of the Atomic Energy Act and is categorized as CH or RH and as alpha or nonalpha on the basis of the types and levels of radioactivity present. However, most LLW contains short-lived radionuclides and generally can be handled without additional shielding or remote handling equipment. DOE has an inventory of approximately 67,500 cubic meters of LLW in storage, and approximately 1,440,000 cubic meters are expected to be generated during the next 20 years (excluding LLW that may be generated as a result of environmental restoration activities), for a total of 1,500,000 cubic meters. This PEIS addresses the treatment and disposal of LLW. Table 1.5–1 summarizes the decisions that DOE must make with respect to LLW.

Table 1.5-1. Decisions DOE Will Make Based on Evaluations in the WM PEIS

Decisions	Type of Waste and Whether DOE Will Decide on Basis of WM PEIS (Yes or No)				
	Low-Level Mixed Waste	Low-Level Waste	Transuranic Waste	High-Level Waste	Hazardous Waste
Where to treat?	YES LLMW could be treated at 1 to 37 DOE sites.	YES LLW volume reduction and treatment could be conducted at 1 to 11 DOE sites. Minimum treatment could occur at all sites.	YES TRUW could be treated at 3 to 16 DOE sites.	NO HLW will be treated at 4 DOE sites where it was generated.	YES HW could be treated at DOE sites, or DOE could rely on commercial treatment.
Where to store?	NO LLMW will be stored at sites where generated until treatment and disposal.	NO LLW will be stored at sites where generated until treatment and disposal.	YES TRUW could be stored at 3 to 16 sites, pending final disposition.	YES HLW canisters containing treated HLW could be placed into storage at 1 to 4 DOE sites.	NO HW sent to commercial facilities will be stored for less than 90 days unless there is a permitted storage facility.
Where to dispose of?	YES LLMW could be disposed of at 1 to 16 DOE sites.	YES LLW could be disposed of at 1 to 16 DOE sites.	NO Separate evaluation of Waste Isolation Pilot Plant (WIPP) Disposal Phase is being prepared.	NO Separate evaluations to be prepared pursuant to the Nuclear Waste Policy Act as amended.	NO Commercial HW disposal facilities will continue to be used.

1.5.3 TRANSURANIC WASTE

TRUW is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years and an atomic number greater than 92, except for (a) high-level radioactive waste, (b) waste that the Secretary has determined, with the concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations, or (c) waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.[3] TRUW is produced during reactor fuel assembly, nuclear weapons production, research and development, and spent nuclear fuel reprocessing.

TRUW, some of which also contains hazardous constituents, has radioactive components such as plutonium, with lesser amounts of neptunium, americium, curium, and californium. TRUW components have half-lives greater than 20 years. These radionuclides generally decay by emitting alpha particles. Like LLMW and LLW, TRUW also contains radionuclides that emit gamma rays, requiring TRUW to be managed as either CH or RH. Approximately 60% is mixed waste, containing both radioactive components and hazardous components regulated under RCRA.

[3] LLW and LLMW may also contain these transuranic isotopes, but with concentrations less than 100 nanocuries per gram of waste.

DOE has approximately 68,000 cubic meters of TRUW retrievably stored since 1970, and about 64,000 cubic meters expected to be generated over the next 20 years (excluding TRUW that could be generated as a result of environmental restoration activities), for a total of about 132,000 cubic meters. The waste volumes do not include TRUW generated before 1970. Pre-1970 TRUW is known as "buried TRUW." This waste is considered environmental restoration waste.

DOE is currently proposing to dispose of retrievably stored and newly generated TRUW in a geologic repository called the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. The environmental impacts of developing WIPP were assessed in previous environmental impact statements (DOE, 1980; DOE, 1990). DOE is examining whether to dispose of TRUW at WIPP in a second supplemental EIS (SEIS-II; DOE, 1996n). Therefore, this PEIS evaluates alternative configurations for the treatment and storage of TRUW. Table 1.5-1 summarizes the decisions that DOE must make with respect to TRUW.

Quantities of Waste*

Low-Level Mixed Waste. *The WM PEIS addresses approximately 82,000 cubic meters of LLMW currently stored and an estimated 137,000 cubic meters expected to be generated over the next 20 years.*

Low-Level Waste. *Approximately 67,500 cubic meters of LLW are stored, and an estimated 1,440,000 cubic meters are expected to be generated over the next 20 years.*

Transuranic Waste. *Approximately 68,000 cubic meters are retrievably stored, and an estimated 64,000 cubic meters are expected to be generated over the next 20 years.*

High-Level Waste. *Approximately 378,000 cubic meters of HLW are stored, and limited additional quantities will be generated. Approximately 21,600 HLW canisters are expected to be produced as a result of treating HLW.*

Hazardous Waste. *Approximately 69,000 cubic meters of nonwastewater HW are expected to be generated in the next 20 years.*

* *Volumes do not include environmental restoration wastes.*

1.5.4 HIGH-LEVEL WASTE

HLW is the highly radioactive waste resulting from reprocessing spent nuclear fuel and irradiated targets from reactors and is liquid before it is treated and solidified. Some of its constituents will remain radioactive for thousands of years. HLW is also a mixed waste because it contains hazardous constituents that are regulated under RCRA. DOE has about 378,000 cubic meters of HLW stored in large tanks at far sites.

DOE is proceeding with plans to treat HLW by processing it into a solid form (e.g., borosilicate glass) that would not be readily dispersible into air or leachable into ground or surface water. This treatment process is called vitrification. The environmental impacts of vitrifying HLW have been analyzed in previous DOE environmental impact statements (DOE, 1982a,b; 1987; 1994a; 1995e). Vitrification will result in the generation of approximately 21,600 canisters from the current inventory of HLW. Canisters are assumed to vary in volume between 0.85 cubic meters and 1.26 cubic meters. DOE plans to dispose of the HLW canisters in a geologic repository. This PEIS addresses only the storage of vitrified HLW prior to its ultimate disposal in a geologic repository. Table 1.5–1 summarizes the decisions that DOE must make with respect to HLW.

Spent Nuclear Fuel

"Spent nuclear fuel" is fuel that has been withdrawn from nuclear reactors following irradiation, the constituent elements of which have not been separated. A "target" is material that is placed in a nuclear reactor to be bombarded with neutrons to produce new, manmade radioactive materials, such as plutonium and tritium. Uranium/neptunium target material is managed as spent nuclear fuel.

Initially, DOE intended to evaluate the management of spent nuclear fuel in this PEIS. However, DOE analyzed its management in a separate PEIS—"Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement" published in April 1995. The impacts of managing spent nuclear fuel presented in that PEIS are included in the cumulative impacts of the WM PEIS.

1.5.5 Hazardous Waste

HW is defined as a solid waste that because of its quantity, concentration, or physical, chemical, or infectious characteristics may significantly contribute to an increase in mortality, or may pose a potential hazard to human health or the environment when improperly treated, stored, or disposed. RCRA defines a "solid" waste to include solid, liquid, semisolid, or contained gaseous material (42 USC 6901 *et seq.*). By definition, HW contains no radioactive components. For purposes of this PEIS, HW includes State-designated HW and TSCA wastes in addition to RCRA wastes.

The quantities and types of HW generated as a result of DOE activities vary considerably and include acids, metals, industrial solvents, paints, oils, rags contaminated with hazardous cleaning compounds, and other

hazardous materials that are byproducts of routine maintenance and operations. Almost 99% of DOE's HW is wastewater and is treated at DOE sites. Treatment residues and the remaining 1%, predominantly solvents and cleaning agents, are treated at commercial facilities. The WM PEIS evaluates the treatment of nonwastewater HW. Over the next 20 years, approximately 69,000 cubic meters of nonwastewater HW are expected to be generated. Treated HW will continue to be disposed of at commercial facilities. Table 1.5–1 summarizes the decisions that DOE must make with respect to HW.

1.5.6 Waste Types Not Considered

Nonhazardous and nonradioactive sanitary waste, nonhazardous solid waste, hazardous and low-level process wastewater, and commercial "Greater-Than-Class-C" (GTCC) LLW are not considered in the WM PEIS. Additionally, some wastes within the radioactive waste type categories, such as LLW, TRUW, and HLW, have characteristics that require special considerations and different management than most of the other waste within that category. These wastes are "special case wastes" and are managed on a case-by-case basis; they not specifically evaluated in the WM PEIS, although the waste volumes reported in the PEIS largely account for them.

Nonhazardous and nonradioactive sanitary and industrial waste requires limited handling and can be treated or disposed in properly designed facilities or used in energy production. DOE currently manages sanitary and industrial waste on a site-by-site basis. Some DOE sites dispose of this waste in onsite landfills that have permits issued by appropriate State agencies, while other sites use commercial landfills. The types and quantities of sanitary and industrial waste vary considerably from site to site. Sanitary and industrial waste was not included in the scope of wastes to be addressed in the WM PEIS because of the site-specific nature of these wastes and because DOE is not proposing a program for managing it. Sanitary and industrial wastes may be appropriate for consideration in sitewide and project-level NEPA reviews.

Wastewater is treated at the site where it is generated because it is not practical to ship relatively large volumes of wastewater between sites for treatment. Because impacts from hazardous wastewater are independent of programmatic decisions to be made in the WM PEIS and are generally minor, they are not analyzed. For the same reasons, the impacts of managing wastewater contaminated with LLW are not analyzed. Secondary sludges resulting from LLW wastewater treatment are, however, captured in the WM PEIS analysis.

Some wastes at some sites are managed on a case-by-case basis independent of the program applicable to that class of waste. Although not a formal waste category, these wastes are frequently designated "special case wastes" by the generating site.[4] Primarily, these are waste streams within existing waste types that have limited or no disposal alternatives at this time, such as LLW that, because of its high radioactivity levels, does not meet site-specific acceptance criteria, or TRUW that may not meet disposal criteria at WIPP. Classified waste, which requires protection against unauthorized information or material disclosure for reasons of national security, is special case waste when there is no management plan for it. Although it may be categorized as LLW or TRUW, such waste would be managed separately. DOE did not undertake a detailed waste-stream and site-specific analysis in the WM PEIS to develop programmatic alternatives for each of these exceptions. As detailed analyses are conducted, management plans for each waste stream will be established. For example, a more detailed analysis could determine that some LLW currently managed as a special case meets the acceptance criteria for disposal; or, some TRUW could be determined acceptable for disposal at WIPP. These waste streams would no longer be considered special case, and the fact that the waste was once classified as special case waste would no longer be relevant. Such determinations would not be expected to affect the overall conclusions reached in the WM PEIS for a waste type, which are based upon evaluation of the majority of that waste. Additionally, a determination would be made regarding the need for supplemental NEPA reviews on an individual special case waste stream basis.

The PEIS, in general, does not address the management of wastes produced from commercial applications of radiation and atomic energy. For example, the Low-Level Radioactive Waste Policy Amendments Act of 1985 (42 USC 2021 *et seq.*) makes the States responsible for the disposal of commercially generated low-level radioactive waste, and consequently disposal of such LLW is not addressed. However, under this Act (42 USC 2021), DOE is responsible for commercially generated GTCC LLW. Commercial GTCC LLW includes activated metals, process wastes, other contaminated solids generated from the operation of commercial nuclear power plants, and radioactive materials that are used in minerals exploration and as part of medical treatments.

Some waste managed as a special case and GTCC LLW must be isolated from human exposure for periods in excess of hundreds or thousands of years. These wastes are not currently authorized for disposal in a geologic repository under the Nuclear Waste Policy Act (42 USC 10101–10270). On March 13, 1995, DOE published a notice in the *Federal Register* inviting interested parties to provide input into the development

[4] Such wastes account for less than 4% of LLW, LLMW, and TRUW inventories.

of proposed strategies for such wastes. Two workshops were held in April 1995 to discuss preliminary strategies. The Department is currently developing strategies for these wastes.

Not all radioactive materials that are contained in waste are discrete waste types. Special nuclear material, for example, is defined by the Atomic Energy Act to be plutonium, uranium enriched in isotope uranium-235 or -233, and any other material that the U.S. Nuclear Regulatory Commission determines to be special nuclear material pursuant to Section 51 of the Atomic Energy Act of 1954. Special nuclear material is not inherently a waste, and although small quantities of SNM may be present in LLW, LLMW, TRUW, and HLW, SNM of sufficient purity can be used for production of energy or for national defense.

1.6 Waste Management Sites

There are 54 sites for which DOE has some waste management responsibility and that are within the scope of this PEIS. Figure 1.6–1 is a map showing the location of these 54 sites. Table 1.6–1 lists the 54 sites and indicates the type of waste that has been generated, is expected to be generated, or is stored at each site.

54 Waste Management Sites

40	*DOE sites*
11	*Joint DOE/Navy Nuclear Propulsion Program sites*
2	*Formerly Utilized Sites Remedial Action Program sites*
1	*Waste Isolation Pilot Plant*

Of the 54 sites, 40 are DOE sites. DOE is also responsible for 11 sites participating in the joint DOE/Navy Nuclear Propulsion Program, two sites managed under the Formerly Utilized Sites Remedial Action Program, and the WIPP in New Mexico, which may be used in the future for TRUW disposal. Two sites, the Charleston Naval Shipyard and Mare Island Naval Shipyard, which may generate small quantities of LLW in addition to LLMW, have been closed and their properties released for unrestricted use subsequent to their inclusion in the WM PEIS as waste management sites.

To evaluate where to manage each of the five waste types, several of the sites and their wastes have been grouped together, as indicated in Table 1.6–1. These groupings are generally based on geographic proximity (for example, Argonne National Laboratory-West [ANL-W] is located within the site boundary

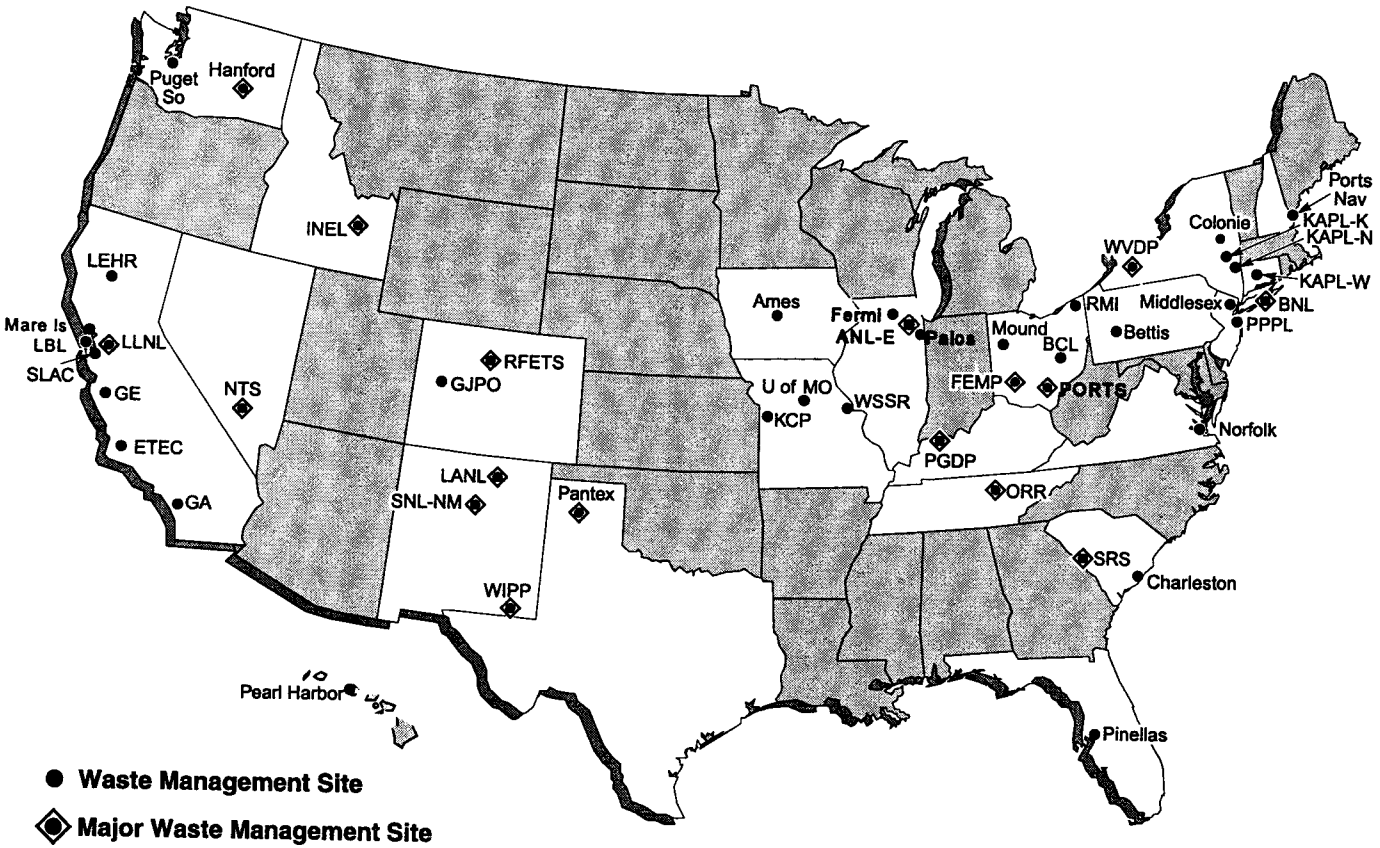

Figure 1.6–1. Waste Management Sites.

Table 1.6–1. Waste Management Sites

Sites	State	Symbol	Major Site[a]	Waste Type Managed				
				LLMW	LLW	TRUW	HLW	HW[b]
1 Ames Laboratory	IA	Ames		✓	✓			
2 Argonne National Laboratory-East	IL	ANL-E	✓	✓	✓	✓		✓
3 Battelle Columbus Laboratories	OH	BCL		✓				
4 Bettis Atomic Power Laboratory	PA	Bettis		✓	✓			
5 Brookhaven National Laboratory	NY	BNL	✓c	✓	✓			
6 Charleston Naval Shipyard	SC	Charleston		✓	g			
7 Colonie	NY	Colonie		d				
8 Energy Technology Engineering Center	CA	ETEC		✓		✓		
9 Fermi National Accelerator Laboratory	IL	Fermi			✓			✓
10 Fernald Environmental Management Project	OH	FEMP	✓	✓	✓			
11 General Atomics	CA	GA		✓				
12 General Electric Vallecitos Nuclear Center	CA	GE		d	d			
13 Grand Junction Projects Office	CO	GJPO		✓				
14 Hanford Site	WA	Hanford	✓	✓	✓	✓	✓	✓
Idaho National Engineering Laboratory	ID	INEL	✓	✓	✓	✓	✓	✓
15 Idaho National Engineering Laboratory	ID	INEL		e	e	e	e	e
16 Argonne National Laboratory-West	ID	ANL-W		e	e	e		
17 Naval Reactor Facility	ID	NRF			e			
18 Kansas City Plant	MO	KCP		✓	✓			✓
Knolls Atomic Power Laboratory	NY	KAPL		✓	✓			
19 Knolls Atomic Power Laboratory (Kesselring)	NY	KAPL-K		e	e			
20 Knolls Atomic Power Laboratory (Niskayuna)	NY	KAPL-N		e	e			
21 Knolls Atomic Power Laboratory (Windsor)	CT	KAPL-W		e	e			
22 Laboratory for Energy-Related Health Research	CA	LEHR		✓				
23 Lawrence Berkeley Laboratory	CA	LBL		✓	✓	✓		
Lawrence Livermore National Laboratory	CA	LLNL	✓	✓	✓	✓		✓
24 Lawrence Livermore National Laboratory	CA	LLNL		e	e	e		c
25 Sandia National Laboratories (California)	CA	SNL-CA		e	e			
26 Los Alamos National Laboratory	NM	LANL	✓	✓	✓	✓		✓
27 Mare Island Naval Shipyard	CA	Mare Is		✓	g			
28 Middlesex Sampling Plant	NJ	Middlesex		d				
29 Mound Plant	OH	Mound		✓	✓	✓		
30 Nevada Test Site	NV	NTS	✓	✓	✓	✓		
31 Norfolk Naval Shipyard	VA	Norfolk		✓	g			

Table 1.6–1. Waste Management Sites—Continued

Sites	State	Symbol	Major Site[a]	Waste Type Managed				
				LLMW	LLW	TRUW	HLW	HW[b]
Oak Ridge Reservation	TN	ORR	✓	✓	✓	✓		✓
32 K-25 Site	TN	K-25		e	e			e
33 Oak Ridge Institute for Science and Education	TN	ORISE			e			
34 Oak Ridge National Laboratory	TN	ORNL		e	e	e		e
35 Y-12 Plant	TN	Y-12		e	e			e
36 Paducah Gaseous Diffusion Plant	KY	PGDP	✓	✓	✓	✓		
37 Palos Forest (Site A/Plot M)	IL	Palos		d	d			
38 Pantex Plant	TX	Pantex	✓c	✓	✓			✓
39 Pearl Harbor Naval Shipyard	HI	Pearl H		✓	g			
40 Pinellas Plant	FL	Pinellas		✓	✓			
41 Portsmouth Gaseous Diffusion Plant	OH	PORTS	✓	✓	✓			
42 Portsmouth Naval Shipyard	ME	Ports Nav		✓	g			
43 Princeton Plasma Physics Laboratory	NJ	PPPL		✓	✓			
44 Puget Sound Naval Shipyard	WA	Puget So		✓	g			
45 RMI Titanium Company	OH	RMI		✓	✓			
46 Rocky Flats Environmental Technology Site	CO	RFETS	✓	✓	✓	✓		
Sandia National Laboratories	NM	SNL-NM	✓c	✓	✓	✓		✓
47 Sandia National Laboratories (New Mex)	NM	SNL-NM		e	e	e		e
48 Inhalation Toxicology Research Institute	NM	ITRI		e	e			
49 Savannah River Site	SC	SRS	✓	✓	✓	✓	✓	✓
50 Stanford Linear Accelerator Center	CA	SLAC			✓			
51 University of Missouri	MO	UofMO		✓		✓		
52 Waste Isolation Pilot Plant	NM	WIPP	✓			f		
53 Weldon Spring Site Remedial Action Project	MO	WSSR		d	d			
54 West Valley Demonstration Project	NY	WVDP	✓c	✓	✓	✓	✓	
Total sites			17	37	27	16	4	11

Notes: ✓ = the facility is included in the indicated group. A site is listed under a waste type if it currently manages or is expected to manage that type of waste in the future. Joint DOE/Navy Nuclear Propulsion Program sites are: Bettis, Charleston, KAPL-K, KAPL-N, KAPL-W, Mare Is, Norfolk, NRF, Pearl H, Ports Nav, and Puget So. Former FUSRAP (Formerly Utilized Sites Remedial Action Program) sites are Colonie and Middlesex.

[a] "Major" sites are those that are the focus of the WM PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite; (2) they are candidates to host disposal facilities; (3) they manage HLW; or (4) they were included to be consistent with the Federal Facility Compliance Act process.

[b] Sites analyzed in the WM PEIS are those 11 sites that generated more than 90% of DOE's HW for the year 1992. Other DOE sites also manage HW but were not evaluated. Naval Nuclear Propulsion Program sites were not considered in the WM PEIS analysis for HW.

[c] Although this site is designated as a major site, none of the alternatives would result in wastes from other sites being shipped to this site for treatment or disposal.

[d] The site is included in the table because it is listed in data sources for LLMW; however, no programmatic waste management decision would be applicable to the site. Since it is managed as an environmental restoration site, it is excluded from the WM PEIS alternatives and waste totals.

[e] For evaluating candidate sites for waste management facilities in this WM PEIS: ANL-W and NRF have been combined with INEL; ITRI has been combined with SNL-NM; K-25, ORISE, ORNL, and Y-12 have been combined under ORR; SNL-CA has been combined with LLNL; and KAPL-K, KAPL-N, and KAPL-W have been combined under KAPL.

[f] TRUW is not currently stored or managed at WIPP. WIPP is a planned disposal site and is included because of its potential to treat TRUW.

[g] Naval shipyards may generate small quantities of LLW; however, they are not reported in the WM PEIS.

of the Idaho National Engineering Laboratory [INEL]; and the location of Sandia National Laboratories-California [SNL-CA], is adjacent to Lawrence Livermore National Laboratory).[5]

Table 1.6-2 lists estimated quantities of LLMW, LLW, TRUW, HLW, and HW to be managed at each of the 54 sites. The values are based on current inventories and projections of generation for a 20-year period. DOE made broad, programmatic assumptions applicable to all sites for the purpose of analysis. These include the assumption that LLMW, LLW, HW, and TRUW would be stored where generated until treatment and disposal. This assumption was not meant to restrict site-specific operations and exceptions where they would not prejudice analysis or decisions.

1.6.1 Major Sites Analyzed in the WM PEIS

Of the 54 sites, 17 were designated major sites in the PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite, (2) they are candidates to host disposal facilities, (3) they manage HLW, or (4) they were included to be consistent with the Federal Facility Compliance Act process. The major sites store or will generate the bulk of the five waste types, have the capability for disposal of LLW or LLMW, or have existing or planned major waste management facilities. The designation of these sites as major has no relevance outside the context of this PEIS analysis. Major and candidate sites were not "preselected" for waste management activities; rather, analysis of potential activities at these sites provides a range of reasonably foreseeable environmental impacts that could arise from treating, storing, and disposing of DOE's wastes. As a result, broad comparisons of potential impacts across sites can be made.

1.6.2 Waste Volumes at Major Sites

Table 1.6–3 lists the major sites and indicates the current and projected volume of each waste type at each of the sites (WIPP does not currently contain any waste and thus is not included). In addition, the table shows the overall percentage of each type of waste at each site.

[5] The one exception to these groupings based on geographic proximity is the Knolls Atomic Power Laboratories—two in New York and one in Connecticut. Data for these sites were compiled on a collective rather than an individual site basis; therefore, these sites are considered as one site.

Table 1.6-2. Quantities of Waste Material at Waste Management Sites (values in cubic meters except HLW in numbers of canisters)

Site	Major Sites[c]	LLMW[a]		LLW[a]		TRUW[a,b]		HLW		HW
		Inventory	20-Year Projected Generation	Inventory	20-Year Projected Generation	Inventory	20-Year Projected Generation	Inventory (Liquid)	Total Canisters Projection	20-Year Projected Generation
Ames		0.3	0.1	26	80					d
ANL-E	✓	34[i]	130[i]	880	5,800	15	1,300			4,100
BCL		0	0.1							d
Bettis		32	16	0	12,000					d
BNL	✓e	85	110	560[i]	5,080[i]					d
Charleston		0.3	3							d
ETEC		3.7	13			0.02	0			d
Fermi				45	1,400					980
FEMP	✓	2,600	48	g	g					d
GA		43	0.4							d
GJPO		0.6	0.9							d
Hanford	✓	3,100	33,000	0	89,000	12,200	39,400	210,000	15,000	6,100
INEL	✓	25,000	9,600	3,500	101,000	38,000	780	10,000	1,700	3,900
INEL[h]		(25,000)	(9,600)	(3,500)	(101,000)	(38,000)	(780)	(10,000)	(1,700)	(3,900)
ANL-W[h]		(16)	(24)							d
NRF[h]				h						
KCP		0.8	0	4	20					12,000
KAPL		3.1	220	0	19,000					d
KAPL-K		(2)	(100)							d
KAPL-N		(1)	(80)							d
KAPL-W			(40)							d
LEHR		4	3							d
LBL		6	270	53	1,200	0.8	0.2			d
LLNL	✓	230	4,100	780	2,800	200	1,500			13,000
LLNL[h]		(220)	(4,000)	(730)	(2,500)	(200)	(1,500)			(13,000)
SNL-CA[h]		(11)	(100)	(50)	(280)					d
LANL	✓	670	2,100	0	150,000	8,300	2,500			4,900
Mare Is		10	42							d
Mound		76	4	1,600	37,000	270	1,200			d
NTS	✓	300[i]	2,700[i]	270[i]	1,400[i]	610	0			d
Norfolk		0	6							d
ORR	✓	26,000	33,000	20,000	250,000	2,000	720			5,500
K-25[h]		(11,000)	(16,000)	(15,000)	(162,000)					d
ORISE[h]					(500)					d
ORNL[h]		(3,000)	(9,500)	(3,500)	(26,000)	(2,000)	(720)			d
Y-12[h]		(12,000)	(7,300)	(1,000)	(62,000)					d

Table 1.6–2. Quantities of Waste Material at Waste Management Sites (values in cubic meters except HLW in numbers of canisters)—Continued

Site	Major Sites[c]	LLMW[a]		LLW[a]		TRUW[a,b]		HLW		HW
		Inventory	20-Year Projected Generation	Inventory	20-Year Projected Generation	Inventory	20-Year Projected Generation	Inventory (Liquid)	Total Canisters Projection	20-Year Projected Generation
Pantex	✓[e]	130	560	210[i]	2,440[i]					10,000
Pearl H		2	4							d
PGDP	✓	600	0	5,300	45,000	14	0			d
Pinellas		0.02	0.02	16	1,300					d
PORTS	✓	7,500	25,000	1,500	96,000					d
Ports Nav		0.4	0.8							d
PPPL		0	0.01	2	220					d
Puget So		62	170							d
RMI		22	7	2,500	48,000					d
RFETS	✓	8,300	13,000	2,400	39,000	1,500	4,800			d
SNL-NM	✓[e]	69	33	680	1,800	1	0			3,100
SNL-NM[h]		(66)		(410)	(820)					(3,100)
ITRI[h]		(4)	(33)	(270)	(1,000)					d
SRS	✓	6,600	13,000	11,000	500,000	5,100	12,000	150,000	4,600	5,500
SLAC				2,200	280					d
UofMO		0.4	1.7			0	2			d
WIPP	✓					f	f			d
WVDP	✓[e]	23	32	14,000[i]	28,000[i]	0.5	0	2,200	340	d
TOTAL	**17**	**82,000**	**137,000**	**67,500**	**1,440,000**	**67,700**	**64,000**	**378,000**	**21,600**	**69,000**

[a] Updated inventories and waste generation rates are summarized in Appendix I - "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW." Most site data reported here have been rounded to two significant figures; therefore, totals may not precisely represent the waste totals as reflected in the following chapters and Appendix I.

[b] TRUW volumes presented in this table include both contact-handled and remote-handled TRUW. In addition, Table 8.1-1 shows in parentheses waste volumes for TRUW inventory as reported in BIR-2 (DOE, 1995i) and the WIPP SEIS-II (DOE, 1996n). Comparison of these values is not necessarily appropriate because the BIR-2 values reflect some level of treatment.

[c] Major sites are those that are the focus of the WM PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite, (2) they are candidates to host disposal facilities, (3) they manage HLW, or (4) they were included to be consistent with the Federal Facility Compliance Act process.

[d] These sites manage HW but were not evaluated. Sites analyzed in the WM PEIS are those sites that generated in total more than 90% of DOE's HW for the year 1992. Volumes include only nonwastewater RCRA-defined waste, which is the focus of this PEIS analysis.

[e] While designated as a major site, none of the alternatives would result in wastes being received from other sites for treatment or disposal.

[f] No waste reported in data sources used in the WM PEIS.

[g] Wastes at these sites are managed as ER wastes.

[h] For evaluating candidate sites for waste management facilities in this WM PEIS, ANL-W and NRF have been combined with INEL; ITRI has been combined with SNL-NM; K-25, ORISE, ORNL, and Y-12 have been combined under ORR; SNL-CA has been combined with LLNL; and KAPL-K, KAPL-N, and KAPL-W have been combined under KAPL.

[i] For purposes of analysis, data for this site were taken from the IDB Report-1994 (DOE, 1995h). See Appendix I, Section I.3, for a comparison of waste volumes between the 1992 IDB and IDB Report-1994.

Table 1.6–3. Volumes and Percent of Waste Management Waste at Major Sites[a] (total inventory and projected waste loads in cubic meters, except HLW in number of canisters)

Waste Type		ANL-E	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Others
LLMW 99% at 16 sites	219,000	160	190	2,600	36,000	35,000	4,300	2,800	3,000	59,000	600	690	33,000	21,000	100	20,000	55	1,100
	100%	*	*	1%	16%	16%	2%	1%	1%	27%	*	*	15%	10%	*	9%	*	1%
LLW 91% at 15 sites	1,500,000	6,700	5,600		89,000	105,000	3,600	150,000	1,700	270,000	50,000	2,700	98,000	41,000	2,500	510,000	42,000	130,000
	100%	*	*		6%	7%	*	10%	*	18%	3%	*	7%	3%	*	34%	3%	9%
TRUW 99% at 12 sites	132,000	1,300			52,000	39,000	1,700	11,000	610	2,700	14			6,200	1	17,000	0.5	1,500
	100%	1%			38%	30%	1%	8%	0.5%	2%	*			5%	*	13%	*	1%
HLW 100% at 4 sites	21,600 canisters				15,000 canisters	1,700 canisters										4,600 canisters	340 canisters	
	100%				69%	8%										21%	2%	
HW[b] 81% at 9 sites	69,000	4,100			6,100	3,900	13,000	4,900		5,500		10,000			3,100	5,500		13,000
	100%	6%			9%	6%	19%	7%		8%		14%			4%	8%		19%

Notes: * indicates that waste percentage at this site is less than 0.5%. Blank cells indicate no volume for this waste type based on data sources analyzed in the WM PEIS.

[a] Waste volume projections contained in this and other WM PEIS tables may vary from the latest site estimates at the time of publication. Significant variances reported (e.g., ANL-E) have typically been in the conservative direction—the WM PEIS analyses were based on larger waste volumes than are currently projected. Updated inventories and waste generation volumes are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW." Table shows 16 of the 17 sites analyzed in detail by WM PEIS. WIPP, the 17th site, does not currently manage waste and is omitted. Site data have been rounded to two significant figures; therefore, totals may not sum to 100% and may not precisely represent the waste totals as reflected in the following chapters.

[b] HW volumes are shown for the 9 major sites managing nonwastewater regulated by RCRA. Other sites also manage HW but were not evaluated. HW volumes are calculated by adding onsite thermal treatment and fuel burning totals with offsite commercial treatment and multiplying the sum by 20 to obtain a 20-year projected inventory. For this PEIS, the conversion factor used is one metric ton of hazardous waste equals one cubic meter in volume.

Sources of data on inventory and projected waste volumes for each of the waste types are listed below and described in detail in the waste type chapters (Chapters 6–10) and Appendix I.

- LLMW—The *Mixed Waste Inventory Report* (DOE, 1994i) was used for all LLMW inventories and generation rates, except for Colonie, ETEC, and RFETS, whose generation rates and inventories come from late 1994 site estimates, and ANL-E and NTS, whose generation rates and inventories come from the updated *Mixed Waste Inventory Report* (DOE, 1995k).
- LLW—The *Integrated Data Base for 1992* (DOE, 1992b) was used for generation rates and inventories of stored waste except for BNL, NTS, ORR, Pantex, and WVDP, whose generation rates and inventories come from the updated *Integrated Data Base Report–1994* (DOE, 1995h). The Waste Management Information System (ORNL, 1992) was consulted for data not available in the Integrated Data Base.
- TRUW—The *Integrated Data Base for 1992* (DOE, 1992b) and the *Interim Mixed Waste Inventory Report* (DOE, 1993) were used for TRUW inventories and generation rates except for Hanford and SRS. SRS generation rates and inventories come from the updated *Mixed Waste Inventory Report* (DOE, 1995k), while Hanford's come from the *WIPP TRUW Baseline Inventory Report (BIR-2) for 1995* (DOE, 1995i).
- HLW—Site-specific plans and NEPA documents for Hanford, INEL, SRS, and WVDP were used for HLW volume and canister production rates.
- HW—The EPA Information System biennial and annual reports (EPA, 1991) were used for HW generation rates. Offsite shipments to commercial treatment were derived from DOE fiscal year 1992 HW shipping manifests.

Waste loads reported in Tables 1.6–2 and 1.6-3, as well as Chapters 6 through 10, represent a "snapshot in time"—accurate to the extent existing inventories and future operations were understood when the databases were developed. Accordingly, inventories and projections reported in Table 1.6–3 and Chapters 6 through 10 may not exactly match projections at the time of publication of the Final WM PEIS.

Factors responsible for the degree of uncertainty in estimating waste loads are discussed in Appendix I, which provides a more recent snapshot of DOE's waste inventory and projections. At selected sites, substantial differences are apparent, reflecting these uncertainties. As described in Appendix I, DOE determined that it was necessary to revise some of the waste load information and associated analyses presented in the WM PEIS on the basis of this more recent information. Additionally, as Appendix I shows,

consolidation of waste loads and operations across sites in Regionalized and Centralized Alternatives serves to dampen uncertainty associated with site-specific waste inventories and projections.

Considering these uncertainties, dampening effects, and the selected updates, the waste loads used for the WM PEIS analysis are sufficiently accurate for programmatic decision making.

17 Major Sites Analyzed

Argonne National Laboratory-East
Brookhaven National Laboratory
Fernald Environmental Management Project
Hanford Site
Idaho National Engineering Laboratory
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Nevada Test Site
Oak Ridge Reservation
Paducah Gaseous Diffusion Plant
Pantex Plant
Portsmouth Gaseous Diffusion Plant
Rocky Flats Environmental Technology Site
Sandia National Laboratories-New Mexico
Savannah River Site
Waste Isolation Pilot Plant
West Valley Demonstration Project

1.7 Scope of the Waste Management Programmatic Environmental Impact Statement

1.7.1 Defining the Scope of the WM PEIS

Initially, the scope of the WM PEIS included both the Department's waste management and environmental restoration programs (DOE, 1994b). Although these programs both address the radioactive and chemical contaminants that are the legacy of the Cold War, they do so in different contexts. Environmental restoration contains or removes contaminants in environmental media such as soil and groundwater; whereas waste management activities include treatment, storage or disposal of wastes that are not part of the environment, such as sludge and liquids stored in tanks. Environmental restoration seeks to clean up past releases of contaminants. Waste management seeks to prevent further releases in the future by treating and disposing of wastes safely. Despite these differences, there is significant overlap between the two programs. They both address many of the same types of contaminants, and to the extent that environmental restoration removes contaminants from the environment, it may create wastes that, in some instances, will be transferred to the waste management program. Because of this overlap, DOE initially attempted to integrate evaluations of alternatives for both programs in the WM PEIS.

As DOE proceeded with preparation of the WM PEIS, however, it concluded that it should not develop or evaluate programmatic alternatives for environmental restoration. The initial decisions DOE must make about environmental restoration are not programmatic or strategic, but specific to its individual sites. These

decisions concern the uses to which each site will be put in the future. For the most part, a decision on how one site can or will be used in the future does not depend on how other sites in the complex will be used, but depends instead on such things as the degree of contamination, the applicable cleanup standards, the views of local residents and regulators, DOE's need for the site in the future, and the alternative uses that are feasible for the site. It would not be sensible to evaluate programmatic alternatives for future uses within the DOE complex, because the process of developing alternative uses and selecting among them will, for the most part, proceed at each site as part of cleanups undertaken pursuant to CERCLA and RCRA. For this reason, DOE announced on January 24, 1995, in the *Federal Register* that the scope of the PEIS would be limited to programmatic alternatives concerning where DOE should manage its different types of wastes (DOE, 1995b). Appendix A of this PEIS contains a summary of the comments received in response to DOE's proposal to change the scope and DOE's responses to those comments.

In contrast, it is appropriate to evaluate programmatic alternatives for waste management. There are economies of scale as to environmental impacts and costs that vary according to the degree to which waste management is centralized or dispersed among the sites in the complex. For example, centralized alternatives tend to increase transportation impacts, concentrate potential impacts from effluent and emissions at a few sites, and reduce costs and impacts from construction. Decentralized Alternatives tend to reduce transportation impacts, disperse potential impacts from effluent and emissions among many sites (but may increase the total amount of these impacts for the entire complex), and increase costs and construction impacts. The WM PEIS allows DOE to evaluate these often countervailing economies of scale so that it can decide how much—if at all—it should centralize the management of each of its five types of wastes.

There was one aspect of environmental restoration, however, that appeared suitable for programmatic analysis at the time DOE redefined the scope of the WM PEIS. This analysis would focus on those wastes generated during environmental restoration that would be transferred to the waste management program. The two general approaches to controlling contaminants in environmental media include containment and removal. Removing contaminated media from the environment creates waste. Although DOE plans to manage the majority of these wastes at commercial facilities or at facilities dedicated to the environmental restoration program, it also plans to transfer some of the waste generated during environmental restoration to the waste management program. These wastes, referred to as "environmental restoration (ER) transferred wastes," would be treated, stored, and disposed of in facilities DOE would also use to manage its inventory wastes and wastes generated from ongoing operations, which are collectively referred to as "waste management (WM) wastes."

If DOE had sufficient information about the ER transferred wastes, it would evaluate their impacts in the same manner as the impacts of WM wastes are evaluated in the WM PEIS. Unfortunately, DOE still does not have enough information on the volume or contaminant composition of these wastes to perform a meaningful impact evaluation at this time. The overall volume of ER transferred wastes depends on the extent of environmental restoration at a site, which in turn depends on decisions regarding the future use of the site and the amount of cleanup necessary to permit that use. It also depends on how sites and regulators strike the balance between containment and removal strategies at a site. For example, the more extensive the use of removal actions, the larger the volume of waste generated during environmental restoration. The volume of ER transferred waste also depends on the availability of commercial or environmental restoration facilities. For example, a site with a large volume of ER waste may transfer relatively little of it to the waste management program if commercial or dedicated environmental restoration facilities are available to manage these wastes.

At present, very little information is available to DOE about factors that will determine the volumes of environmental restoration wastes overall and the portion of the wastes that DOE will transfer to the waste management program. DOE lacks this information primarily because the Department and its regulators do not yet know how much environmental restoration is needed at sites or how it will be accomplished. Without this information, it is difficult to predict when and where environmental restoration wastes will be generated during the coming decades. Based on the limited information it does have, DOE has made some preliminary estimates of the volumes of environmental restoration wastes it may generate and the amounts it may transfer to the waste management program. These estimates are discussed in Appendix B.

Additionally, very little information is available to DOE about the composition of environmental restoration wastes. This prevents the Department from evaluating the impacts of managing these wastes at this time. Environmental restoration can produce low-level wastes, low-level mixed wastes, and transuranic wastes. Although DOE has made preliminary estimates about how much of each of these wastes environmental restoration may generate at a particular site, it has almost no information on how chemical or radiological contaminants vary within each of these broad types of environmental restoration wastes. Without this basic information on the nature and composition of these wastes, DOE cannot determine the facilities needed to manage them or the impacts those facilities would have on the environment. Appendix B of the WM PEIS discusses recent estimates of the expected volumes of ER transferred waste and how these wastes may affect waste management facilities.

Faced with these uncertainties about ER transferred wastes, DOE chose to proceed to evaluate programmatic alternatives for managing the WM wastes rather than delay the WM PEIS until detailed information about ER transferred wastes became available. For the following reasons, DOE concluded it would be better to proceed with the WM PEIS despite the uncertainties surrounding environmental restoration transferred wastes.

First, information about ER transferred wastes, particularly about its radiological and chemical composition, may be unavailable until most of DOE's environmental restoration activities are underway. Waiting for this information could delay DOE's decisions on how to treat and dispose of its WM wastes for years or decades. Second, decisions DOE's sites and regulators make about environmental restoration and the use of commercial and dedicated facilities to manage the wastes that cleanup activities generate could greatly reduce the amounts of wastes transferred to the waste management program. This would result in DOE having to postpone improving the management of its existing wastes in order to evaluate a set of wastes that by then might have become insignificant at many sites. Third, the impacts of sending ER transferred wastes to the waste management program are expected to be no more than adding equivalent amounts of waste management wastes, and could be much less because wastes generated during environmental restoration tend to have lower concentrations of chemical and radiological contaminants than WM wastes of the same type. Finally, DOE will have the opportunity to evaluate the impacts of ER wastes on waste management facilities during sitewide or project-level NEPA reviews or during the CERCLA process, which requires an evaluation of alternatives similar to NEPA's.

On the basis of the WM PEIS, DOE will decide which sites will manage its existing wastes and those wastes that DOE will generate in its ongoing operations. Regardless of the amount of ER transferred wastes that DOE may generate in the future, DOE needs to select the sites at which it will manage the WM wastes and, to the extent necessary, begin planning and building additional facilities it needs for these wastes. These new facilities will require additional NEPA analyses before DOE can decide where they would be located at a site, what technologies they would use, how they would be operated, how their adverse impacts would be mitigated, and what would be reasonable alternatives to the proposed facility. If at the time DOE conducts these analyses it proposes to use the facility for both ER transferred wastes and WM wastes, the Department can develop reasonable alternatives that incorporate more recent information about the specific ER transferred wastes it proposes to send to that facility. On the other hand, if DOE decides not to send ER transferred wastes to a waste management facility (either because such a facility is not available or because there is still insufficient information about the wastes), DOE would have to evaluate at some time — under either NEPA or CERCLA — the reasonable alternatives for managing these wastes, which could include

building a new facility dedicated to handling these wastes, modifying an existing facility, or sending them to a commercial facility.

While DOE determined that environmental restoration decisions, including the level of site remediation should be made on a site-specific basis, some national perspective and public participation is needed. Public input can guide consistency in site-specific decisions, weigh equity trade-offs between sites, and ensure an adequate level of protection and financial controls.

DOE has begun a "National Dialogue" initiative to provide a means for comprehensive discussion with governmental officials, regulatory authorities, and other interested organizations and publics regarding the major materials, waste, and cleanup decisions DOE needs to make. This dialogue will include public participation and input on national environmental restoration issues.

1.7.2 Public Involvement Related to the Draft WM PEIS

Before release of the Draft WM PEIS, DOE expanded its outreach efforts to focus on public awareness of its revised scope. These efforts included briefings to groups such as the Environmental Management Advisory Board and the Site Specific Advisory Board chairpersons, participation in quarterly public meetings at several sites, wide distribution of a WM PEIS Update newsletter, and the release of a video describing the WM PEIS. On September 22, 1995, DOE published a *Federal Register* notice announcing the release of the Draft WM PEIS and invited the public to comment on the document during the 90-day public comment period (September 22 through December 21, 1995). Opportunities to comment were provided in a series of 13 video conference hearings held from October 17, 1995, through January 24, 1996. Several of these video conferences linked multiple DOE sites together with DOE Headquarters; altogether, 18 locations were involved in the hearings.

The video conference hearing format was used to provide a wider opportunity for Headquarters' participation, allow an interactive meetings approach, and reduce costs. The public hearings were advertised through local newspapers, morning and evening drive-time radio announcements, and other mechanisms such as direct mailings to interested members of the public, meeting announcements to active groups or advisory boards, and additional advertising as deemed necessary by the DOE site representatives. Public comments collected at the hearings were summarized in the *Draft WM PEIS Hearing Summary Report: A Compilation of Public Hearing Summaries* and placed in DOE public reading rooms in early

February 1996. Comments were also received from the public and other interested parties directly through the mail.

During the public comment period for the Draft WM PEIS, more than 1,200 individuals, states, tribal nations, agencies, and organizations provided DOE with comments. Comments were received from virtually all of the communities near DOE sites identified as "major" in the PEIS, and from many other interested publics. Many citizens and organizations posed questions, comments, or objections regarding proposed waste management activities at particular DOE sites. Some suggested other alternatives for waste management activities; others expressed their preferences for the alternatives described in the PEIS. A few commenters thought that DOE should prepare one comprehensive environmental impact statement on all of its activities; some expressed their support for DOE's current efforts.

One recurring and controversial issue raised during the public comment period was potential human health impacts of treatment, storage, and disposal of the five waste types. The concerns raised included the risk assessment methodologies (e.g., models and assumptions) used in the analysis, risks to densely populated areas or minority and low-income populations, risks associated with subsistence fishing in some communities, transportation risks, impacts on future generations, and additional exposure to populations affected by other DOE nuclear activities.

Commenters challenged DOE's designation of particular sites as "major" sites in the PEIS and requested that these sites be removed from consideration. Related to this issue were comments regarding the accuracy of current waste loads at particular sites.

DOE also received comments and questions on the relationship of the WM PEIS to other DOE programs or projects; the perceived inconsistency of the PEIS with other DOE documents; other waste types or radioactive materials not analyzed in the PEIS; waste management technologies, particularly for waste treatment; the decision criteria DOE will use in making its waste management decisions; the future availability of geologic repositories at Yucca Mountain, Nevada, and the Waste Isolation Pilot Plant in New Mexico; and DOE credibility. Many commenters questioned DOE's February 1995 decision to separate environmental restoration decisions from the scope of the PEIS.

Several commenters offered comments on policies or Federal programs not specifically related to this PEIS, including suggestions to eliminate the production of radioactive and hazardous waste by eliminating certain DOE defense- and energy-related programs.

All comments were carefully considered by DOE. DOE made substantial changes to the Draft WM PEIS as a result of the comments and prepared the Comment Response Document, Volume V of this Final PEIS, to respond specifically to the comments received. In general, public comments, coupled with consultations with commenting agencies and state and tribal governments, resulted in additional analyses, clarification or correction of facts, or expanded discussion in several technical areas. The Comment Response Document provides an explanation of why certain comments did not warrant further change to the PEIS.

In response to the comments received, DOE made the following major changes to the PEIS.

- DOE modified the Decentralized Alternative for HW to replace LANL with INEL as a candidate site for onsite treatment of hazardous waste. This change recognizes the HW treatment capacity that exists at INEL but does not currently exist at LANL. The HW Decentralized Alternative remains the same for purposes of this programmatic analysis (treatment of HW at three sites). Thus, replacement of LANL with INEL does not constitute a substantial change in the proposed action or alternative.
- With respect to information on waste loads, DOE prepared a new appendix, Appendix I, which presents updated waste volume inventories and projections for all waste types. Further, Appendix I provides site-specific comparisons with earlier inventories and projections upon which the analysis in the Draft WM PEIS was based to determine if any of the more recent data would substantially change any of the impacts described in the Draft WM PEIS. Subsequently, DOE performed new analyses using the more recent data at selected sites for LLMW, LLW, TRUW, and HLW. The results of these additional analyses are contained in the relevant chapters.
- DOE modified its analysis of environmental justice concerns to provide a more precise analysis of whether high and adverse human health impacts could disproportionately affect a minority or low-income population. The maps illustrating the proximity of these populations around the major DOE sites have been improved and moved from the former Appendix I (in the Draft WM PEIS) to Appendix C of the Final WM PEIS. DOE performed additional analyses of the potential for offsite general population risk as a result of the disposal of LLMW and LLW. With respect to transportation impacts, DOE clarified the comparison of radiological risks in truck and rail transportation and included the potential number of shipments that would enter and exit each site. DOE also reiterated that the intersite routes used in the analysis are representative of possible routes, not descriptive of actual routes to be used, as the WM PEIS Records of Decision will not select transportation routes.
- DOE revised Chapter 11, "Cumulative Impacts," to provide a more comprehensive evaluation of other DOE actions (e.g., tritium supply and recycling, weapons material stockpile stewardship and management, and storage and disposition of excess fissile materials) that may affect the sites. In this

chapter, DOE also included estimates of fatalities that result from implementation of the alternatives in the absence of mitigation measures and clarified the analytical assumption concerning commingling of groundwater contaminated by releases from different disposal units.

Other substantive changes to the Draft WM PEIS include: an enhanced description of the decisions to be made by DOE (Section 1.7.3, which also consolidates decision criteria information from former Section 1.8); a statement clarifying DOE's compliance with state and local laws and a narrative on relevant DOE orders (Section 1.4); a more comprehensive discussion of site treatment plans, pollution prevention, and other DOE actions and programs (Section 1.8.2); a discussion of privatization (Section 1.7.4); a discussion of safeguards and security (Section 4.3.12); an enhanced discussion of interpreting risk values (Section 5.4.1); and an explanation as to why the No Action Alternatives for some wastes have smaller potential impacts than other alternatives (Sections 6.3.1, 7.3.1, and 8.3.1). DOE has also made other suggested changes to improve readability, including a short Readers' Guide at the beginning of Volume I, commonplace examples to demonstrate waste volumes, and a table for converting waste volumes to both cubic meters and cubic yards. The Final WM PEIS includes an updated list of preparers in Chapter 13.

1.7.3 DOE Waste Management Decisions

In accordance with its NEPA regulations, DOE can prepare three tiers of NEPA reviews: programmatic, sitewide, and project-level. These tiers represent a hierarchy in which broad and general programs and policies can be addressed in an initial programmatic NEPA review. Subsequent NEPA reviews could then analyze narrower proposals related to the program or policy. First-tier programmatic reviews, such as the WM PEIS, provide environmental evaluations for consideration in making decisions on broad agency actions, such as the adoption of new strategies, programs and policies to guide future actions. Sitewide NEPA reviews provide the opportunity for considering changes in the overall operations of a DOE site, including mission changes, and provide a current environmental baseline at the site, both to support and simplify project-level NEPA reviews. Project-level NEPA reviews evaluate the impacts of a specific project at specific locations at a site and are intended in part to provide environmental information on the impact of siting, constructing, and operating a facility. Sitewide NEPA reviews, which evaluate projects that could be implemented in the near-term at a site, may also serve as project-level NEPA reviews if projects can be evaluated sufficiently in the sitewide review. Project-level or sitewide NEPA reviews are generally more focused than programmatic NEPA reviews with regard to detailed site parameters.

In addition, compliance agreements and permitting requirements may require more detailed assessments of technologies prior to their implementation at a site. Project-level and sitewide NEPA reviews that address specific impacts at a site may, therefore, also evaluate the impacts of alternative technologies based on site-specific performance standards that differ from the representative technologies considered in this PEIS. Sitewide and project-level NEPA reviews may also consider more detailed waste characteristics and volumes, including waste from environmental restoration activities. These NEPA reviews may also consider the role that pollution prevention will play in minimizing the wastes under consideration.

In addition to preparing sitewide or project-level NEPA reviews tiered from the WM PEIS, DOE may also rely upon reviews that have already been completed. Existing sitewide and project-level NEPA analyses will be reviewed to determine whether modifications are needed to implement the decisions based on evaluations in the WM PEIS.

With the end of the Cold War, DOE's mission has shifted from an emphasis on nuclear weapons production to cleanup of contamination and disposal of the war's legacy of radioactive and hazardous wastes. Before the Department expends resources to establish new treatment, storage, and disposal facilities at every site where these wastes exist, it is prudent to determine whether to consolidate such functions at fewer sites to reduce costs and potential environmental impacts.

DOE will use the analyses presented in the PEIS to decide on a programmatic or strategic approach to managing its waste. DOE intends to select a configuration of DOE sites for waste management activities on the basis of the WM PEIS and other factors. The level of analysis in the WM PEIS is appropriate for making broad programmatic decisions on what DOE sites should be used for waste management. At the programmatic level, however, it is not possible to take into account special requirements for particular waste streams, different technologies that are or may be available to manage particular wastes, or site-specific environmental considerations such as the presence of culturally important resources or endangered species at a specific location on a site. DOE will rely upon other NEPA reviews, primarily ones that evaluate particular locations on sites or projects (sitewide or project-level reviews), for these analyses. Thus, decisions regarding specific locations for waste management facilities at DOE sites or the waste management technologies to be used will be made on the basis of sitewide or project-level NEPA reviews.

The WM PEIS analyzes four broad categories of alternatives that represent the range of reasonable alternatives concerning where DOE can manage its wastes. Within these broad categories of alternatives (No Action or "status quo," Decentralized, Regionalized, and Centralized), DOE developed different

configurations or sets of DOE sites that could be used for waste management activities. The sites identified in each alternative configuration were selected for evaluation based on the volume of waste they currently had in inventory, the amount of waste they were expected to generate in the future, the waste's origin and characteristics, and the waste treatment facilities at each site. DOE then analyzed the potential environmental impacts associated with the waste management activities under each alternative configuration for each waste type, which allowed DOE to assess and compare the alternatives. The WM PEIS describes the results of those analyses for use by the public and DOE's decision makers.

Because the locations of potential facilities cannot be determined at this time, some impacts that are inherently location-specific could not be assessed in this programmatic analysis. For example, the effects of construction of a waste treatment facility on a particular aspect of the environment may be significant if the facility were built at a certain location, and may be easily mitigated or eliminated if the facility were elsewhere. Such effects may include impacts on geology and soils, noise and aesthetic impacts, impacts on species and habitats, and impacts to land use and cultural resources. Although a number of these site-specific impacts are discussed in this PEIS in Chapters 6 through 10, they can be analyzed thoroughly only in sitewide or project-level NEPA reviews. DOE anticipates that, in the majority of cases, any such impacts found to be significant can be mitigated or eliminated by alteration of a proposed facility's location or by other changes.

This PEIS is intended to provide environmental information to assist DOE in determining where it should modify existing waste management facilities or construct new facilities. The types of facilities evaluated in this PEIS are:

- Treatment and disposal facilities for LLMW
- Treatment and disposal facilities for LLW
- Treatment and storage facilities for TRUW
- Storage facilities for treated (vitrified) HLW canisters until a geologic repository is available
- Treatment facilities for nonwastewater HW

LLMW. The evaluation of alternatives for managing LLMW in this PEIS was coordinated with the development of STPs that were prepared pursuant to the FFCAct. Information on possible alternatives, preliminary risk analyses, and cost studies was shared with the States to provide information for use in developing STPs. Although the Draft PEIS analyzed potential environmental risks and costs associated with a range of management alternatives for LLMW in the context of NEPA, decisions on LLMW treatment are made by the States and EPA under the FFCAct. This Final WM PEIS is being released after EPA or

authorized State agencies issued orders implementing most of the STPs. DOE will issue Records of Decision on the treatment and disposal of LLMW, explaining what decisions were made by the States and EPA and what alternatives were considered.

LLW. There is no regulatory requirement or timetable for LLW decisions. However, managing LLW is closely tied to the management of LLMW. Accordingly, DOE expects to issue a Record of Decision with respect to LLW in conjunction with its Record of Decision on LLMW management. As a result of a recommendation by the Defense Nuclear Facilities Safety Board (DNFSB)—identified as recommendation DNFSB 94-2—DOE has undertaken a review of the LLW management program across the nuclear weapons complex. This includes review of the regulatory structure for the program as well as an assessment of current operating facilities. Activities conducted in this effort were coordinated with analyses in the WM PEIS.

TRUW. DOE will decide where to treat and store TRUW based on evaluations in the WM PEIS and the requirements of the FFCAct because much of DOE's TRUW is also mixed waste. DOE needs to decide where to treat TRUW if treatment is deemed necessary before disposal at WIPP or some other form of disposition. The final acceptance criteria for TRUW disposal at WIPP are expected to be determined in 1997; at that time, DOE will need to be able to define necessary treatment requirements and select sites for treatment facilities. DOE will also decide where to store treated TRUW on the basis of the PEIS, a decision it must make regardless of whether or when WIPP opens.

HLW. In 1996, DOE began treating HLW at SRS and WVDP. DOE has also entered into an agreement with the State of Washington and EPA to begin treatment of HLW at the Hanford Site in 2009. DOE agreed with the State of Idaho to begin treating the HLW stored in tanks at INEL in 2014. DOE needs to decide where to store treated HLW until it can be permanently disposed of in a geologic repository.

HW. DOE's program for treatment of HW is well established and has been operating for some time. There is existing capacity in the commercial market for HW treatment, storage, and disposal. Accordingly, DOE will decide whether to continue its reliance on commercial vendors or to treat HW at selected DOE sites.

Preferred Alternatives. DOE has identified its preferred alternative for each waste type in Section 3.7. These alternatives were selected on the basis of factors and criteria developed after considering public

comments and other available information. The factors and criteria DOE used to select preferred alternatives are described below, in alphabetical order:

Factor:	**Criteria:**
Consistency	Favors alternatives that are consistent with other complexwide studies using methodologies that allow valid comparisons across sites.
Cost	Favors alternatives that have the potential to minimize overall cost for implementation of selected waste management strategies.
Cumulative Impacts	Favors selection of alternatives and sites that minimize cumulative adverse environmental impacts resulting from other activities at the site.
DOE Mission	Favors alternatives that further the Department's mission to safely and efficiently treat, store, and ultimately dispose of wastes.
Economic Dislocation	Favors alternatives that tend to minimize economic dislocation such as job losses.
Environmental Impact	Favors selection of alternatives and sites that minimize adverse environmental impacts.
Equity	Favors alternatives that distribute waste management facilities in ways that are considered equitable.
Human Health Risk	Favors alternatives that reduce human health risk to both workers and the public. Human health risks depend not only upon the magnitude of releases of radionuclides and hazardous chemicals, but also upon parameters such as population surrounding the sites, the hydrogeology of disposal sites, and the number of vehicle accidents that are expected to occur during transportation of waste.
Implementation Flexibility	Favors alternatives that maximize DOE's ability to modify activities at selected sites as circumstances change, e.g., to potentially manage large volumes of ER wastes.
Mitigation	Favors alternatives that increase DOE's ability to mitigate adverse impacts and that reduce the cost of mitigation.

Regulatory Compliance	Favors alternatives that comply with regulatory requirements, DOE Orders, and commitments made under the FFCAct or in compliance agreements with States and other regulators.
Regulatory Risk	Considers the potential for changes in statutes and regulations when evaluating alternatives and siting options.
Site Mission	Favors alternatives that are consistent with site capabilities and feasible for each waste type, particularly capacities and availability of technologies for treatment, storage, and disposal.
Transportation	Favors alternatives that balance the amount of transportation needed to transport wastes to the sites considered in the alternatives with potential environmental and human health risks, vehicle accidents, public concerns, mission needs, and costs.

Programmatic Decisions. The preferred alternatives are not decisions. Rather, they are the Department's preliminary preferences, which are subject to further discussion and deliberation. No sooner than 30 days after the issuance of this WM PEIS, DOE will begin to make decisions regarding each waste type, using the factors and criteria described above and the evaluations in the WM PEIS. DOE will issue a Record of Decision that will explain the decisions DOE made, why it made these decisions, and what alternatives it considered.

Decisions on waste management sites will be based on the information and analyses in the WM PEIS and other considerations such as regulatory compliance, budget constraints, schedules, compliance with regulatory agreements, including public input on each of the preferred alternatives for each waste type, national priorities, and other DOE studies. For example, DOE will continue to work with the DOE Disposal Workgroup and with state representatives in the National Governors Association to evaluate and discuss the issues related to the potential disposal of residuals from treatment of LLMW at sites subject to the FFCAct. DOE will work with interested members of the public and the National Governors Association to explore principles that may help DOE in making decisions that reflect public concerns.

Site-Specific Decisions. The Records of Decision issued on the basis of the WM PEIS will identify sites at which waste management activities will occur. However, a decision on the specific technology and the particular location of a waste management facility at a site will be made on the basis of sitewide or project-level NEPA reviews "tiered" from this PEIS.

1.7.4 USE OF COMMERCIAL OR PRIVATIZED FACILITIES

> ***Helping the Private Sector***
>
> *In April 1995, States asked DOE to consider treating mixed waste generated by public and private entities for which no commercial treatment capacity is available. DOE and the National Governor's Association/Federal Facility Compliance Act Task Force are addressing this issue. States would first need to satisfy several specific DOE conditions before DOE would proceed with such a plan. This "privatization in reverse" would deal with a very small volume of waste (less than 200 cubic meters) and therefore would not affect programmatic alternatives evaluated in this PEIS.*

For purposes of the WM PEIS, a "commercial facility" is defined as one that is owned and operated by a private entity (or a State) and that treats, stores, or disposes of waste from a variety of sources for a fee. Commercial facilities are generally constructed in response to market forces. Commercial facilities are currently available for the treatment and disposal of LLMW, LLW, and HW. DOE expects that the capacity of commercial facilities to treat and dispose of LLMW and LLW will increase in the future in response to increasing demand from the private sector, DOE, and other government agencies. No commercial management of TRUW or HLW currently exists or is anticipated.

At present, DOE uses commercial facilities for the management of HW, LLW and LLMW. DOE's most extensive and prolonged use of commercial facilities is for treatment of HW. For a number of years, the Department has routinely sent nonwastewater HW to commercial facilities. The WM PEIS analyzes the alternative of using DOE facilities for treatment of this category of HW so that the Department can make an informed programmatic decision on whether to continue to use commercial facilities for this purpose. DOE's use of commercial facilities for management of LLW and LLMW is more limited at present, and much of the LLW and LLMW that DOE currently ships to commercial facilities for treatment or disposal consists of environmental restoration wastes rather than wastes from the Department's waste management program. As noted above in Section 1.7.1, environmental restoration wastes are outside the scope of the WM PEIS because DOE has concluded that it would be inappropriate to make programmatic decisions concerning their management.

Much of the LLMW that DOE sends to commercial facilities for treatment is subject to agreements and orders under the FFCAct. Under this Act, Federal and State authorities made decisions regarding treatment of LLMW on the basis of the site treatment plans prepared by the Department, and these plans contain detailed descriptions of the commercial treatments that DOE currently uses. DOE also uses a commercial

facility for disposal of LLMW after treatment. At present, DOE's use of commercial facilities for managing LLW is even more limited than its use of them for LLMW management.

In contrast to the term "commercial facility," the WM PEIS uses the term "privatized facility" to refer to a waste management facility owned by the Department on a DOE site that is operated, maintained, and eventually decontaminated and decommissioned by a private entity. The private entity operates the waste management facility for the exclusive use of DOE, and is reimbursed by the Department on a competitive, fixed-price basis. The term also refers to situations in which a private entity finances, constructs and operates a new waste management facility on a DOE site.[6] For example, the Department is privatizing treatment of some HLW at the Hanford Site; a private entity also operates a LLMW vitrification facility at SRS. There is the potential for DOE to use privatized facilities to manage all five types of waste in the future.

Many DOE sites are exploring opportunities to make greater use of commercial facilities for the treatment and disposal of LLMW and LLW. The WM PEIS does not analyze alternatives that involve extensive use of commercial facilities for managing these two waste types for several reasons.[7] First, DOE's current use of commercial facilities to manage these wastes is limited, and the potential for expanding the use of these facilities in the future is unclear at this time. In particular, DOE cannot predict where new commercial facilities would be located in relation to DOE's sites, what waste streams they would manage, or what their capacity might be. More importantly, DOE does not anticipate that it will make programmatic decisions regarding the use of commercial facilities to manage LLMW and LLW. Instead, each DOE site will decide the extent to which it will use commercial facilities based on the wastes it needs to manage, the capacities and capabilities of the commercial facilities available to the site, and the advantages these facilities offer in comparison to other alternatives, such as using facilities at DOE sites. Sites considering the use of commercial facilities for managing LLMW or LLW may need to include alternatives with such facilities

[6] Outside of the context of the WM PEIS, the term "privatization" is often used to refer to the use of all types of waste management facilities operated by the private sector, including "commercial facilities" as defined in the WM PEIS and facilities constructed and operated by the private sector for the exclusive use of DOE at locations other than DOE's sites.

[7] At this time, the commercial facilities DOE primarily uses for treatment of LLMW include DSSI and SEG in Tennessee and Envirocare in Utah. Envirocare is the only commercial disposal facility for LLMW presently in operation, and DOE sends LLMW to this facility for disposal as well as treatment. The commercial facilities to which DOE currently sends LLW for treatment include SEG and US Ecology in Tennessee and Permafix in Florida. The Department also sends some LLW to commercial facilities for disposal. The vast majority of this goes to Envirocare; a small amount is shipped to the Barnwell Disposal Site in South Carolina. DOE's current use of commercial facilities to manage LLMW and LLW is not explicitly analyzed in the WM PEIS because DOE's present use of these facilities is limited and much of that use is for wastes already analyzed in existing CERCLA or NEPA reviews or is for wastes subject to orders or consent agreements issued by State and Federal regulators under the FFCAct.

in sitewide, project-level, or other NEPA reviews before making a decision on whether to use commercial options. Sites may be able to incorporate aspects of the analyses in the WM PEIS in these reviews. For example, the WM PEIS analyzes the potential transportation impacts associated with shipments of LLMW and LLW; this analysis applies to representative routes and is based on the amounts of waste involved, the number and distance of shipments through representative communities, and the radiological or chemical profile of the waste. Accordingly, the transportation analyses in the WM PEIS may be applicable to some shipments between DOE sites and commercial facilities. Sites may be able to use other aspects of the WM PEIS in any additional NEPA reviews that evaluate the use of commercial facilities to manage LLMW or LLW.

With respect to privatized facilities, the analyses in the WM PEIS would be directly applicable to such facilities located on DOE sites because the impacts of using a privatized facility would be the same as using a DOE facility at that site. Therefore, the alternatives in the WM PEIS include the option of using privatized facilities at the DOE sites analyzed in the WM PEIS.

1.8 WM PEIS Relationship to Other Actions and Programs

1.8.1 Relationship to Other NEPA Reviews and Decisions

Several NEPA documents have been completed recently, are ongoing, or have been proposed that are related to this PEIS. Table 1.8-1 lists these documents, and the following sections briefly discuss the relationship of these documents to this PEIS. Where these other NEPA reviews have identified impacts that could add to the impacts identified in the WM PEIS, these impacts were included in the analysis of cumulative impacts in Chapter 11.

The priorities of DOE have shifted away from nuclear weapon production as discussed in Section 1.2, and the documents referenced in Table 1.8-1 reflect DOE's new and redirected missions. These documents describe selected proposed actions that are important to our nation's defense and energy needs. Consequently, an integrated waste management strategy will remain important to DOE.

Among the actions identified in the following sections, DOE is preparing project-level and site specific NEPA documents that consider waste management facilities in parallel with the preparation of this PEIS.

These parallel NEPA efforts will help to expedite compliance with site-specific agreements and orders issued pursuant to the FFCAct. Prior to reaching decisions on whether to construct waste management facilities evaluated in project-level and sitewide NEPA reviews, DOE will first determine, on a case-by-case basis, whether the implementation of waste management facilities would proceed in accordance with 40 CFR 1506.1(c), which states:

> While work on a required program environmental statement is in progress and that action is not covered by an existing program statement, agencies shall not undertake in the interim any major Federal action covered by the program which may significantly affect the quality of the human environment unless such action (1) is justified independently of the program; (2) is itself accompanied by an adequate environmental statement; and (3) will not prejudice the ultimate decision on the program. Interim action prejudices the ultimate decision on the program when it tends to determine subsequent development or limit alternatives.

Records of Decision on project-level and sitewide NEPA reviews that may be issued prior to decisions on the WM PEIS will reflect DOE's determinations pursuant to 40 CFR 1506.1. However, once decisions are made as a result of the WM PEIS, prior sitewide or project-level decisions may need to be revisited to assure consistency with the programmatic decisions.

Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS (Volume 1). On June 28, 1993, as an outgrowth of civil litigation, the U.S. District Court for the District of Idaho ordered DOE to prepare a comprehensive, sitewide EIS on the direct and indirect environmental effects of all major Federal actions involving spent nuclear fuel at INEL. Subsequent to this order, DOE decided to expand the scope of the in-progress INEL Environmental Restoration and Waste Management EIS to include the programmatic analysis of spent nuclear fuel alternatives that was being considered for inclusion in the WM PEIS.

In April 1995, DOE issued the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE, 1995e), which evaluated alternatives for managing existing and reasonably foreseeable inventories of spent nuclear fuel through the year 2035. Subsequently, DOE in its Record of Decision (ROD) (DOE, 1995f) decided to regionalize spent nuclear fuel management by fuel type

Table 1.8–1. Major Related NEPA Reviews

Title	Document	Status	Site(s)
Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS (Volume 1)	PEIS (DOE/EIS-0203-F)	Final issued April 1995 ROD May 1995	Hanford Site, Idaho National Engineering Laboratory, Nevada Test Site, Oak Ridge Reservation, Savannah River Site, and other locations
Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS (Volume 2)	EIS (DOE/EIS-0203-F)	Final issued April 1995 ROD May 1995	Idaho National Engineering Laboratory
Tritium Supply and Recycling PEIS	PEIS (DOE/EIS-0161)	Final issued October 1995 ROD December 1995	Idaho National Engineering Laboratory, Nevada Test Site, Oak Ridge Reservation, Pantex Plant, Savannah River Site
Storage and Disposition of Weapons-Usable Fissile Materials PEIS	PEIS (DOE/EIS-0229)	Final issued December 1996	Idaho National Engineering Laboratory, Nevada Test Site, Oak Ridge Reservation, Pantex Plant, Savannah River Site, Los Alamos National Laboratory, Hanford Site, Rocky Flats Environmental Technology Site
Stockpile Stewardship and Management PEIS	EIS (DOE/EIS-0236)	Final issued November 1996	Kansas City Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Nevada Test Site, Y-12 Plant at the Oak Ridge Reservation, Pantex Plant, Sandia National Laboratories-New Mexico, and the Savannah River Site
Sitewide EIS for Continued Operation of the Los Alamos National Laboratory	EIS (DOE/EIS-0238)	In preparation	Los Alamos National Laboratory
Nevada Test Site EIS	EIS (DOE/EIS-0239)	Final issued November 1996 ROD December 1996	Nevada Test Site
Rocky Flats Environmental Technology Sitewide EIS	EIS (DOE/EIS-0257)	Deferred	Rocky Flats Environmental Technology Site
Plutonium Interim Storage EIS for the Rocky Flats Environmental Technology Site	EIS (DOE/EIS-0276)	In preparation	Rocky Flats Environmental Technology Site
Solid Residue Treatment, Repackaging, and Storage EA[a]	EA	FONSI[b]	Rocky Flats Environmental Technology Site
Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site EIS	EIS (DOE/EIS-0277)	In preparation	Rocky Flats Environmental Technology Site

Table 1.8-1. Major Related NEPA Reviews—Continued

Title	Document	Status	Site(s)
Savannah River Site Waste Management EIS	EIS (DOE/EIS-0217)	Final issued July 1995 ROD September 1995	Savannah River Site
Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapons Components EIS	EIS (DOE/EIS-0225)	Final issued December 1996	Pantex Plant, Nevada Test Site, Hanford Site, and Savannah River Site
Defense Waste Processing Facility Supplemental EIS	EIS (DOE/EIS-0082-S)	Final issued November 1994 ROD April 1995	Savannah River Site
Interim Management of Nuclear Materials at the Savannah River Site	EIS (DOE/EIS-0220)	Final issued October 1995 ROD December 1995	Savannah River Site
Tank Waste Remediation System EIS	EIS (DOE/EIS-0189)	Final issued August 1996	Hanford Site
Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Services Center EIS	EIS (DOE/EIS-0226-D)	Draft issued March 1996	West Valley Demonstration Project
Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel EIS	EIS (DOE/EIS-0218)	Final issued February 1996 ROD March 1996	Savannah River Site, Idaho National Engineering Laboratory, plus 10 seaports
Disposition of Surplus Highly Enriched Uranium EIS	EIS (DOE/EIS-0240)	Final issued June 1996 ROD July 1996	Y-12 Site at the Oak Ridge Reservation, Savannah River Site, Babcox and Wilcox--Lynchburg Virginia, Nuclear Fuel Services—Erwin, Tennessee
Hanford Plutonium Finishing Plant Complex EIS	EIS (DOE/EIS-0244)	Final issued May 1996 ROD issued July 1996	Hanford Site
Waste Isolation Pilot Plant Disposal Phase Supplemental EIS	SEIS-II (DOE/EIS-0026-S2)	Draft issued November 1996	Waste Isolation Pilot Plant
Long-Term Management of Depleted Uranium Hexafluoride PEIS	PEIS (DOE/EIS-0269)	In preparation	K-25 Site at the Oak Ridge Reservation, Paducah Gaseous Diffusion Plant, Portsmouth Gaseous Diffusion Plant
Medical Isotope Production EIS	EIS (DOE/EIS-0249)	Final issued April 1996 ROD issued September 1996	Sandia National Laboratories-New Mexico, Los Alamos National Laboratory, Oak Ridge National Laboratory, Idaho National Engineering Laboratory

Table 1.8-1. Major Related NEPA Reviews—Continued

Title	Document	Status	Site(s)
Management of Spent Nuclear Fuel Currently Stored in the K-Basins EIS	EIS (DOE/EIS-0245)	Final issued February 1996 ROD issued March 1996	Hanford Site
Safe Retrieval, Transfer, and Interim Storage of Hanford Tank Wastes EIS	EIS (DOE/EIS-0212)	Final issued October 1995 ROD December 1995	Hanford Site
Hanford Remedial Action EIS and Comprehensive Land Use Plan	EIS (DOE/EIS-0222)	Draft issued August 1996	Hanford Site
Savannah River Site F-Canyon Plutonium Solutions EIS	EIS (DOE/EIS-0219)	Final issued December 1994 ROD February 1995	Savannah River Site
Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories—California EIS	EIS (DOE/EIS- 0157)	Final issued August 1992 ROD issued January 1993	Lawrence Livermore National Laboratory, Sandia National Laboratories-California
Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain EIS	EIS (DOE/EIS-0250)	In preparation	Yucca Mountain, Nye County, Nevada
Evaluating Container Systems for the Management of Naval Spent Nuclear Fuel EIS	EIS[c] (DOE/EIS-0251)	Final issued November 1996	Idaho National Engineering Laboratory
Disposal of Decommissioned, Defueled Cruiser Ohio Class and Los Angeles Class Naval Reactor Plants EIS	EIS[c] (DOE/EIS-0259)	Final issued April 1996 ROD issued July 1996	Hanford
S1C Prototype Reactor Plant Disposal EIS	EIS (DOE/EIS-0275)	Final issued November 1996	KAPL-W

[a] EA = Environmental Assessment.
[b] FONSI, a Finding of No Significant Impact, was determined for this EA.
[c] The Department of the Navy was the lead agency for these NEPA reviews. DOE was a cooperating agency.

at three sites: the Hanford Site, INEL, and the Savannah River Site (SRS) pending disposal in a geologic repository. Under this decision, the fuel distribution would be as follows:

- Hanford production reactor fuel will remain at the Hanford Site.
- Aluminum clad fuel will be consolidated at the SRS.
- Nonaluminum-clad fuels (including spent nuclear fuel from the Fort St. Vrain Reactor and Naval spent nuclear fuel) will be consolidated at INEL.

In addition to regionalizing the management of spent nuclear fuel, DOE also decided to resume the shipments of Naval spent nuclear fuel to INEL immediately, upon the staying or dissolution of an injunction order by the United States District Court for the District of Idaho.

The cumulative impact analysis of the waste management alternatives in Chapter 11 of this PEIS includes the environmental impacts resulting from this decision on spent nuclear fuel management.

Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS (Volume 2). In April 1995, DOE issued Volume 2 of the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE, 1995e), which in addition to evaluating programmatic spent nuclear fuel alternatives, evaluated sitewide alternatives for environmental restoration and waste management programs at INEL. Subsequently, DOE in its ROD (DOE, 1995f) decided to implement the Modified Ten-Year Plan, or the preferred alternative, for INEL as evaluated in the Final EIS. Commensurate with this decision, INEL would accept nonaluminum-clad spent nuclear fuel for management; continue the restoration of priority sites and the stabilization of sites based on health and environmental risks and budget; develop cost-effective waste treatment technologies; and implement projects and facilities to prepare waste and spent nuclear fuel for final disposition and allow more efficient examination of naval spent nuclear fuel.

Implementation of certain projects and facilities for preparing and managing waste at INEL would be subject to further reviews under NEPA and decisions to be reached as result of the WM PEIS. The cumulative impact analysis of the waste management alternatives in Chapter 11 of the WM PEIS includes the environmental impacts resulting from the decision to implement the Modified Ten-Year Plan at INEL.

Tritium Supply and Recycling PEIS. In 1991, DOE was actively considering the reconfiguration of its nuclear weapons complex and proposed to evaluate the environmental consequences of that reconfiguration in a PEIS. In 1994, as a result of reevaluating current and projected future requirements for the nuclear weapons complex in light of a number of recent world and national developments, DOE proposed to divide its previously planned Reconfiguration PEIS into two separate PEISs: a Tritium Supply and Recycling PEIS and a Stockpile Stewardship and Management PEIS (DOE, 1994c). The Tritium Supply and Recycling Final PEIS, issued in October 1995 (DOE, 1995g), evaluates alternatives associated with new tritium production and recycling of tritium recovered from weapons retired from service. The ROD, issued in December 1995, selected the Savannah River Site for tritium production should that technology be adopted, and also for the upgrade and consolidation of tritium recycling activities. The Tritium Supply and Recycling EIS will consider decisions regarding waste management resulting from the WM PEIS

Storage and Disposition of Weapons-Usable Fissile Materials PEIS. The *Storage and Disposition of Weapons-Usable Fissile Materials PEIS* (DOE 1996a) analyzes the environmental impacts of alternatives being considered for the long-term storage of weapons-usable plutonium and highly enriched uranium (HEU), and the disposition of weapons-usable plutonium that has been declared surplus to national security needs. Three alternatives, in addition to the No Action Alternative, are being considered for long-term storage: upgrade at multiple sites, consolidation of plutonium at one site, and collocation of plutonium and HEU at one site. Six sites are being considered for long-term storage: Hanford Site, INEL, NTS, ORR, Pantex, and SRS. All of the alternatives considered the removal of all weapons-usable fissile materials from the RFETS and removal of the surplus fissile materials from the LANL.

There are nine alternatives in three categories being analyzed for the disposition of surplus plutonium. The three disposition categories are "deep borehole," "immobilization," and "burn in reactors." For disposition, decisions will be made on the strategy and technologies for disposition of surplus weapons-usable plutonium. Until other environmental analyses are completed, no specific location will be selected for any disposition alternative action (DOE, 1996a).

Any waste type resulting from actions taken in the Storage and Disposition PEIS would be treated, stored, and disposed of in accordance with the decisions resulting from the WM PEIS. There is no expectation that the storage and disposition actions will result in a waste form that is not addressed in the WM PEIS.

In the event that the "burn in reactors" option is selected, any resultant spent fuel would be disposed of in accordance with the Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain EIS (see narrative).

Stockpile Stewardship and Management PEIS. Stockpile stewardship refers to activities associated with research, design, development, and testing of nuclear weapons and the assessment and certification of the safety and reliability. The stockpile stewardship portion of the PEIS evaluates the potential impacts of three proposed facilities: the National Ignition Facility, the Contained Firing Facility, and the Atlas Facility. The Stockpile Stewardship alternatives involving these facilities could affect four sites: LANL, LLNL, SNL, and Nevada Test Site (NTS) (DOE, 1996b).

Stockpile management refers to activities associated with the production, maintenance, surveillance, refurbishment, and dismantling of the nuclear weapons stockpile. The stockpile management portion of this PEIS evaluates the potential impacts of carrying out Stockpile Management Alternatives at eight sites: Oak Ridge Reservation (ORR), SRS, Kansas City Plant (KCP), Pantex Plant, LANL, LLNL, SNL, and NTS. The Management Alternatives are assessed for nuclear weapons assembly/disassembly and for fabricating pits, secondaries and cases, high explosives, and nonnuclear components. The Stockpile Stewardship and Management PEIS also evaluates the No Action Alternative of relying on existing facilities in their current configuration and continuing the missions at current sites to achieve both the stockpile stewardship and management missions.

DOE has identified the preferred alternatives in the final *Stockpile Stewardship and Management PEIS*. The preferred alternatives for the stockpile stewardship portion of the PEIS include the construction and operation of the National Ignition Facility and Contained Firing Facility at LLNL and the construction and operation of the Atlas Facility at LANL. The preferred alternative for the stockpile management portion includes secondary and case component fabrication at ORR, pit component fabrication at LANL, assembly and disassembly and high explosives fabrication at Pantex, and nonnuclear component fabrication at KCP. The *Stockpile Stewardship and Management PEIS* also includes the preferred alternative for strategic reserve storage; however, this may change based upon decisions to be made with regard to the final *Storage and Disposition of Weapons-Usable Fissile Materials PEIS*.

Evaluation of impacts on waste management is included in the assessment, and wastes generated as a result of the stockpile stewardship and management activities are compatible with treatment, storage, and disposal decisions resulting from the WM PEIS.

Sitewide EIS for Continued Operation of the Los Alamos National Laboratory. DOE is preparing a sitewide EIS for the Los Alamos National Laboratory (LANL) that will provide an analysis of existing and planned activities at that site within the next 5 to 10 years (DOE, 1994e). This EIS is currently in the scoping process, but the EIS is expected to explore environmental impacts caused by LANL facilities and operations, mitigation opportunities for impacts identified, strategies for waste management, and projects reasonably expected over the next 5 to 10 years. Completion of the draft LANL sitewide EIS is anticipated in spring 1996. Wastes expected to be generated from continuing activities at LANL are considered in the WM PEIS, and waste management activities will consider results of the WM PEIS.

Nevada Test Site Environmental Impact Statement. NTS has prepared a sitewide EIS to evaluate the potential impacts that could result from future mission activities (DOE, 1996c). Similar to the INEL Environmental Restoration and Waste Management EIS and the LANL Sitewide EIS, the NTS EIS evaluates both waste management and environmental restoration activities as well as other existing mission activities for the next 10 years. The final NTS EIS was released early in 1996. Waste generation from future activities at NTS was considered and included in the WM PEIS, and waste management activities at NTS will consider decisions arising from the WM PEIS.

Sitewide Environmental Impact Statement for the Rocky Flats Environmental Technology Site. DOE has issued a Notice of Intent (DOE, 1994g) to prepare a sitewide EIS for RFETS. The Notice described the intended scope of the sitewide EIS as providing a basis for selection of a sitewide strategic approach for nuclear materials storage, waste management, cleanup, and economic conversion, as well as project-level decisions for land use, management of nuclear materials, deactivation of RFETS facilities, decontamination and decommissioning of existing facilities, and possible onsite and offsite transportation of radioactive, hazardous, and mixed waste. The scope of the SWEIS has been modified so that issues associated with the safe interim storage of plutonium at RFETS will be analyzed in the Plutonium Interim Storage EIS, and completion of the sitewide EIS has been deferred pending completion of a new RFETS cleanup agreement and decisions based on completion of the WM PEIS.

Plutonium Interim Storage EIS for RFETS. DOE has issued a Notice of Intent (DOE, 1996m) to prepare an EIS for safe interim storage of approximately 10 metric tons of plutonium in inventory at RFETS. The plutonium consists of metals and oxides that were generated during weapons production and oxides generated from stabilization of plutonium-bearing residues. Even though DOE is engaged in a programmatic (Departmentwide) evaluation of alternatives for the long-term storage and disposition of plutonium, no decisions regarding long-term storage and disposition have been made and the Department needs to improve the interim storage arrangements for the plutonium. This EIS will analyze interim storage issues and will serve to ensure that decisions on safe and cost-effective interim storage can be made and implemented in the event that long-term storage and disposition decisions, or the implementation of these decisions, should be delayed for any reason. This EIS will take into consideration any decisions resulting from the completion of the WM PEIS or the *Storage and Disposition of Weapons-Usable Fissile Materials PEIS*.

Environmental Assessment—Solid Residue Treatment, Repackaging, and Storage. The proposed action is to stabilize, if necessary, and repackage approximately 106,600 kilograms of plutonium-contaminated residues (containing approximately 3,100 kilograms of plutonium) for safe interim storage, while awaiting decisions on the further disposition of the materials. Depending on the residue type, stabilization treatment can include oxidation, washing, cementation, calcination, thermal desorption, drying to eliminate liquids, and chemical treatment. Interim storage would be in containers and under conditions appropriate for a period of approximately 20 years, but actual length of storage would be until an appropriate offsite disposal location becomes available. The WM PEIS considers RFETS residues waste for purposes of its programmatic analysis. The subject EA provides greater precision on DOE's plans for managing residues.

Rocky Flats Plutonium Residues and Scrub Alloy EIS. DOE is preparing an EIS that will evaluate the potential environmental impacts associated with reasonable management alternatives for certain plutonium residues and all scrub alloy currently being stored at RFETS in Golden, Colorado (DOE, 1995r). The residues and scrub alloy are materials that were generated during the separation and purification of plutonium or during the manufacture of plutonium-bearing components for nuclear weapons. Preliminary Alternatives are no action, onsite treatment with or without plutonium separation, and offsite treatment with or without plutonium separation. Potential locations for offsite treatment include SRS, LANL, and LLNL.

While SRS appears to be a more likely offsite location for treating the RFETS plutonium residues and scrub alloy due to economies of scale, DOE cannot rule out the possibility that some of these materials might need to be treated at LANL or LLNL. Evaluation of these alternatives at this time will facilitate planning for disposal or other disposition and allow any additional treatment to be integrated with the ongoing stabilization process so that handling the material can be minimized (i.e., by avoiding potential double handling). Minimizing such handling would reduce the worker risk associated with achieving a material form suitable for disposal or other disposition. Any wastes resulting from actions analyzed in the *Rocky Flats Plutonium Residue and Scrub Alloy EIS* would be treated, stored, and disposed of in accordance with the decisions resulting from the WM PEIS.

Savannah River Site Waste Management EIS. The final SRS waste management EIS was issued in July 1995 (DOE, 1995c). It provides a baseline for the analysis of future SRS waste management needs. In the EIS, DOE assessed how to manage over the next 30 years liquid high-level radioactive, low-level radioactive, mixed, hazardous, and transuranic wastes generated during 40 years of past operations and ongoing activities at the Savannah River Site. The wastes are currently stored at SRS. DOE seeks to dispose of the wastes in a cost-effective manner that protects human health and the environment. In the EIS, DOE assessed the cumulative environmental impacts of storing, treating, and disposing of the wastes and examined the impacts on water quality, air quality, ecological systems, land use, geologic resources, cultural resources, socioeconomics, and the health and safety of onsite workers and the public. In the ROD, issued in September 1995, DOE announced its intention to implement the moderate treatment configuration alternative using a phased approach to making decisions on treatment, storage, and disposal facilities identified in the final EIS. The ROD identified decisions regarding continuation of existing activities, current operation of existing facilities, new waste recycling initiatives, operation of the Consolidated Incineration Facility, volume reduction activities for low-level waste, and the operation of a mobile soil sort facility.

Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapons Components EIS. The final EIS issued in December 1996 (DOE, 1996h) evaluates all current and proposed facilities and activities at the Pantex Plant, including weapons dismantlement and storage of the resulting nuclear materials and classified weapons components during the near-term (in a 5- to 10-year period). The sitewide EIS addresses alternative interim storage sites for plutonium pits that result from the Pantex Plant dismantlement activities. Waste generated from activities at the Pantex Plant are considered in the WM PEIS.

Defense Waste Processing Facility Supplemental EIS. DOE issued the final supplemental EIS on completing construction and operation of the Defense Waste Processing Facility (DWPF) in November 1994 (DOE, 1994a). The supplemental EIS assessed the environmental impacts of completing construction and operating the DWPF as modified from the original design addressed in a 1982 EIS. The DWPF includes the HLW pretreatment process, the vitrification facility, saltstone manufacturing and disposal (LLW resulting from the pretreatment of HLW), radioactive glass waste storage facilities, and associated support facilities. The ROD (March 28, 1995) describes the DOE choice to complete construction and start-up testing and begin operation of the DWPF. The ROD also describes additional safety modifications to the DWPF that will substantially reduce or eliminate potential accidental releases of radioactive material and chemicals in the unlikely event of a severe earthquake. When the WM PEIS is completed, DOE will review this supplemental EIS to determine whether a further supplemental or a revised ROD is needed to conform to the HLW canister storage decisions arising from the WM PEIS.

Interim Management of Nuclear Materials at the Savannah River Site (IMNM) EIS. The final EIS was issued in October 1995 (DOE, 1994f, 1995d). In this EIS, DOE assessed the environmental impacts of actions necessary to manage nuclear materials at Savannah River Site until it can make and implement decisions on their ultimate disposition. The actions evaluated in the EIS would stabilize SRS materials that represent environmental, safety, and health vulnerabilities in their current storage conditions or that might represent a vulnerability within the next 10 years. These vulnerabilities are the result of the suspension of nuclear materials production and processing operations that accompanied the end of the Cold War. Although DOE has initiated programmatic and project-specific environmental evaluations on the ultimate disposition of nuclear materials in the DOE complex that are now surplus to national defense requirements, the implementation of decisions on ultimate disposition will take several years, and the decisions themselves are the subject of several ongoing programmatic EISs. In the interim, DOE wants to eliminate vulnerabilities associated with certain current nuclear material nuclear configurations to protect the environment and the health and safety of workers and the public. The first ROD (December 12, 1995) describes the types of materials and methods of processing them in F- and H-Canyon facilities. The second ROD (February 8, 1996) describes fuel elements to be stabilized in F- and H-Canyon facilities and vitrified in the DWPF. The RODs will be reviewed based on decisions resulting from the WM PEIS to determine whether revisions should be made to conform with WM PEIS results.

Tank Waste Remediation System EIS. The Final Tank Waste Remediation System (TWRS) EIS, issued in August 1996 (DOE, 1996q), satisfies the DOE commitment made in the 1988 Hanford Defense Waste

EIS Record of Decision to prepare a supplemental NEPA analysis (DOE, 1994d). The TWRS EIS was prepared in response to several important changes since the 1988 Record of Decision, including a revised strategy to manage and dispose of tank waste and encapsulated cesium and strontium. The approach for achieving environmental compliance at the Hanford Site, including specific milestones for the retrieval, treatment, and disposal of tank waste, is contained in a legally enforceable agreement among DOE, the Washington State Department of Ecology, and EPA, known as the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement).

The TWRS EIS evaluated, as a part of the proposed action: the continued operation and management of the tank farms, including the use of existing and planned facilities such as the Cross-Site Transfer System; waste transfer system upgrades; and the retrieval and treatment of the tank waste, which would include vitrification of HLW and immobilization of the low-activity waste (LAW). The HLW would be stored onsite pending disposal at a geologic repository and the LAW would be disposed of onsite. A range of alternatives was evaluated for the encapsulated cesium and strontium. An ROD is anticipated in October 1996. When the WM PEIS is completed, DOE will review this EIS to determine whether actions stemming from waste generation and disposal conform with decisions arising from the WM PEIS.

Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at Western New York Nuclear Service Center EIS. DOE and the New York State Energy Research Development Authority have prepared a draft EIS (DOE, 1996d) that evaluates alternatives for completing West Valley Demonstration Project (WVDP) activities and managing nuclear waste at the Western New York Nuclear Service Center near West Valley, New York. Radioactive wastes would be produced from vitrifying HLW and from decontaminating and decommissioning tanks, facilities, and hardware associated with the WVDP, and long-term management or closure of the balance of the site. The alternatives being evaluated range from shipping all stored, buried, and newly-generated wastes to other DOE and commercial facilities, to discontinuing operations. The alternatives would be implemented in the 2000 to 2030 time frame. The EIS will take into consideration decisions resulting from the completion of the WM PEIS.

Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel EIS. DOE issued the final Foreign Research Reactor EIS (DOE, 1996e) to adopt a policy to manage SNF from foreign research reactors in a manner consistent with United States nuclear weapons nonproliferation policy. The EIS evaluates the proposed policy which, in part, encourages research reactors

to convert from the use of highly enriched uranium (HEU) to low enriched uranium (LEU). The EIS involves the selection of a United States policy on how to manage the spent fuel elements containing United States-origin enriched uranium from 41 nations during a period of up to 13 years. Depending on fuel type, the preferred alternative would be to manage this spent nuclear fuel at the Savannah River Site and the Idaho National Engineering Laboratory. The preferred alternative includes acceptance and management of spent nuclear fuel from the foreign research reactor in the United States. This would include wet or dry storage, processing or chemical separation, if necessary, or a combination of both to stabilize it for either storage or disposal. A review of proposed waste disposal activities in this EIS will be made after considering WM PEIS decisions.

Disposition of Surplus Highly Enriched Uranium EIS. DOE issued the Final Disposition of Surplus Highly Enriched Uranium EIS in June 1996 (DOE, 1996j). This EIS addresses the disposition of a nominal 200 metric tons of surplus HEU (175 metric tons has been declared surplus to defense needs to date) to make the material nonweapons-usable and to recover its economic value where possible. The EIS analyzes a range of alternatives, all of which (other than the "No Action" Alternative) involve blending the HEU down to low-enriched uranium (through isotopic dilution) to make it nonweapons-usable. The EIS analyzes blending the HEU down to an enrichment level suitable for commercial use in nuclear reactors (nominally 4%), or blending it down to an enrichment level suitable for disposal as LLW (nominally 0.9 percent). Four action alternatives are identified that involve blending different portions of the material for commercial use or for disposal as waste, using various combinations of two DOE and two commercial candidate blending sites. All of the commercial use alternatives include the proposal to transfer 50 metric tons of HEU to the United States Enrichment Corporation for blending to LEU and subsequent use in commercial reactor fuel. The ROD based upon the final EIS calls for a blending, over time, of as much of the material as possible (up to 85%) for commercial use, and blending the remainder for disposal as waste. The potential waste loads from the surplus HEU disposition decision are bounded by the inventory projections provided in the WM PEIS.

Hanford Plutonium Finishing Plant Stabilization EIS. DOE issued the *Final Plutonium Finishing Plant Stabilization Draft Environmental Impact Statement* in May 1996 (DOE, 1996i). This EIS evaluates the potential environmental impacts associated with alternative approaches for: (1) stabilization of residual, plutonium-bearing materials at the Plutonium Finishing Plant to a form suitable for long-term storage; (2) removal of readily retrievable, plutonium-bearing material left behind in process equipment, process areas, and air quality and liquid waste management systems as a result of historic uses; and (3) interim

storage of stabilized fissile material in existing vaults at the Plutonium Finishing Plant pending the WM PEIS decision on ultimate storage and disposition of the material. The ROD, issued in July 1996, will be reviewed based on decisions made from the WM PEIS.

Waste Isolation Pilot Plant Disposal Phase Supplemental EIS (SEIS-II). WIPP is the planned repository for retrievably stored defense TRUW. In October 1980, DOE issued a final EIS on proposed development of WIPP (DOE, 1980). The January 1981 ROD called for phased development of WIPP, beginning with construction of the WIPP facility. In 1990, DOE issued a supplemental EIS that considered previously unavailable information (DOE, 1990). Based on this supplemental EIS, DOE decided to continue phased development of WIPP by implementing test phase activities. On October 30, 1992, the Waste Isolation Pilot Plant Land Withdrawal Act (WIPP LWA) transferred the WIPP site from the U.S. Department of Interior to DOE. The 1997 Defense Authorization Act, which was signed on September 23, 1996, contains amendments to the WIPP LWA. The amendments make RCRA LDRs inapplicable to WIPP, thus eliminating the need to obtain a No Migration Determination before beginning disposal operations.

DOE has prepared a second supplemental EIS (SEIS-II; DOE, 1996n), which updates the information contained in the previous EIS and Supplemental EIS for WIPP, incorporates the PEIS analysis of various treatment alternatives for TRUW, and examines changes in environmental impacts due to new information or changed circumstances.

The WM PEIS is intended to provide environmental information to assist DOE in determining at which sites it should modify existing TRUW storage and treatment facilities or construct new facilities. DOE intends to select sites for TRUW treatment and storage facilities using the WM PEIS analysis but will not select the level of treatment needed. The WIPP SEIS-II will be used to support decisions on whether to dispose of TRUW at WIPP, the treatment level of TRUW, mode of transportation, and other activities associated with TRUW disposal.

Although the Draft SEIS-II incorporates by reference, and where appropriate, updates and adjusts information from the Draft WM PEIS, the potential actions analyzed in SEIS-II are not connected to the potential actions analyzed in the Draft WM PEIS. The WM PEIS evaluates alternative configurations for managing five types of waste, including TRUW, that are at DOE sites or are otherwise under DOE's control or responsibility. The alternative configurations range from managing the wastes where they are presently located to transporting them to one centralized site for management. The WM PEIS evaluates

trends in various impacts under alternative configurations become more or less centralized. The WM PEIS postulates three generic types of treatment for TRUW in order to analyze the impacts of treating and storing TRUW under the various configurations. These generic treatments allow DOE, in the WM PEIS, to compare the relative impacts of centralized, regionalized, and decentralized treatment and storage. To reduce the potential impacts of storing untreated wastes, DOE must decide, pursuant to the WM PEIS, where to treat and store TRUW regardless of whether the Department decides to dispose of this waste at WIPP.

It is important to note that the analysis in the second WIPP SEIS-II will differ from the WM PEIS analysis in several significant aspects. These differences should not be misconstrued as being inconsistent with the WM PEIS, rather the product of different purpose and scope. Again, the impacts of TRUW disposal at the WIPP are not analyzed in the WM PEIS. This information is presented in the WIPP SEIS-II. In addition, the long-term environmental impacts of indefinite storage are also not included in the WM PEIS analysis.

Also, for purposes of bounding the WM PEIS analysis, certain assumptions were made that are inconsistent with current WIPP planning bases and assumptions. For example, although WIPP does not currently have statutory authority to accept nondefense-generated waste, the WM PEIS assumes that all TRUW would be disposed of at WIPP. The WIPP SEIS-II will examine disposal of all TRUW, but only as alternatives to the proposed action that involves disposal of only defense TRUW.

Long-Term Management of Depleted Uranium Hexafluoride EIS. This PEIS will evaluate alternative strategies for long-term management of DOE-owned DUF_6 currently stored at the K-25 site in Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio. The Notice of Intent was published on January 25, 1996 (DOE, 1996s), and the Draft PEIS is scheduled to be available for public review in February 1997. The alternatives are No Action (continued storage until 2020 followed by conversion to uranyl uranate [U_3O_8] and disposition through 2040), long-term storage (beyond 2020) as uranium hexafluoride (UF_6), conversion to an oxide followed by continued storage, conversion to uranium dioxide (UO_2) or metal followed by use, and conversion to an oxide followed by disposal as LLW. The PEIS will consider any decisions resulting from the completion of the WM PEIS.

Medical Isotopes Production EIS. DOE issued the final *Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement* (DOE/EIS-0249F) in April 1996. The EIS identified alternatives and evaluated the potential for significant impacts to the public and the

environment of producing molybdenum-99 (Mo-99) domestically. Mo-99 is a precursor of the isotope technetium-99m, which is used approximately 36,000 times each day in the United States for a variety of medical diagnostic purposes. The United States is currently dependent upon a single, aging reactor in Canada for its supply. DOE identified alternative Mo-99 production facilities in four locations: SNL-NM, LANL, ORNL, and INEL. The analysis for each alternative included the identification and description of the waste generated by the Mo-99 process. A combination of facilities at SNL-NM and LANL is identified as the preferred alternative (DOE, 1996f). The ROD, issued in September 1996, will be reviewed based on decisions made in the WM PEIS.

Management of SNF From the K-Basins at the Hanford Site EIS. The final EIS, issued in February 1996 (DOE, 1996g), evaluated whether and how to take action to reduce risks associated with SNF and sludge currently stored in the water-filled K-East and K-West storage basins at the Hanford site. Decisions regarding management of K-Basins SNF were made and implemented in a manner consistent with the Record of Decision for the Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS. Management Alternatives will be reviewed upon completion of the WM PEIS.

Safe Retrieval, Transfer, and Interim Storage of Hanford Tank Wastes. DOE issued the EIS for final safe interim storage of Hanford tank waste (DOE, 1995j) in October 1995. This EIS dealt with urgent tank waste safety concerns that required action before implementing decisions based on the EIS for tank waste remediation system. Alternatives evaluated in the EIS included the construction of new HLW storage tanks and a replacement cross-site transfer line. In the ROD issued in November 1995 (60 FR 61687), DOE decided that existing mitigation measures and tank farm waste inventory management strategies had alleviated the need for additional HLW storage capacity. Therefore, DOE decided not to construct additional double-shell tanks. DOE also decided that the safe interim storage of tank waste did require the construction of a replacement cross-site transfer line between the 200 West Area and 200 East Area of the Hanford site. The transfer line would allow for operational flexibility and permit DOE to continue to stabilize single-shell tank waste in the 200 West Area. These waste management activities will be reviewed pending completion of the WM PEIS.

Hanford Remedial Action EIS and Comprehensive Land Use Plan. The draft Hanford remedial action EIS was published in August 1996 (DOE, 1996p). It establishes future land-use objectives to assist DOE in developing a cost-effective, technically sound remediation strategy for the Columbia River, Central

Plateau, and all other geographic areas of the Hanford Site. The EIS analyzes the impacts of remediating past-practice waste sites that are DOE's responsibility under CERCLA. RCRA past-practice sites that are covered under the provisions of the Hazardous and Solid Waste Amendments of 1984 were also analyzed. In addition, impacts from decontamination and decommissioning of selected surplus facilities were analyzed along with remediation of some miscellaneous RCRA units on or near the primary past-practice remediation sites. The EIS analyzes the impacts of remediation for each future land-use alternative, as well as the cumulative impacts for waste management facilities, such as the Environmental Restoration Disposal Facility.

Savannah River Site F-Canyon Plutonium Solutions EIS. The final F-Canyon Plutonium Solutions EIS was issued in December 1994 (DOE, 1994h). After issuing the Notice of Intent to prepare the EIS on interim management of nuclear materials at SRS, DOE determined that there is a potentially significant safety concern associated with about 85,000 gals of solutions containing plutonium-239. Accordingly, DOE initiated a separate EIS on an urgent schedule for the proposed stabilization of these solutions. The EIS evaluated potential environmental impacts over the next 10 years of alternatives for the stabilization of plutonium solutions stored in F-Canyon. The solutions remain from chemical separations operations that DOE suspended in 1992. The ROD (February 1, 1995) describes the DOE choice to implement the preferred alternative, processing the F-Canyon plutonium solutions to metal, as discussed in the final EIS. Waste management activities described in the EIS will be reviewed based on WM PEIS decisions.

Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories-California. DOE issued a final EIS in August 1992 that evaluates all activities at the Laboratories, including the minimization, treatment, and storage of radioactive and hazardous wastes. The EIS supports decisions on the operation of Laboratory facilities, including specific waste treatment and storage in the near-term (10 years and less), and provides a baseline for analyzing environmental impacts of future waste management activities at the sites (DOE, 1992a). Wastes expected to be generated from LLNL and SNL are included in the WM PEIS analysis. Decisions regarding waste management will be made pending the completion of the WM PEIS.

Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain EIS. The Notice of Intent, published August 1995 (DOE, 1995l), describes Yucca Mountain as the candidate site for disposing of spent nuclear fuel and defense HLW. The Nuclear Waste Policy Act was intended to solve the national problem created by the accumulation of spent nuclear fuel and

defense HLW. The Nuclear Waste Policy Act made DOE responsible for managing the disposal of this spent nuclear fuel and HLW, specified the siting process, and authorized the construction of one geologic repository. Under the Nuclear Waste Policy Amendments Act of 1987, the process for selecting this repository was streamlined, and the Yucca Mountain Site in Nevada was selected for detailed study as the candidate site for the nation's first geologic repository. A draft EIS is scheduled for July 1999.

Because the environmental evaluation process for geologic disposal was established by the Nuclear Waste Policy Act, the WM PEIS does not analyze environmental impacts of disposal at Yucca Mountain or alternative locations for a geologic repository. However, the WM PEIS does analyze the environmental impacts of the longer term storage of treated HLW in the event that the construction and operation of a national geologic repository is delayed.

Evaluating Container System for the Management of Naval Spent Nuclear Fuel EIS. *The Department of the Navy Final Environmental Impact Statement for a Container System for the Management of Naval Spent Nuclear Fuel*, issued in November 1996 (Navy, 1996a), evaluates the environmental impacts of alternative container systems for the management of naval SNF following examination at INEL. A container system is needed to place naval SNF in dry storage at INEL and to transport it to a centralized interim storage facility if authorized by Congress or to a geologic repository when one becomes available. The Final EIS specifically addresses the need, alternatives, and environmental impacts of manufacturing containers; loading containers; handling and storage of naval SNF at INEL; transportation of naval SNF loaded containers to a notional repository or centralized interim storage site; and the storage, handling, and transportation of special case waste associated with naval SNF management. The Final EIS demonstrates that the environmental and health impacts are small and comparable among alternatives. The Navy identified a preferred alternative in the Final EIS but will not select an alternative until the Record of Decision is issued. Decisions regarding waste management will be made pending the completion of the WM PEIS.

Disposal of Decommissioned, Defueled Cruiser, OHIO Class, and LOS ANGELES Class Naval Reactor Plants EIS. *The Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Cruiser, OHIO Class, and LOS ANGELES Class Naval Reactor Plants*, issued in April 1996 (Navy, 1996b), analyzes the alternate ways for disposing of decommissioned, defueled reactor compartments from those classes of U.S. Navy vessels. A disposal method for the defueled reactor compartments is needed when the cost of continued operation is not justified by the ships' military capability or when the ships are no longer needed. The preferred alternative is land burial of the entire reactor

compartment at the DOE Low Level Waste Burial Grounds at Hanford, Washington. The Record of Decision was published in the *Federal Register* (61 FR 41596) on August 9, 1996, and selects the preferred alternative. The ROD, issued in July 1996, will be reviewed pending completion of the WM PEIS.

S1C Prototype Reactor Plant Disposal EIS. The S1C Prototype reactor plant was permanently shut down in March, 1993, reflecting the end of the Cold War and projected downsizing of the U.S. Naval fleet. All SNF was removed from the S1C Prototype reactor and has been shipped off site. The DOE gave notice of the availability of the Draft EIS in the July 1, 1996, *Federal Register* (61 FR 33908). The Final EIS evaluates in detail three alternatives for the disposal of the S1C Prototype reactor plant (DOE, 1996o). These alternatives include prompt dismantlement and disposal of the entire S1C Prototype reactor plant, deferred dismantlement, and "no action," or continued surveillance and monitoring for an indefinite period of time. The EIS demonstrates that the environmental and health impacts are small and comparable among alternatives. The Navy will select an alternative in the Record of Decision. This EIS will be reviewed based on decisions made in the WM PEIS.

1.8.2 Related DOE Actions and Programs

Environmental Management Accelerating Cleanup: Focus on 2006. The DOE Environmental Management Program is continually working to accelerate cleanup schedules, increase efficiency, and foster cooperative relationships with its regulators and other stakeholders. However, there is concern whether support can be sustained for a program that may stretch beyond 70 years with an estimated cost of more than $200 billion (DOE, 1996l). DOE wants to accelerate reduction of this "cleanup mortgage" of the Cold War to reduce long-term economic and environmental liabilities. DOE is working on a 2006 Plan (previously known as the Ten-Year Plan) to meet this challenge. The vision of this plan is that within the next decade most DOE facilities will be able to treat and dispose of their backlog of nuclear materials and wastes safely and clean up the land and buildings onsite. These steps would dramatically reduce long-term costs and open a large portion of the lands and other resources controlled by DOE for other purposes.

However, some aspects of the Environmental Management Program will demand additional time and resources. For example, DOE will not be able to complete the treatment and disposal of certain wastes such as high-level radioactive waste stored in tanks at Hanford or transuranic waste stored throughout the complex. Also, there will be ongoing groundwater cleanup projects, decontamination of buildings, and

surveillance and maintenance activities. At a small number of sites, DOE will continue treatment of a few remaining waste streams.

The 2006 Plan will be used to inform the budget decisions, sequencing of projects, and actions taken to meet program objectives. EM will implement this vision in collaboration with regulators and the public. Development of the 2006 Plan will be guided by the following seven principles:

- Eliminate urgent risks
- Reduce mortgage and support costs to free up funds for further risk reduction
- Protect worker health and safety
- Reduce the generation of waste
- Create a collaborative relationship between DOE and its regulators and stakeholders
- Focus technology development on cost and risk reduction
- Integrate waste treatment and disposal within the complex.

DOE's sites have already prepared initial draft site plans, and DOE is now developing a national discussion draft based upon these principles. The discussion draft will be distributed for public comment to elicit feedback on the strategic approaches for accomplishing compliance and completion goals, and on DOE's management strategies to accomplish these goals. This approach will ensure that DOE has a broad perspective when developing a draft National 2006 Plan later this year. The 2006 Plan will be a living document, evolving to reflect revised assumptions, stakeholder viewpoints, and newly obtained information.

The Final WM PEIS evaluates many potential waste management activities that may become components of the 2006 Plan. To conduct the WM PEIS analysis, DOE assumed that all waste management facilities necessary to implement a given alternative would be constructed in an initial 10-year period, followed by a 10-year operations period. As a result, 20 years of waste generation was analyzed in the WM PEIS. On the other hand, the 2006 Plan will set a goal that waste will be substantially treated and disposed within a 10-year period. Therefore, the WM PEIS considers more waste (existing inventory plus 10 years' new generation) in a period of time similar to the time covered by the 2006 Plan.

Baseline Environmental Management Report. In the Fiscal Year 1994 National Defense Authorization Act, Congress required DOE to submit a report that specified all the activities and projects within the Environmental Management Program. *The 1996 Baseline Environmental Management Report* (BEMR) (DOE, 1996l) includes waste management, transition of operational facilities to safe shutdown status,

technology research and development, pollution prevention, and environmental restoration. The report includes an estimate of the total cost of the Environmental Management Program, describes each project or activity at each site, describes the environmental problems, specifies the proposed remedy, and provides a schedule and estimated completion date for each project.

The BEMR was based on a broad range of assumptions regarding the outcomes of various decision-making processes that will determine the ultimate disposition of DOE facilities and sites and thus the scope and pace of the program. One of the key assumptions was related to the location of sites for treatment, storage, and disposal facilities. Current plans and agreements were used to define where waste would be treated and disposed. The WM PEIS examines additional configurations, such as pollution prevention, to that which was used to develop the baseline cost estimate.

Of particular importance to the cost of Environmental Management Programs are the complexwide savings from expanded pollution prevention efforts over the period covered in the BEMR. Results and projections from specific projects demonstrate that the savings from pollution prevention activities could reach tens of billions of dollars, surpassing the initial cost of implementation of these activities. DOE will continue to pursue pollution prevention activities as they relate to the WM PEIS because they result in an efficient use of limited resources by reducing site operating costs, and they maintain consistency with DOE's commitment to respecting the environment.

Environmental Restoration Program. A legacy of the Nuclear Weapons Program is environmental contamination at the sites where research, development, test, and production of nuclear weapons took place. The volumes of contaminated media at some locations are quite large. The Environmental Restoration Program was established to address this problem. "Environmental restoration" refers to activities undertaken pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA) and can include removal and treatment of hazardous substances, containment of a source of contamination, or placement of land use restrictions on a contaminated site. It encompasses a wide range of activities such as stabilizing contaminated soil, treating groundwater, decommissioning process buildings, including nuclear reactors and chemical separations plants, and exhuming buried drums of waste. The extent to which a site is "cleaned up" will depend largely on assumptions regarding future land use. For most sites, the process of determining future site use has just begun.

The CERCLA process is generally implemented at specific sites through agreements among the DOE, EPA, and frequently the host state. The process can be described as follows:

First, a site or portion of a site is "characterized" to identify contaminants, determine the extent of contamination, and assess potential threats to public health and the environment. If significant contamination is indicated, and limited action will result in mitigation of risk, an expedited response action or interim action may be conducted as a means to quickly address the problem. Upon completion of characterization, a detailed analysis is performed to quantify risk and evaluate remedial alternatives. The analysis is followed by a formal decision process including public hearings and formal comment period.

If the results of the analysis indicate that a potential release site is not a threat to health and the environment or that an interim action adequately remediated the contamination, a recommendation of no further action is made to the regulators. If, however, a threat is deemed to be present, the appropriate remediation is identified, and a recommendation is submitted for formal approval. In either case, DOE makes a recommendation on what action is to be taken. The decision on what action will be taken is made by the regulator, not DOE.

During each stage of environmental restoration from characterization of contaminated media to final remediation, waste may be generated. The projected volumes of waste that might be generated by environmental restoration were analyzed by each DOE site during development of the BEMR. These analyses included consideration of treatment, storage, and disposal capabilities, specific restoration requirements, and negotiations with state and Federal regulatory agencies in order to estimate how much of the contaminated media would need to be managed as waste. Estimates and descriptions of total quantities of the contaminated media to be managed, and the wastes that will be generated during environmental restoration are contained in Appendix B. Although most wastes that are generated as a result of DOE's environmental restoration activities would be managed outside of the alternatives evaluated in the WM PEIS, some of the wastes generated by environmental restoration may be transferred to the Waste Management Program. However, given the incomplete information about the final volumes and composition of the transferred wastes, it was not possible to analyze the potential impacts of managing these wastes in the WM PEIS (see Section 1.7.1). The evaluation of waste management facilities in Chapters 6, 7, and 8 does contain information on the anticipated volumes of environmental restoration transferred waste and qualitative analyses of the extent to which these wastes may affect alternatives in the WM PEIS. Appendix B contains a more detailed discussion of ER waste volumes and the potential effects of these wastes on

WM PEIS waste management facilities and alternatives. Decisions based on the WM PEIS are not expected to impact environmental restoration activities at individual sites.

Pollution Prevention Program Plan. The Pollution Prevention Program Plan serves as the principal crosscutting guidance to DOE Headquarters, Operations Office, laboratory, and contractor management to fully implement pollution prevention programs within the DOE complex between now and 2000.

To demonstrate DOE's commitment to pollution prevention, the Secretary of Energy established goals, to be achieved by December 31, 1999, that will reduce DOE's routine generation of radioactive, mixed, and hazardous wastes, and total releases and transfers of toxic chemicals by at least 50%. The Secretary also has established sanitary waste reduction, recycling, and affirmative procurement goals. Site progress in meeting these goals will be reported annually to the Secretary in the *Annual Report on Waste Generation and Waste Minimization Progress*, using 1993 as the baseline year.

Pollution prevention is defined as the use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and wastes into land, water, and air. Pollution prevention includes practices that reduce the use of hazardous materials, energy, water, and other resources along with practices that protect natural resources through conservation or more efficient use.

The Department is faced with the challenge of removing and treating wastes already generated from past production and manufacturing operations. Facility and equipment stabilization, deactivation and decommissioning, and weapons dismantlement activities will also result in significant amounts of wastes that must be handled. Many pollution prevention techniques may not directly apply to wastes that were generated and media that were contaminated by previous practices (nonroutine wastes). However, two techniques, waste segregation and recycling, will be key to reducing the amount of such wastes that would otherwise require additional treatment and disposal.

Additional waste and pollutants will be generated in the process of conducting restoration and dismantlement activities. Pollution prevention is applicable to the generation of secondary wastes and will be incorporated into remedial investigations, feasibility studies, design, and execution of all restoration and dismantlement projects. Restoration projects will be performed in a manner that reduces or prevents the generation of new waste and pollutants and reduces the further release or spread of contamination.

Today, a major barrier impeding the DOE pollution prevention program is the inadequacy of generator involvement in site planning and the shortage of generator project funds to implement pollution prevention opportunities. The DOE pollution prevention program relies on the establishment and maintenance of strong site programs with commitment and support from Headquarters. The success of the overall program hinges on the ability of the sites to reduce pollutant generation and increase recycling rates. Many sites have already achieved positive results from implementing pollution prevention programs. Details on specific pollution prevention programs at the various sites addressed in this PEIS can be obtained from local DOE officials.

In order to provide a conservative analysis of the impacts of DOE's future waste management program, the projected volumes of future waste loads contained in Chapters 6–10 did not assume significant minimization of current waste generation. Appendix G discusses how DOE's pollution prevention program practices may affect waste loads, and consequently the need for facilities. Appendix G contains estimates of reductions in waste loads and associated impacts.

Site Treatment Plans for Mixed Waste Required by the Federal Facility Compliance Act. The FFCAct, which amended RCRA, required DOE to prepare Site Treatment Plans for the development of capacity and technologies for treating mixed waste to RCRA land disposal restriction standards, and to submit them to the State or EPA for approval. A plan is required for each facility at which DOE stores or generates mixed waste.

The FFCAct also subjects Federal facilities to fines and penalties for violations of RCRA. However, DOE was not subject to fines and penalties for violations of the land disposal restrictions for mixed waste until October 6, 1995, and is not subject to fines and penalties after that if it is in compliance with approved plans and compliance orders issued by the appropriate regulator.

DOE followed a three-phased approach for developing the Site Treatment Plans. In October 1993, DOE sites submitted Conceptual Plans to their regulators, which identified a broad range of options for treating DOE's mixed waste. Draft plans, submitted in August 1994, presented the individual sites' proposed treatment option for its mixed waste. Proposed Plans were submitted in April 1995 to the appropriate regulatory agency for approval, approval with modification, or disapproval, as required by the FFCAct.

DOE worked closely with the regulatory agencies and the public throughout the process. The National Governors' Association coordinated representatives from 20 states and EPA to assist DOE in evaluating candidate treatment options and developing mixed waste treatment plans. The conceptual, draft, and proposed plans were also made available to the public, with additional opportunities provided for information and input on the plans at the site and national levels.

Negotiations were completed for 28 plans on October 6, 1995; four additional plans have been finalized since then. Negotiations are ongoing for another three sites; plans for these sites are expected to be finalized in 1997. These plans, taken together, establish a complexwide treatment configuration, including schedules for bringing new treatment facilities into operation. Sixteen of the 17 major sites analyzed in the WM PEIS are required to prepare STPs. Each of these sites has submitted an STP and all but three (ANL-E, BNL, and LLNL) have been approved by the appropriate agencies. Compliance orders or agreements have been made or issued for the approved sites.

The approved plans contain the treatment configuration that resulted from discussions among States, EPA, tribal governments, and the public, and from DOE's evaluation of its treatment needs. However, the evaluation will continue as the plans are implemented to streamline and improve the configuration. For example, individual sites continue to pursue commercial and privatized treatment options for some waste streams. The Compliance Orders that govern implementation of the Plans all provide for modification and changes as new technical and cost information becomes available. Any changes to the configuration or to schedules will be made through formal modification processes.

The Final WM PEIS preferred alternative for LLMW treatment is consistent with the configuration established through the FFCAct process.

DOE Disposal Workgroup Process for Evaluating Potential Mixed Low-Level Waste Disposal Sites. Although the FFCAct does not specifically address disposal of treated mixed wastes, both DOE and the States have recognized that disposal issues are an integral part of treatment discussions. A process was established by the DOE Disposal Workgroup in conjunction with state representatives in the National Governor's Association to evaluate and discuss the issues related to the potential disposal of the residuals from the treatment of DOE LLMW at the sites subject to the FFCAct.

The focus of this process has been to identify sites that are suitable for further evaluation of their potential as disposal sites from the sites that currently store or are expected to generate mixed waste. The evaluation is intended to increase understanding of the strengths and weaknesses of a site's potential for disposal but is not a site selection process. Ultimately the identification of sites that may receive mixed waste for disposal will follow state and Federal regulations for siting and permitting, and will include appropriate public involvement.

Of the DOE sites considered under the process, sites determined to have marginal or no potential for disposal were removed or deferred from further evaluation using the following criteria:

- Grouping of sites in close, geographic proximity
- Screening sites using criteria derived from Federal and state requirements regarding the siting of waste treatment, storage, and disposal facilities
- The application of risk-based criteria related to technical, potential receptor and practical considerations to determine site suitability
- Deprioritization of further evaluation of selected sites with the agreement of states

The remaining sites were evaluated more extensively using site performance evaluations. These 15 sites reflect the same set analyzed for LLMW disposal under the EM PEIS with the exception that the WM PEIS analysis includes Brookhaven. The performance evaluation was used to review site characteristics related to disposal potential and estimate the radionuclide concentration limits of waste that may be disposed at a given site.

Future activities being undertaken by DOE that are either ongoing or are to be completed to facilitate an informed decision about the disposal of DOE LLMW include:

- Develop estimates of waste volumes and radionuclide concentrations in treated residuals
- Compare estimates of radionuclide concentration in treated residuals to performance evaluation-derived radionuclide concentration guides
- Develop sample configurations for disposal of treated residuals
- Develop a draft disposal system configuration

Information obtained through the Disposal Workgroups Process will be considered with information contained in the WM PEIS during the development of an ROD. Following the issuance of the ROD for the WM PEIS, DOE may (1) initiate site-specific NEPA evaluations for new proposed disposal facilities; (2) initiate performance assessment analyses for compliance with DOE Order 5820.2A; and (3) initiate

processes for permitting disposal facilities. Coordination with the states and stakeholders will continue to ensure stakeholder input and to resolve concerns at the earliest possible stage.

National Dialogue. DOE recognizes the need to develop an effective decision-making process to integrate not only waste storage, treatment, and disposal decisions, but also other radioactive materials disposition and cleanup decisions as well. In 1995, DOE began an ongoing "national dialogue" on radioactive waste and materials disposition through discussions with interested states, site-specific advisory boards, and other forums. The National dialogue is intended to promote openness, increase trust and confidence in DOE decision making, and complement traditional public outreach efforts conducted under the NEPA process. This effort will allow DOE and stakeholders, especially affected States, to explore decision-making processes that may benefit DOE and host communities. The dialogue will focus on major decisions DOE needs to make over the next few years, principles to be considered in the decision process, and stakeholder involvement. DOE will strive to reach traditional and nontraditional stakeholders in an open and inclusive manner to effectively integrate all potential decision-making processes.

Future Use Project. DOE initiated the Future Use Project in 1994 to begin to evaluate future use options at its sites. The primary purpose of the Future Use Project is to develop stakeholder future use recommendations that can serve as input to efforts and decisions concerning environmental management, site comprehensive planning and stewardship responsibilities, and reuse of excess land and facilities. In light of these goals, the Future Use Project encourages sites to address a number of factors as part of their future use planning processes. In order to develop recommendations that reflect both internal and external preferences, sites should undertake planning processes that include tribal and local governments, regulators, internal program representatives, advisory boards, and advocacy groups, among others. Sites must work with interested individuals and groups to consider data that might influence the development of appropriate recommendations. Relevant information includes existing regulatory agreements, site characteristics, natural resources, cultural and historic resources, contamination profiles, technological feasibility, and cost implications.

Four new areas of focus, in particular, compelled the Department to reconsider and define future uses for its sites with significant involvement by affected governments and the public. As the first new focus, the Department adopted environmental management as a primary mission in response to growing recognition of environmental contamination and the legacy of wastes. Second, the Department has emphasized a new commitment to disclosing information to the public so that the public can make more informed decisions

about DOE sites. The Department is also actively involving governmental partners, organizations, and citizens in its decisions. Third, in 1994, the Department issued a secretarial policy on land use that formally recognized its responsibility to act as a steward of national resources. Finally, as defense activities declined and the Environmental Management program matured, the Department recognized the need to define reuse strategies for many of its facilities and buffer areas that are now or will be excess to Departmental mission needs. The overall findings and site recommendations are summarized in *Charting the Course* (DOE, 1996k).

Draft Risk Report. The Draft Risk Report to Congress, entitled *Risks and The Risk Debate: Searching For Common Ground, "The First Step,"* was requested by Congress under the Fiscal Year 1994 House and Senate Conference Committee Report on Energy and Water Development Appropriations. In June 1995, DOE submitted the draft risk report to Congress. The report provides the first link between budget, compliance agreements, and risk. DOE field program managers evaluated the risks associated with all types of environmental management work in a qualitative fashion. The results of that evaluation allowed DOE to capture the spectrum of risks and to link risk to compliance and budget information.

The draft report sets the foundation for a consistent approach in evaluating risks posed by conditions at DOE sites and facilities and in establishing priorities for human health, worker safety, and the environment. In addition to responding to Congress, this report provides public access to risk data, develops recommendations to fill gaps in the available risk information, advances the national debate on the use of risk in decision making, and provides data for establishing priorities among competing requirements.

The Risk Report evaluates the full range of DOE environmental management programs and the activities associated with those programs including waste characterization, treatment, storage, disposal, and minimization; program management; and technology development. Actual or planned activities are evaluated. The Risk Report provides a qualitative summary of the risks and potential risk reduction associated with an activity within six risk categories: public safety and health, worker safety and health, environmental protection, compliance, cost-effective risk management, and site mission completion. However, the focus of the WM PEIS hypothetical programmatic receptor census can be used to support the qualitative risk evaluation provided by the Risk Report.

Nuclear Materials and Facility Stabilization. DOE is responsible for certain nuclear materials that are surplus to the current mission and which may have residual quantities of enriched uranium, plutonium, and

other transuranics that may preclude direct disposal of the material at WIPP. These materials are commonly referred to as "residues."

Residues are a byproduct of nuclear weapons material production. Large quantities were generated as a result of the chemical and thermal processes applied to separate and purify plutonium at RFETS, Richland, LANL, LLNL, and SRS. Examples of residue forms include impure oxides and metals, halide salts, combustibles, ash, sludges, and contaminated glass. These materials may also contain RCRA-regulated waste. When nuclear weapons were being produced and the stockpile was growing, the vast majority of these residues were recycled back into the weapons production process. These materials were designed, handled, and packaged for short-term storage. When the weapons production lines were halted in the late 1980s, many materials were left in conditions unsuitable for long-term storage.

Recently, DOE and the Defense Nuclear Facilities Safety Board (DNFSB) initiated activities to investigate the conditions of nuclear materials within the Department. Numerous plutonium packaging and facility vulnerabilities were identified and documented in the DOE *Plutonium Working Group Report* (DOE/EH-0415), *Plutonium Vulnerability Management Plan* (DOE/EM-0199), and DNFSB Recommendation 94-1.

The Department has responded by developing a complexwide implementation plan to address the plutonium vulnerabilities and ensure safe storage of nuclear material until it can be ultimately dispositioned. As part of that plan, some residues throughout the complex will need to undergo some type of treatment process. These processes could include separation of nuclear material, which, if considered weapons-usable, would then become part of the decision-making process associated with the *Storage and Disposition of Weapons-Usable Fissile Material PEIS*. During these processes, secondary TRUW may be generated. Other residues may be designated waste and will need to be treated (along with any secondary wastes) to meet WIPP waste acceptance criteria.

An EIS is currently being developed to address the environmental impacts of alternatives associated with residue processing. Waste volumes for the different alternatives have not been determined but are bounded in both the WM PEIS and the WIPP Supplemental EIS.

Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2. The DNFSB was established and authorized by Congress to oversee DOE. On September 8, 1994, the DNFSB issued

Recommendation 94-2, "Conformance with Safety Standards at Department of Energy Low-Level Nuclear Waste and Disposal Sites." Recommendation 94-2 concluded that DOE's LLW program has not kept pace with the evolution of commercial practices, that no radiological performance assessments for LLW disposal facilities required by the DOE Order on Radioactive Waste Management had been approved, and that the Department's radiological performance assessments do not account for other source terms that potentially add to the dose projected for LLW disposal facilities. The Board recommended that DOE conduct a complexwide review to establish the dimensions of the LLW problem, take steps to complete the radiological performance assessments, and include in these assessments all interacting source terms. The Board also recommended that DOE issue new standards, requirements and guidance for LLW management and perform a number of studies to improve the management of LLW. To respond to the Board's recommendations, DOE set up tasks in six areas.

- **Systems Engineering for the LLW Program**, which will document LLW system requirements and functions and identify the need for any additional requirements and functions necessary to integrate the program across the complex and accomplish the mission. A study will also be conducted under this task to evaluate the safety merits and demerits of privatizing LLW disposal as one scenario for process improvement.
- **Complexwide Review**, which involved an evaluation of LLW management activities at the 38 DOE facilities that actively manage LLW and LLMW to identify vulnerabilities associated with DOE's management of LLW. Onsite assessments were conducted at the eight DOE sites which manage 80% of the LLW currently being managed. The remaining sites were evaluated through a review of available site information and interviews with DOE headquarters and DOE field and contractor LLW management personnel.
- **DOE Regulatory Structure and Process**, which will provide the policies and requirements needed to improve the management of DOE LLW. Essential requirements for the management of LLW will be identified, developed, and technically justified for functions and activities that are necessary to meet the mission of the LLW Program, and to satisfy the top-level requirements for safety and health of the workers, the public, and protection of the environment. Commercial and international standards will be evaluated and considered for potential adoption by DOE.
- **Radiological Assessments**, which will address the completion and approval of Performance Assessments for LLW disposal facilities and the groundwork for addressing interacting source terms.
- **Low Level Waste Projections**, which will provide a report on current and planned LLW disposal capacity, develop a routine program for projecting waste volumes, and develop a waste minimization strategy.

- **Research and Development**, which will provide the framework to support necessary technology development for LLW.

1.9 DOE Public Reading Rooms

The public reading rooms listed on the following pages are available for referencing documentation related to the WM PEIS. Information regarding the status of this EIS as well as some related EISs can be found at these sites. When a decision regarding the WM PEIS is made, it will be made available to the public at these sites. Information not available at these sites can be accessed through the Office of NEPA Policy and Assistance at 202-586-4600 or the Department of Energy NEPA Information Line at 800-472-2756.

California

DOE Reading Room
1301 Clay Street
Oakland, CA 94612

The State (DTSC) Library
Lincoln Plaza Building
4th and P Street
Sacramento, CA 92410

The State (DTSC) Library
State of California
P.O. Box 806
Sacramento, CA 95812-0806

Lawrence Livermore Eastgate Visitors Center
Greenville Road
Livermore, CA 94550

Simi Valley Public Library
Tapo Canyon Road
Ventura, CA 93001

Davis Public Library
14th Street
Davis, CA 95617

Berkeley Public Library
Kittredge and Shattuck
Berkeley, CA 94794

MINSY Public Affairs
Office Code 1160–Building 47
Vallejo, CA 94592-5100

Concord Branch Library
2900 Salvio Street
Concord, CA 94519

SNL/CA Public Reading Room
7011 East Avenue
Building 901
Livermore, CA 94550

Colorado

Government Reference Center
Mesa County Public Library
530 Grand Avenue
Grand Junction, CO 81503

Technical Resource Center
Grand Junction Project Office
2597 B 3/4 Road
Grand Junction, CO 81503

Rocky Flats Environmental Technology
Site Reading Room
Front Range Community College Library
3645 West 112th Avenue
Westminster, CO 80030

Rocky Flats Citizens Advisory Board
Attn: Ken Korkia
9035 Wadsworth Parkway
Suite 2250
Westminster, CO 80021

U.S. EPA Region VIII
Attn: Michelle Bontrager
999 18th Street, Suite 500
Denver, CO 80202-2405

Colorado Department of Health
Attn: Dan Scheppers
4300 Cherry Creek Drive,
South Denver, CO 80222-2405

Standley Lake Library
Attn: Kathy Hollaran
8485 Kipling Street
Arvada, CO 80005

Connecticut

Windsor Public Library
Attn: Mary Ellen Johnson
323 Broad Street
Windsor, CT 06095

Florida

Jacksonville Public Library
Documents Department
122 North Ocean Street
Jacksonville, FL 32202

Largo Public Library
351 East Bay Drive
Largo, FL 34640

Martin Marietta Specialty Components
Community Relations Center
7381 114th Avenue, North
Suite 403A
Largo, FL 34643

Pinellas Park Public Library
7770 52nd Street, North
Pinellas, FL 34665

Georgia

Atlanta Public Library
Government Documents Section
Attn: Gene Hughs
1 Margaret Mitchell Square
Atlanta, GA 30303

Chatham County Public Library
2002 Bull Street
Savannah, GA 31401

Reese Library
Attn: Elfriede McLean
Document Center
Augusta College
2500 Walton Way
Augusta, GA 30904-2200

Hawaii

Pearl Harbor Naval Base Library
Code 90L
1614 Makalapa Drive
Pearl Harbor, HI 96860-5350

Aiea Public Library
99-143 Monanalua Road
Aiea, HI 96701

Hawaii State Library
478 South King Street
Honolulu, HI 96813

Pearl City Public Library
1138 Waimano Home Road
Pearl City, HI 96782

Idaho

Boise Basin District Library
Attn: Elizabeth Prusha-Parlor
411 Montgomery Street
P.O. Box 219
Idaho City, ID 83631

Boise Public Library
Attn: Julie Davis
Government Documents
715 South Capitol Boulevard
Boise, ID 83702

INEL Oversight Program Library
Department of Health and Welfare
Attn: Nancy Quirk
1410 North Hilton, 3rd Floor
Boise, ID 83706

State Library
Attn: Stephanie Kirkay
325 West State Street
Boise, ID 83702

Library and Archives
State Historical Society
Attn: Wm. E. Tydeman
450 North Fourth Street
Boise, ID 83209

INEL Boise Outreach Office
Attn: Cheryl Burgess
816 W. Bannock, Suite 306
Boise, ID 83702

City of Burley Public Library
Attn: Mona Kenner
1300 Miller Avenue
Burley, ID 83318

Clearwater Memorial Library
Attn: Jill Lynch
402 Michigan Avenue
P.O. Box 471
Orofina, ID 83544

INEL Technical Library
1776 Science Center Drive
P.O. Box 1625
Idaho, ID 83415-2300

Idaho Falls Public Library
Attn: Ginny Atwood
457 Broadway
Idaho Falls, ID 83402

State University Library
Documents Department
Attn: Larry Murdock
P.O. Box 8089
Pocatello, ID 83209

Pocatello Public Library
Attn: Gaila Clough
113 South Garfield
Pocatello, ID 83204

Shoshone-Bannock Library
Attn: Ardith Peyope
Bannock and Pima Streets-HRDC Building
Fort Hall, ID 83203

Twin Falls Public Library
Attn: Linda Parkinson
434 Second Street, East
Twin Falls, ID 83301

Consolidated Free Library
Hayden Branch
Attn: Lee Starr
8385 North Government Way
Hayden Lake, ID 83835

City of Emmett Public Library
Attn: Marsha Werle
275 South Hayes
Emmett, ID 83617

Illinois

Lemont Public Library
Attn: Jackie
810 Porter Street
Lemont, IL 60439

U.S. DOE Public Document Room
Document Department
University Library
3rd Floor Center
University of Illinois at Chicago
801 South Morgan Street
Chicago, IL 60607

Bedford Park Public Library
Attn: Head Librarian
7816 West 65th Place
Bedford Park, IL 60510

Bridgeview Public Library
Attn: Head Librarian
7840 West 79th Street
Bridgeview, IL 60455

Iowa

Ames Laboratory
111 T.A.S.F.
Attn: Steve Karsjen
Ames, IA 50011

Ames Public Library
515 Douglas Avenue
Ames, IA 55001

Kentucky

Environmental Information Center
175 Freedom Boulevard
Kevil, KY 40253

Maine

Rice Public Library
8 Westworth Avenue
Kittery, ME 03904

Missouri

Red Bridge Branch
Mid-Continent Library
11140 Locust Street
Kansas City, MO 64108

U.S. Department of Energy
Attn: Martha Carey
7295 Highway 94 South
St. Charles, MO 63304

Columbia Public Library
Attn: Marilyn McCleod
100 West Broadway
Columbia, MO 65203

Nevada

Carson City Public Library
Attn: Wendell Huffman
900 North Roop Street
Carson City, NV 89701

Nevada State Library
Attn: Patricia Deadder
Capitol Complex
Carson City, NV 89710

Nevada Test Site Reading Room
Coordination and Information Center
Attn: Cinde Ashley
3084 South Highland Drive
Las Vegas, NV 89109

New Hampshire

Portsmouth Public Library
8 Islington Street
Portsmouth, NH 03601

New Jersey

Maywood DOE Public Information Center
43 West Pleasant Avenue
Maywood, NJ 07607

Middlesex County Library
Plainsboro Branch
P.O. Box 278
Plainsboro, NJ 08536

New Mexico

National Atomic Museum
Kirkland Air Force Base
20358 Wyoming Boulevard, South
Albuquerque, NM 87116

Albuquerque Technical Vocational Institute
Main Campus Library
525 Buena Vista Drive, Southeast
Albuquerque, NM 87106

Museum Park Complex
15th and Central
Suite 101
Los Alamos, NM 87544

New York

Longwood Public Library
800 Niddle County Road
Middle Island, NY 11953

Records Center
26 Federal Plaza
29th Floor, Room 2900
New York, NY 10278

EPA Records Center
290 Broadway
New York NY 10007-1866

Mastics-Moriches-Shirley Community Library
425 William Floyd Parkway
Shirley, NY 11967

Brookhaven National Laboratory
Research Library–Building 477A
Upton, NY 11973

Colonie Library
629 Albany-Shaker Road
Loudenville, NY 12211

Saratoga Springs Library
Attn: Claudia Hayes
320 Broadway
Saratoga Springs, NY 12866

Schenectady Public Library
Attn: Tim McGowan
Main Branch
99 Clinton Street
Schenectady, NY 12305-2093

Jennifer Nelson, Public Affairs
MS-Trailer A
10282 Rock Springs Road
West Valley, NY 14171

Buffalo & Erie County Public Library
Science and Technology Department
Lafayette Square
Buffalo, NY 14203

Town of Concord Library
23 North Buffalo Street
Springville, NY 14141

Olean Public Library
Attn: Lance Chaffee
134 North 2nd Street
Olean, NY 14760

North Carolina

Brunswick County Government Center
Attn: Andrea Merklinger
45 Court House Drive, Northeast
Bolivia, NC 28422

New Hanover County Public Library
Attn: Daniel Horn
201 Chestnut Street
Wilmington, NC 28401

Ohio

Columbus Metropolitan Library
Main Branch
96 South Grant Avenue
Columbus, OH 43215

Northside Branch Library
1423 North High Street
Columbus, OH 43201

State Library of Ohio
Attn: Clyde Hordusky
65 South Front Street
Columbus, OH 43215

West Jefferson Public Library
Attn: Sharon Shrum
270 Lily Chapel Road
West Jefferson, OH 43162

Kent State University
Ashtabula Campus Library
3431 West 13th Street
Ashtabula, OH 44004

Public Environmental Information Center
10845 Hamilton Cleves Highway
Harrison, OH 45030

Miamisburg Senior Adult Center
Public Reading Room
305 Central Avenue
Miamisburg, OH 45343

DOE Environmental Information Center
505 West Emmitt Avenue, Suite 3
Waverly, OH 45690

Oregon

Portland State University
Branford Price Millar Library
Attn: Michael Bowman
SW Harrison and Park
Portland, OR 97202

Pennsylvania

Carnegie Library
Attn: James Bobick
Science and Technology Department
4400 Forbes Avenue
Pittsburgh, PA 15213

South Carolina

Charleston County Library
Attn: Nancy Woodward
404 King Street
Charleston, SC 29403

Gregg-Graniteville Library
University of South Carolina-Aiken
Attn: Allison Johnson
171 University Parkway
Aiken, SC 29801

DOE/SRS Public Reading Room
Savannah River Operations Office
Attn: Becky Craft
P.O. Box A
Aiken, SC 29802

South Carolina State Library
Attn: Mary Bostick
1500 Senate Street
Columbia, SC 29201

Tennessee

DOE Environmental Information Resource Center (IRC)
105 Broadway
Oak Ridge, TN 37830

DOE Public Reading Room
Oak Ridge Operations Office
Attn: Amy Rothrock
Room 112B
55 Jefferson Circle
Oak Ridge, TN 37831

Oak Ridge Public Library
Civic Center
1401 Oak Ridge Turnpike
Oak Ridge, TN 37830

Clinton Public Library
Attn: Jane Giles
118 South Hicks Street
Clinton, TN 37716

Lawson McGhee Public Library
Attn: Nelda Hill
500 West Church Avenue
Knoxville, TN 37902

Oliver Springs Public Library
Attn: Jennifer Newcome
607 Easterbrook Avenue
Oliver Springs, TN 37840

Memphis/Shelby County Public Library and Information Center
Attn: Government Publications
1850 Peabody Avenue
Memphis, TN 38104

Rockwood Public Library
Attn: Margaret Marrs
117 North Front Avenue
Rockwood, TN 37854

Texas

Amarillo College Library
Attn: Karen McIntosh
Lynn Library
DOE Reading Room
2201 South Washington
Amarillo, TX 79109

Carson County Library
Public Reading Room
Attn: Teri Keotting
P.O. Box 339
401 Main Street
Panhandle, TX 79060

Mae S. Bruce Public Library
Attn: Rose Holloway
P.O. Box 950
13302 6th Street
Santa Fe, TX 77510

Friendswood Public Library
Attn: Mary Perroni
416 South Friendswood
Friendswood, TX 77546

LaMarque Public Library
Attn: Greg Burns
1011 Bayou Road
La Marque, TX 77568

Genevieve Miller Public Library
Attn: Kathleen Brooks
8005 Barry Street
Hitchcock, TX 77563

Moore Memorial Public Library
Attn: Joanne Turner
1701 9th Avenue North
Texas City, TX 77590

Rosenberg Library
Attn: Jackie Kinsey
2310 Sealley Avenue
Galveston, TX 77550-2296

Helen Hall Public Library
Attn: Shelly Leader
400 West Walker
League City, TX 77537

Houston Public Library
Attn: Carol Johnson
500 McKinney
Houston, TX 77002

Virginia

Portsmouth Public Library
601 Court Street
Portsmouth, VA 23704

Washington

Gonzaga University, Foley Center
Attn: Joyce Cox
East 502 Boone
Spokane, WA 99258

Westinghouse Hanford Company
Environmental Data Management Center
Attn: Debbie Isom
2440 Stevens Center Place
Room 1101
Richland, WA 99352

U.S. Department of Energy Reading Room
Washington State University
Attn: Terri Traub
100 Sprout Road, Room 130
Richland, WA 99352

Department of Ecology
Washington State Nuclear &
Mixed Waste Library
Attn: Marilyn Smith
300 Desmond Drive
Lacey, WA 98503

U.S. Environmental Protection Agency
Attn: Karen Prater
1200 6th Avenue, HW-070
Seattle, WA 98101

University of Washington
Suzzallo Library
Attn: Hillary Reinert
Box 352900
Seattle, WA 98195

Kitsap Regional Library
Attn: Tobey Gustafson
1301 Sylvan Way
Bremerton, WA 98310

Tacoma Public Library
Attn: Larry Mischo
1102 Tacoma Avenue South
Tacoma, WA 98402

Washington, D.C.

U.S. Department of Energy
Room 1E-190
Attn: Carolyn Lawson
1000 Independence Avenue, Southwest
Washington, DC 20585

Center for EM Information
Attn: Kim Tulley
479 L'Enfant Plaza East SW
Suite 7112
Washington, DC 20024

Wyoming

Wyoming State Library
Supreme Court Building
Government Publications
Attn: Venice Beske
Cheyenne, WY 82002

Chapter 1
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CHAPTER 2
Purpose and Need for Action

In accordance with the Council on Environmental Quality (NEPA) regulations, this chapter identifies the Department of Energy's (DOE) proposed action and the purpose and need for DOE action with respect to each of the five waste types analyzed in this Programmatic Environmental Impact Statement (PEIS).

2.1 Proposed Action

DOE is proposing to improve the management (treatment, storage, or disposal) of five types of waste. The Department will comply with all applicable Federal and State laws, to protect public health and safety as well as the environment. In the context of this WM PEIS, management includes:

- Pollution prevention
- Identifying/contracting with private vendors to manage waste
- Modifying existing waste management facilities or constructing new facilities at particular sites
- Operating modified or new waste management facilities at those sites
- Transporting wastes between waste management sites, as necessary
- Handling, surveillance, and maintenance

The WM PEIS will help DOE identify the optimal national configuration for the following waste management activities:

- Treatment and disposal of LLMW
- Treatment and disposal of LLW
- Treatment and storage of TRUW
- Storage of treated (vitrified) HLW canisters until a geologic repository is available
- Treatment of nonwastewater HW

This focus on a national configuration in the first attempt made by DOE to conduct an integrated examination of impacts across the Department's waste management complex and the specific cumulative impacts from all the waste facilities at a given site.

2.2 Purpose and Need for DOE Action

DOE needs to manage its current and anticipated volumes of LLMW, LLW, TRUW, HLW, and HW in order to comply with all applicable Federal and State laws and to protect public health and safety, and to enhance protection of the environment.

DOE is required by the Atomic Energy Act (42 USC 2011 *et seq.*) to manage the radioactive wastes that it generates. LLMW, LLW, TRUW, and HLW have radioactive components. In addition, DOE needs to make waste management decisions concerning HW and hazardous components in mixed wastes (waste that is both hazardous and radioactive) in order to comply fully with the Resource Conservation and Recovery Act (RCRA) (42 USC 6901 *et seq.*). RCRA sets forth requirements for managing HW including mixed waste. HLW, LLMW, and some TRUW are all mixed wastes and thus are subject to RCRA. RCRA requires the U.S. Environmental Protection Agency (EPA) to issue land disposal restrictions (40 CFR 268), which prohibit storage of hazardous and mixed wastes, except to facilitate proper recovery, treatment, and disposal.

The Federal Facility Compliance Act (FFCAct) (42 USC 6961 *et seq.*) amended RCRA to allow EPA and individual States to impose fines and penalties on Federal facilities for RCRA violations. The FFCAct requires DOE to prepare site treatment plans (STPs) for developing treatment capacity for its mixed wastes (waste containing both radioactive and hazardous components subject to RCRA requirements). Sixteen of the 17 major sites analyzed in the WM PEIS are required to prepare STPs. Each of these sites has submitted an STP, and all but three (ANL-E, BNL, and LLNL) have been approved by the appropriate agency. Compliance orders or agreements have been issued or made for the approved STPs. The FFCAct subjects DOE to fines after October 6, 1995, for violations of RCRA's LDRs for waste storage, unless the site is otherwise in compliance with an approved STP and compliance order issued by the appropriate waste regulator. The WM PEIS provides the NEPA basis for the FFCAct LLMW treatment configuration, while the FFCAct STPs detail the LLMW treatment program.

DOE manages each waste type separately and therefore will make waste management decisions by waste type.

2.2.1 LOW-LEVEL MIXED WASTE

This PEIS examines the potential environmental impacts of treatment and disposal of LLMW. Although existing commercial and DOE capacity is insufficient to treat DOE's LLMW it is possible that some portion of the inventory could be treated at commercial facilities and that overall capacity could increase to meet demand. To comply with the land disposal restrictions and the FFCAct, DOE has developed site-specific plans for developing treatment capacities for the LLMW stored, generated, and disposed of at its sites. Although the FFCAct does not require DOE to develop plans for LLMW disposal, DOE also needs to determine where to dispose of treated LLMW.

2.2.2 LOW-LEVEL WASTE

This PEIS examines the potential environmental impacts of treatment and disposal of LLW. Currently, LLW is packaged to meet waste acceptance criteria where it is generated and is disposed of at six DOE sites. This arrangement for disposing of LLW at a limited number of sites has evolved based on past research and weapons production operations, without considering either the total quantities of LLW generated or the sites at which it is generated. Accordingly, DOE needs to re-examine its management of LLW and determine where to dispose of LLW in the future. As part of this decision, DOE also needs to consider where LLW should be treated before disposal.

2.2.3 TRANSURANIC WASTE

This PEIS examines the potential environmental impacts of treatment and storage of TRUW. Since 1970, DOE has stored all of its TRUW, including TRUW containing hazardous components that are subject to RCRA. DOE is proposing to dispose of its retrievably stored defense TRUW in a geologic repository known as the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, if acceptable disposal performance can be demonstrated and regulatory requirements are met. Several studies are under way to characterize and understand more fully the potential long-term behavior of the disposal of TRUW at WIPP. Based on the results of these studies and independent of this PEIS, DOE will determine whether to dispose of TRUW at WIPP. To reduce the potential for delays in future TRUW disposal at WIPP, DOE needs to identify those sites where TRUW would be treated and stored.

2.2.4 HIGH-LEVEL WASTE

This PEIS examines the potential environmental storage impacts of treated (vitrified) HLW canisters. DOE is proceeding with plans at four sites to treat HLW by processing it into a glass form that would not be readily dispersible into the air or leachable into ground or surface water. Under the Nuclear Waste Policy Act (42 USC 10101–10270), treated HLW is to be disposed of in a geologic repository. Because of delays in opening this repository (now scheduled to open in 2010, with acceptance of DOE-managed HLW beginning in 2015), the quantity of treated HLW requiring storage will be more than originally anticipated, and the post-treatment storage time will also be greater. Thus, DOE needs to decide whether storage facilities for treated HLW should be constructed at the four HLW sites or whether larger storage facilities should be built at fewer sites. Treated HLW would be stored at these facilities until a geologic repository becomes available for permanent disposal.

2.2.5 HAZARDOUS WASTE

This PEIS examines the potential environmental impacts of treatment of nonwastewater HW. Currently, DOE uses a combination of its own and commercial treatment, storage, and disposal facilities for HW, as determined by each site that generates this material. DOE treats about 99% of its HW (primarily wastewater) onsite, and ships about 1% (primarily organic substances such as solvents and cleaning agents) to commercial HW facilities. DOE needs to decide the extent to which it should rely on commercial facilities for the treatment of nonwastewater HW.

CHAPTER 3
Alternatives

This chapter describes the four categories of waste management alternatives analyzed in the Waste Management Programmatic Environmental Impact Statement (WM PEIS). It also describes the methodology used to develop the alternatives and the alternatives considered but not analyzed in detail. A comparison of the impacts of the alternatives can be found in the waste-type Chapters 6 through 10.

3.1 Introduction

This chapter describes the waste management alternatives considered in the WM PEIS. These alternatives reflect different national configurations of particular sites evaluated in this document for the management of low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), high-level waste (HLW), and hazardous waste (HW). The alternatives considered for each waste type fall within four broad categories: the No Action Alternative and the Decentralized, Regionalized, and Centralized Alternatives. Under each of the four broad categories for each of the five waste types, there are one or more alternatives that vary by the number and location of U.S. Department of Energy (DOE) sites at which waste management facilities could be located.[1] As shown in Table 3.1-1, 36 alternatives from the four categories are evaluated for the five waste types. The waste management alternatives eventually selected by DOE may vary among the five waste types. The configurations considered for each waste type, including the name of each site included in a particular configuration, are presented in Section 3.4.

3.2 Regulatory Background

The Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA) (42 USC 4231 *et seq.*) require Federal agencies to include a discussion of all reasonable alternatives to the proposed action in an environmental impact statement (EIS) (40 CFR 1502.14). An agency must provide sufficient information for each alternative so that reviewers may evaluate the comparative merits of those alternatives.

[1] The alternatives within the four broad categories of alternatives are sometimes referred to as "cases" in the accompanying appendices and technical reports.

Table 3.1–1. Number of Alternatives Analyzed by Waste Type

Category	LLMW	LLW	TRUW	HLW*	HW	TOTAL
No Action	1	1	1	1	1	5
Decentralized	1	1	1	1	1	5
Regionalized	4	7	3	2	2	18
Centralized	1	5	1	1	0	8
TOTAL	7	14	6	5	4	36

* HLW alternatives are analyzed both in terms of final disposal beginning in 2015 and final disposal beginning at some later date. However, the decision of when disposal will begin is not part of the WM PEIS. A separate National Environmental Policy Act (NEPA) document will be prepared in accordance with the HLW candidate program.

In addition, an EIS must include a discussion of the "No Action Alternative." Such a "status quo" alternative would not necessarily comply with applicable laws and regulations, but it provides an environmental baseline against which the impacts of other alternatives can be compared.

For alternatives that were eliminated from detailed study, the agency must briefly discuss the reasons for their elimination. Further, the agency must identify its preferred alternative or alternatives, if one exists, in the draft EIS, and must identify the preferred alternative in the final EIS unless another law prohibits the expression of such a preference.

3.3 Four Categories of Alternatives

In this PEIS, an alternative is the configuration of sites for treating, storing, or disposing of a specific waste type. The categories of alternatives analyzed in this PEIS for each waste type are No Action, Decentralized, Regionalized, and Centralized. These categories are described below:

No Action Alternative. Selection of this alternative would involve using only currently existing or planned waste management facilities at DOE sites or commercial vendors.

Decentralized Alternatives. Selection of these alternatives would result in managing waste where it is or where it will be generated, treated, or disposed of in the future. Unlike the No Action Alternative, the

Decentralized Alternatives may require the siting, construction, and operation of new facilities or the modification of existing facilities. Under the Decentralized Alternatives, the waste management facilities would be located at a larger number of sites than under the Regionalized or Centralized Alternatives.

Regionalized Alternatives. Selection of these alternatives would result in transporting wastes to various numbers of sites (fewer than the number of sites considered for the Decentralized Alternatives but greater than the number of sites considered for the Centralized Alternatives). In general, those sites that now have the largest volumes of a given waste type were considered as regional sites for treatment, storage, or disposal.

Centralized Alternatives. Selection of these alternatives would result in transporting wastes to one or two sites for treatment, storage, or disposal. As with the Regionalized Alternatives, those sites that have the largest volumes of a given waste type were considered as sites for Centralized treatment, storage, or disposal.

3.4 Alternatives Under Each Category

An alternative is the configuration of sites for treating, storing, or disposing of a specific waste type. For example, under "LLMW Regionalized Alternative 2," DOE would transport LLMW to seven sites for treatment and treated LLMW to six sites for disposal. Each alternative specifies the sites involved. The alternatives considered under each category for each waste type are described fully in the subsequent waste-type Chapters 6 through 10. The following tables (3.4–1 through 3.4–5) identify, by alternative for each site, the proposed waste management actions at that site.

The alternatives were developed and defined to incorporate all possible actions of DOE concerning waste management. They were based on waste type origin and character, current and projected volumes and locations within the DOE complex, existing facilities and capabilities, and specialized treatment and disposal requirements. The analysis of the alternatives presented in this PEIS encompass the human health risks; environmental, transportation, and socioeconomic impacts; and costs associated with the range of waste treatment, storage, and disposal activities available to DOE.

Table 3.4–1. Proposed Waste Management Actions at Each Site Under the Low-Level Mixed Waste Alternatives[a]

Alternative	Number of Sites		ANL–E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL–NM	SRS	WVDP
	CH Nonalpha Treat	Dispose																
No Action	3	0	S	S	S	S	TS	S	S	S	TS	S	S	S	S	S	TS	S
Decentralized	37	16	TD	TD	TD	TD	TD∝[b]	TD∝	TD∝	TD∝	TD	TD	TD	TD	TD∝	TD	TD∝	TD
Regionalized 1	11	12			TD	TD	TD∝	TD∝	TD∝	D∝	TD	TD	TD	TD	TD∝		TD∝	
Regionalized 2	7	6				TD	TD∝	TD∝		D∝	TD			T	T∝		TD∝	
Regionalized 3	7	1				T	T∝	T		D∝	T			T	T∝		T∝	
Regionalized 4	4	6				TD	TD∝	D∝		D∝	TD						TD∝	
Centralized	1	1				TD∝												

Notes: T = treatment to meet land disposal restrictions; D = disposal; S = indefinite storage. All sites have wastewater treatment capability as needed. Treatment, storage and disposal could also take place at a privatized or commercial facility on a site- or project-specific basis. Blanks indicate that treatment, storage, or disposal of LLMW does not occur at a site under the specified alternative.

[a] The actions shown are for contact-handled (CH) wastes. Contact-handled waste is subdivided into two types of LLMW, alpha and nonalpha. These two types of LLMW are generally treated in separate facilities. Remote-handled (RH) wastes would be treated and disposed onsite at the Hanford Site, INEL, ORR, and SRS in all alternatives except No Action. RH waste would be stored under No Action.

[b] Facilities with the ∝ symbol treat or dispose of both contact-handled alpha and nonalpha waste.

Table 3.4-2. Proposed Waste Management Actions at Each Site Under the Low-Level Waste Alternatives

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	Treat	Dispose																
No Action	10[a]	6				TD	TD	D	T	D	TD	T			T		TD	
Decentralized		16	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Regionalized 1		12			D	D	D	D	D	D	D	D	D	D	D		D	
Regionalized 2	11	12			TD	TD	TD	TD	TD	D	TD	TD	TD	TD	TD		TD	
Regionalized 3		6				D	D	D		D	D						D	
Regionalized 4	7	6				TD	TD	TD		D	TD			T	T		TD	
Regionalized 5	4	6				TD	TD	D		D	TD						TD	
Regionalized 6		2				D											D	
Regionalized 7		2								D							D	
Centralized 1		1				D												
Centralized 2		1								D								
Centralized 3	7	1				TD	T	T			T			T	T		T	
Centralized 4	7	1				T	T	T		D	T			T	T		T	
Centralized 5	1	1				TD												

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. All sites would do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. Treatment, storage, and disposal could also take place at a privatized or commercial facility on a site- or project-specific basis. Blanks indicate that LLW is not treated or disposed at a site under the specified alternative.
D=dispose. Each of the 6-site disposal alternatives uses the 6 same sites; each of the 12-site disposal alternatives uses the same 12 sites.
[a] Ten sites use existing facilities for volume reduction. Three sites (LBL, RMI, and Mound) not listed as major sites above include volume reduction facilities.

Table 3.4–3. Proposed Waste Management Actions at Each Site Under the Transuranic Waste Alternatives

Alternative	Number of Sites: CH Treat	Number of Sites: RH Treat	Treat Stand	ANL–E	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	RFETS	SNL–NM	SRS	WIPP	WVDP
No Action	11	5	WIPP-WAC	TS	TS	TS	TS	TS	S	TS	S	TS	S	TS		S
Decentralized	16	5	WIPP-WAC	TS	TS	TS	TS	TS	TS	TS	T	TS	T	TS		T
Regionalized 1	5	2	Reduced gas		TS[a]	TS	TS			TS[b]		TS		TS		
Regionalized 2	5	2	LDR		TS[a]	TS	TS			TS[b]		TS		TS		
Regionalized 3	3	2	LDR		TS[a]	TS				TS[b]				TS		
Centralized	WIPP	2	LDR		TS[c]					TS[b]					T	

Notes: T = treatment to one of three standards: process to current waste acceptance criteria at WIPP (WIPP-WAC); shred and grout to reduce potential for gas generation at the repository (Reduced Gas); and treat to meet land disposal restrictions using thermal organic destruction and complete treatment train; S = storage after treatment under No Action and Decentralized Alternatives or store current inventory under the No Action Alternative. Blanks indicate that TRUW is not treated or stored at a site under the specified alternative.

[a] The Hanford Site treats both contact-handled (CH) and remote-handled (RH) waste.

[b] ORR treats RH waste only.

[c] The Hanford Site treats RH waste only.

Table 3.4–4. Proposed Waste Management Actions at Each Site Under the High-Level Waste Alternatives

Alternative	Store	Hanford	INEL	SRS	WVDP
No Action	4	S	S	S	S
Decentralized	4	S	S	S	S
Regionalized 1	3	S	S	S	
Regionalized 2	3	S	S	S	
Centralized 1[a]	1	S			

Note: S = storage. Blanks indicate that LLW is not stored at INEL, SRS, and WVDP under the specified alternative.
[a] Canisters generated at WVDP, SRS, and INEL prior to acceptance at the candidate repository in 2015 would be shipped to the Hanford Site for storage. Canisters generated at SRS and INEL after 2015 would be shipped directly to the candidate repository. If acceptance of the DOE-managed HLW is delayed past 2015, then all HLW canisters would be shipped to the Hanford Site for storage.

Table 3.4–5. Hazardous Waste Alternatives

Alternative	Treat	ANL–E	Hanford	INEL	LANL	LLNL	ORR	Pantex	SNL–NM	SRS
No Action	2			T			T			
Decentralized	3			T			T			T
Regionalized 1	5		T	T	T		T			T
Regionalized 2	2			T			T			

Note: T = treatment. Blanks indicate that HW is not treated at a site under the specified alternative. Fermi and KCP were not included in this table because they are not major sites as defined in Section 1.6 of Volume I, and impacts were not evaluated at those sites.

Although the four broad categories of alternatives analyzed for each waste type encompass the range of reasonable alternatives available to DOE, there are many possible combinations for the number and locations of DOE sites for treatment, storage, and disposal facilities. To narrow these combinations to a level where meaningful analysis could occur, DOE selected a range of reasonable alternatives for analysis under each category.

The waste management configuration that DOE ultimately selects for a particular waste type is not necessarily limited to one of the alternatives presented. A hybrid alternative could be developed that would incorporate components from one or more of the alternatives analyzed. For example, DOE may choose to treat a particular waste type on a regionalized basis and dispose of it at a centralized location. Another example would be to select a disposal site analyzed under a centralized alternative and additionally select a second disposal site analyzed under a regionalized alternative.

3.5 Methodology for Selecting and Identifying Alternatives

The PEIS considers alternatives within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. However, the number of possible alternatives under these broad categories is vast. For example, LLMW is generated, stored, or projected to be generated at 16 major sites. From one to 16 sites could be possible alternatives for the treatment of LLMW, and from one to 16 sites could be possible alternatives for disposal. The same general multisite scenario holds true for the other waste types.

The three "action" categories of alternatives encompass the range of reasonable alternatives available to DOE for the siting of waste management facilities. The Decentralized Alternatives consider waste management facilities at major sites where the waste is located or could be generated in the future, the Centralized Alternatives consider waste management facilities at one or two major sites, and the Regionalized Alternatives consider waste management activities at a number of major sites in between all and one. More than one Regionalized Alternative is considered for all waste types.

In order to determine reasonable proposed sites for Regionalized or Centralized waste management facilities, DOE determined where the largest waste volumes are located and where transportation requirements would be minimized. Treatment, storage, or disposal facilities were analyzed at those sites. However, total volumes of waste were not the sole criterion used to select Regionalized or Centralized sites. The character of the waste, specialized treatment requirements, and existing facilities were also taken into account. For example, some wastes that require special treatment were analyzed separately, and treatment sites were selected for analysis based on the volumes requiring special treatment rather than on total volumes.

3.6 Alternatives for Specific Waste Types

Complete descriptions of the alternatives, an analysis of the environmental impacts, and a comparison of the impacts are contained in the subsequent waste-type Chapters 6 through 10. Alternatives considered under each category in the WM PEIS are summarized in the following tables (3.6–1 through 3.6–5) for each waste type.

Table 3.6–1. Low-Level Mixed Waste—7 Alternatives

No Action	Sites would use existing and approved treatment facilities; residues from treatment would be stored indefinitely; LLMW would not be transported
Decentralized	All sites with contact-handled wastes would treat, and 16 sites would dispose of contact-handled wastes (remote-handled waste is treated and disposed of at 4 sites)
Regionalized (4 Alternatives)	1 Treatment of contact-handled wastes would occur at 11 sites; disposal would occur at 12 sites 2 Treatment of contact-handled wastes would occur at 7 sites; disposal would occur at 6 sites 3 Treatment of contact-handled wastes would occur at 7 sites; disposal would occur at 1 site 4 Treatment of contact-handled wastes would occur at 4 sites; disposal would occur at 6 sites
Centralized	The Hanford Site would treat and dispose of LLMW (remote-handled wastes would be treated and disposed of at 4 sites)

Table 3.6–2. Low-Level Waste—14 Alternatives

No Action	All sites would transport and dispose of LLW at 6 sites (the Hanford Site, INEL, LANL, NTS, ORR, SRS) under current arrangements; all sites would use existing treatment facilities
Decentralized	16 sites would dispose of all LLW projected to be generated over the next 20 years; a minimum level of treatment at each site is assumed
Regionalized (7 Alternatives)	2, 6, or 12 sites would dispose of all LLW projected over the next 20 years; in three alternatives, treatment to reduce volumes is also assumed, using regional sites 1 Disposal of LLW at 12 sites, without volume reduction 2 Volume reduction at 11 sites; disposal at 12 sites 3 Disposal at 6 sites, without volume reduction 4 Volume reduction at 7 sites; disposal at 6 sites 5 Volume reduction at 4 sites; disposal at 6 sites 6 Disposal at 2 sites (the Hanford Site and SRS), without volume reduction 7 Disposal at 2 sites (NTS and SRS), without volume reduction
Centralized (5 Alternatives)	One site (either the Hanford Site or NTS) disposes of all LLW projected over the next 20 years; in three alternatives, treatment to reduce volumes is also assumed 1 Disposal at the Hanford Site, without volume reduction 2 Disposal at NTS, without volume reduction 3 Volume reduction at 7 sites; disposal at the Hanford Site 4 Volume reduction at 7 sites; disposal at NTS 5 Volume reduction and disposal at the Hanford Site

Table 3.6–3. Transuranic Waste—6 Alternatives

No Action	Continue storage in existing facilities
Decentralized	TRUW would be treated to meet WIPP current criteria. Sites with small amounts would transport to 10 largest sites until disposal at WIPP
Regionalized (3 Alternatives)	1 Contact-handled TRUW would be treated at 5 sites and remote-handled TRUW would be treated at 2 sites, to intermediate level (to reduce gas generation), and transported to WIPP for disposal 2 Same as Regionalized 1, but waste would be treated to more stringent levels to meet land disposal restrictions (LDRs) 3 Contact-handled TRUW would be treated at 3 sites, and remote-handled TRUW at 2 sites to meet LDRs, then transported to WIPP for disposal
Centralized	Contact-handled TRUW would be transported to WIPP for treatment to meet LDRs and disposal; remote-handled TRUW would be transported to ORR and the Hanford Site for treatment to LDRs and then to WIPP for disposal

Table 3.6–4. High-Level Waste—5 Alternatives

No Action	HLW canisters would be stored at the Hanford Site, SRS, and WVDP until acceptance at geologic repository; HLW at INEL would be stored as calcine or liquids
Decentralized	HLW canisters of solidified waste would be stored at the 4 sites producing canisters until acceptance at geologic repository
Regionalized (2 Alternatives)	1 Canisters from WVDP would be transported to SRS; canisters would be stored at the Hanford Site, SRS, and INEL until acceptance at geologic repository 2 Canisters from WVDP would be transported to the Hanford Site; canisters would be stored at the Hanford Site, SRS, and INEL until acceptance at geologic repository
Centralized	Canisters would be transported from WVDP, INEL, and SRS to the Hanford Site; canisters would be stored at the Hanford Site until acceptance at geologic repository

Note: Each of the five alternatives is analyzed under two timing assumptions: (1) acceptance at the candidate repository begins in 2015; and (2) acceptance is delayed past 2015.

Table 3.6-5. Hazardous Waste—4 Alternatives

No Action	Nonwastewater HW would continue to be transported to commercial facilities; two DOE sites would thermally treat organic materials
Decentralized	Similar to the No Action Alternative, except organic materials would be thermally treated at three DOE sites
Regionalized (2 Alternatives)	1 50% of nonwastewater HW would be treated at five DOE sites (the Hanford Site, INEL, LANL, ORR, and SRS); 50% would be treated at commercial facilities 2 90% of nonwastewater HW would be treated at two DOE sites (INEL and ORR); 10% would be treated at commercial facilities
Centralized	None

3.7 Preferred Alternatives

The DOE selected its preferred alternatives after considering the analyses presented in the WM PEIS, the decision criteria presented in Section 1.7 of Volume I, and all of the comments submitted on the Draft WM PEIS. Table 3.7-1 summarizes the preferred alternatives for all of the major sites analyzed in the WM PEIS, and Tables 3.7-2 through 3.7-6 identify the waste management activities that each of the major sites would conduct under the preferred alternative. The preferred alternatives for each waste type are as follows.

Treatment of LLMW. A number of the Department's sites (generally sites with small amounts of LLMW) would send their LLMW to other sites for treatment. The sites that would receive these wastes and treat them under the DOE's preferred alternative are Hanford, INEL, ORR, and SRS. ANL-E, FEMP, LLNL, LANL, Pantex, PORTS, RFETS, and SNL-NM would treat LLMW onsite.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several Regionalized Alternatives as shown in Table 3.7-1. The potential environmental impacts of all alternatives for treatment of LLMW evaluated in the WM PEIS are small. DOE's preferred alternative is generally consistent with the Site Treatment Plans prepared under the FFCAct; these plans include the use of commercial facilities to treat some LLMW. DOE realizes that the compliance orders issued by State and Federal regulators on the basis of these Site Treatment Plans establish the requirements for treatment of DOE's LLMW.

Table 3.7-1. Summary of Preferred Alternatives

Waste Type	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR
LLMW	Treatment	D	R1[a]	D	R1	R4	D	D	R1[a]	R2
	Disposal[b]	R	R	R	R	R	R	R	R	R
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	R3	R3
	Disposal[b]	R	R	R	R	R	R	R	R	R
TRUW	Treatment	D			D	R3	D	D	D	R1
HLW	Storage				D	D				
HW	Treatment	N	-	-	N	N	N	N	-	N

Waste Type	Decision	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	WIPP
LLMW	Treatment	R2	D	D	D	D	R1	R1[a]	
	Disposal[b]	R	R	R	R	R	R	R	
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	
	Disposal[b]	R	R	R	R	R	R	R	
TRUW	Treatment	D	**		D	R1	R1	D	*
HLW	Storage						D	D	
HW	Treatment	-	N	-	-	N	N	-	

Notes: N = No Action; D = Decentralized; R1, R2, R3, R4 = Regionalized; - = site not analyzed as a major generating site; * = no impacts from treatment or storage. ** = the very small amount of TRUW at Pantex would be shipped to LANL for treatment and storage. A blank cell indicates that the waste type is not found at the site.

[a] Wastes from these sites (BNL, NTS, and WVDP) are shipped offsite to regional treatment centers.

[b] DOE prefers to further narrow its configuration of LLMW and LLW disposal sites to two to three sites. The selection of sites would be made following consultation with regulatory authorities, State and Tribal governments, and other interested stakeholders.

Table 3.7–2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Ames	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
ANL-E	Treatment	Onsite		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
BCL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Bettis	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
BNL	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Charleston	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
ETEC	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
FEMP	Treatment	Onsite[d]		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
GA	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
GJPO	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
Hanford	Treatment	Onsite	Regional treatment site[b]	
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
INEL	Treatment	Onsite	Regional treatment site[b]	Some INEL waste may be shipped to another regional treatment site[b]
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
KCP	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
KAPL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LEHR	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LBL	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LLNL	Treatment	Onsite		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LANL	Treatment	Onsite		
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
Mare Island	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]

Table 3.7–2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW—Continued

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Mound	Treatment	Onsite[e]		Regional treatment site[b,e]
	Disposal	Offsite		Regional disposal site[c]
NTS	Treatment	Offsite		Regional treatment site[b]
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
Norfolk	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
ORR	Treatment	Onsite	Regional treatment site[b]	
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
PGDP	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Pantex	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
Pearl Harbor	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Pinellas	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
PORTS	Treatment	Onsite[f]		Regional treatment site[b,f]
	Disposal	Offsite		Regional disposal site[c]
Ports Nav	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
PPPL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Puget So	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
RMI	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
RFETS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
SNL-NM	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
SRS	Treatment	Onsite	Regional treatment site[b]	Some SRS waste may be shipped to another regional treatment site
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
UofMO	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
WVDP	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]

See footnotes on next page.

Table 3.7–2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW—Continued

Note: A blank cell indicates that a site either does not receive LLMW from other sites or does not ship LLMW to other sites.
[a] A site is listed if it currently manages LLMW or is expected to manage it in the future.
[b] The regional treatment sites would be Hanford, INEL, ORR, or SRS, depending upon which site is shipping waste. The configuration analyzed in the WM PEIS for Hanford, INEL, ORR, and SRS is not exactly the same as those in the Site Treatment Plans; under the Site Treatment Plans:

- Hanford receives LLMW from BCL;
- INEL receives LLMW from Bettis, Charleston, ETEC, KAPL, LBL, LLNL, Mare Island, NTS, Norfolk, Pearl Harbor, PORTS, Puget So, SRS, and UofMO;
- ORR receives LLMW from ANL-E, BNL, FEMP, INEL, LBL, Mound, NTS, PGDP, PORTS, RMI, and WVDP; and
- SRS receives LLMW from Bettis, Charleston, KAPL, and Norfolk.

The evaluation of impacts at each of the major sites under the Preferred Alternative provides similar results as the configurations specified in the Site Treatment Plans. DOE realizes that the Site Treatment Plans, unless modified by the appropriate regulatory agency, establish the requirements for treatment of DOE's LLMW.
[c] The selection of two or three regional disposal sites will be made following further consultation with regulatory agencies, State and Tribal Governments, and other interested stakeholders.
[d] Site Treatment Plan indicates some waste may be treated onsite.
[e] Site Treatment Plan indicates some waste may be treated offsite at ORR.
[f] Site Treatment Plan indicates some waste may be treated offsite at INEL and ORR.

Table 3.7–3. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Ames	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
ANL-E	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Bettis	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
BNL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Fermi	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
FEMP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Hanford	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
INEL	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
KCP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
KAPL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
LBL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]

Table 3.7–3. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLW—Continued

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
LLNL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
LANL	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
Mound	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
NTS	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
ORR	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
PGDP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Pantex	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Pinellas	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
PORTS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
PPPL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
RFETS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
RMI	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
SNL-NM	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
SRS	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
SLAC	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
WVDP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]

Note: A blank cell indicates that a site ***either*** does not receive LLW from other sites or does not ship LLW to other sites.
[a] A site is listed if it currently manages LLW or is expected to manage it in the future.
[b] The selection of two or three regional disposal sites will be made following further consultation with regulatory agencies, State and Tribal governments, and other interested stakeholders.

Table 3.7–4. Waste Management Activities Under the Preferred Alternative for Treatment and Storage of TRUW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to[c]
ANL-E	Treatment	Onsite		
	Storage	Onsite		
ETEC	Treatment	Onsite		
	Storage	Onsite		
Hanford	Treatment	Onsite		
	Storage	Onsite		
INEL	Treatment	Onsite	RFETS	
	Storage	Onsite	RFETS	
LANL	Treatment	Onsite	Pantex, SNL-NM	
	Storage	Onsite	Pantex, SNL-NM	
LBL	Treatment	Onsite		
	Storage	Onsite		
LLNL	Treatment	Onsite		
	Storage	Onsite		
Mound	Treatment	Onsite		
	Storage	Onsite		
NTS	Treatment	Onsite		
	Storage	Onsite		
ORR[b]	Treatment	Onsite/offsite	SRS	CH-TRUW to SRS
	Storage	Onsite/offsite	SRS	CH-TRUW to SRS
Pantex	Treatment	Offsite		LANL
	Storage	Offsite		LANL
PGDP	Treatment	Onsite		
	Storage	Onsite		
RFETS	Treatment	Onsite/offsite		INEL
	Storage	Onsite/offsite		INEL
SNL-NM	Treatment	Offsite		LANL
	Storage	Offsite		LANL
SRS[b]	Treatment	Onsite/offsite	ORR	RH-TRUW to ORR
	Storage	Onsite/offsite	ORR	RH-TRUW to ORR
UofMO	Treatment	Onsite		
	Storage	Onsite		
WVDP	Treatment	Onsite		
	Storage	Onsite		

Notes: *CH-TRUW = contact-handled TRUW; RH-TRUW = remote-handled TRUW.* A blank cell indicates that a site either does not receive TRUW from other sites or does not ship TRUW to other sites.

[a] A site is listed if it currently manages TRUW or is expected to manage it in the future.

[b] Under the Preferred Alternative, ORR is a regional treatment center for RH-TRUW, and SRS is a regional treatment center for CH-TRUW.

[c] Storage of treated TRUW pending final disposition.

Table 3.7–5. Waste Management Activities Under the Preferred Alternative for Storage of Treated HLW

Generating Site[a]	Stores Waste at	Receives Waste	Ships Waste to[b]
Hanford	Hanford		
INEL	INEL		
SRS	SRS		
WVDP	WVDP		

Note: A blank cell indicates that a site either does not receive HLW from other sites or does not ship HLW to other sites.
[a] A site is listed if it currently manages HLW or is expected to manage it in the future.
[b] Storage pending ultimate disposition.

Table 3.7–6. Waste Management Activities Under the Preferred Alternative for Treatment of HW

Generating Site[a]	Treats Waste at	Receives Waste	Ships Waste to
ANL-E	Offsite commercial facility		Offsite commercial treatment facility
Fermi	Offsite commercial facility		Offsite commercial treatment facility
Hanford	Offsite commercial facility		Offsite commercial treatment facility
INEL	Organic HW onsite, other HW at offsite commercial facility		Offsite commercial treatment facility
KCP	Offsite commercial facility		Offsite commercial treatment facility
LANL	Offsite commercial facility		Offsite commercial treatment facility
LLNL	Offsite commercial facility		Offsite commercial treatment facility
ORR	Organic HW onsite, other HW at offsite commercial facility		Offsite commercial treatment facility
Pantex	Offsite commercial facility		Offsite commercial treatment facility
SNL-NM	Offsite commercial facility		Offsite commercial treatment facility
SRS	Offsite commercial facility		Offsite commercial treatment facility

Note: A blank cell indicates that a site either does not receive HW from other sites or does not ship HW to other sites.
[a] Sites analyzed in the WM PEIS are those 11 sites that generated more than 90% of DOE's HW in 1991.

Disposal of LLMW. The Department's preferred alternative at this time is to send its LLMW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW or LLMW disposal operations and, except for NTS and LANL, each has relatively large LLMW volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLMW the Department will need to dispose of, there is no need for additional candidate sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLMW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLMW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Treatment of LLW. Each site with LLW would treat its waste onsite. Each site would perform minimum treatment on its wastes to prepare them for disposal, although DOE would allow each of its sites the flexibility to perform additional treatment if it would decrease costs and requirements for transportation by significantly reducing the volume of LLW requiring disposal. The potential environmental impacts of all alternatives for treatment of LLW evaluated in the WM PEIS are small. The impacts of DOE's preferred alternative for LLW are identified in Regionalized Alternative 3 as

shown in Table 3.7–1, under which the potential impacts associated with minimum treatment of LLW at each site were analyzed, assuming regionalized disposal, as discussed below.

Disposal of LLW. The Department's preferred alternative at this time is to send its LLW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW disposal operations and, except for NTS, each has large waste volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLW the Department will need to dispose of, there is no need to establish additional sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, with correspondingly higher traffic accident fatalities, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. However, a disposal configuration that included at least one eastern site and one western site would require less transportation and produce fewer fatalities from traffic accidents than an eastern-only or western-only configuration. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Treatment and Storage of TRUW. Most of the DOE's sites with TRUW would treat and store it onsite. Five sites would ship TRUW to other sites for treatment under the preferred alternative: Pantex would ship its de minimis amount of TRUW to LANL for treatment; RFETS would ship some of its TRUW to INEL for treatment; ORR would send its CH-TRUW to SRS for treatment; SRS would send its RH-TRUW to ORR for treatment; and SNL-NM would send its TRUW to LANL for treatment. This preference assumes that WIPP will require treatment to the waste acceptance criteria the Department has proposed to EPA for this geologic repository. DOE's preference could change if WIPP requires a different level of treatment. The Department would store its TRUW where it is treated pending a decision on its disposal or other disposition.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several of the Regionalized Alternatives as shown in Table 3.7–1. It provides for cost-effective management of TRUW, poses low potential risks to the public, and has relatively small environmental impacts. DOE's preference is consistent with the preferred alternative identified in the *Waste Isolation Pilot Plant Disposal Phase Draft Supplemental Environmental Impact Statement* (WIPP SEIS-II).

Storage of HLW. The Department's preferred alternative at this time is to store its HLW where the waste is treated pending a decision on its disposal or other disposition. Because it is impractical to ship liquid HLW for treatment, DOE had previously decided that each of the four sites with HLW (Hanford, INEL, SRS, and WVDP) will treat its own waste onsite.

The potential impacts of DOE's preferred alternative are presented under the Decentralized Alternative for HLW. This alternative minimizes the transportation of treated HLW, makes use of existing storage capacity at WVDP and SRS, and would cost less than regionalized or centralized storage. The potential environmental impacts of all alternatives for HLW evaluated in the WM PEIS are small.

Treatment of HW. DOE's preferred alternative for HW is the No Action Alternative, which means the Department would continue to use commercial facilities to treat most of its non-wastewater HW. The transportation and environmental impacts are low for all of the alternatives for HW evaluated in the WM PEIS; however, the No Action Alternative costs less than the Decentralized or Regionalized Alternatives for HW treatment.

3.8 Use of Commercial or Privatized Facilities

After Records of Decision are issued, particular sites may propose to use commercial or privatized facilities for waste management activities. Such proposals would be analyzed in sitewide or project-specific NEPA documents. This WM PEIS does not preclude the use of waste management facilities constructed and operated by private entities on DOE sites at DOE's direction.

3.9 Comparison of Alternatives

A comparison of the alternatives analyzed for each waste type can be found in Chapters 6 through 10.

3.10 Alternatives Not Evaluated in Detail in the WM PEIS

Only DOE sites were analyzed as potential locations for waste management facilities in this PEIS. Other Federal sites (e.g., Department of Defense sites) were not considered to be reasonable alternatives. DOE prefers to avoid introduction of radioactive waste at DOE and other Federal sites where none exists. However, the WM PEIS does consider (at a conceptual level) the use of commercial and privatized waste management facilities for all waste types, including facilities at sites that may be purchased or leased from other Federal agencies.

The WM PEIS analysis does not assume the use of commercial waste management facilities across the Department except for hazardous waste because commercial capabilities for other waste types are limited. There are no commercial facilities for HLW or TRUW treatment, storage, or disposal. Nothing in the WM PEIS precludes a site from considering privatization or the use of commercial waste management facilities, since sitewide or project-level NEPA reviews of proposals for waste management may include alternatives for use of commercial vendors.

DOE analyzed representative alternatives ranging from management of wastes at all of the sites (the Decentralized Alternatives) to management at one site (the Centralized Alternatives) as potential locations for waste management facilities. CEQ has indicated that, when there are a very large number of possible reasonable alternatives, "... only a reasonable number of examples, covering the full spectrum of alternatives, must be analyzed and compared in the EIS" (CEQ, 1981). DOE believes that the

Regionalized Alternatives selected for analysis in this PEIS are representative of the numerous permutations between the Decentralized and Centralized Alternatives.

Chapter 3
Reference

Council on Environmental Quality (CEQ). 1981. "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations." *Federal Register* (March 23), p. 18026.

CHAPTER 4
Affected Environment

In this chapter, summary information is presented to characterize the pertinent environmental conditions at the U.S. Department of Energy (DOE) sites potentially affected by implementation of the various waste management alternatives (see Chapter 3). This chapter focuses on the 17 major DOE sites where most waste is located and where the waste management actions that have the potential to cause significant impacts will occur. The chapter describes the methodology and assumptions used to define and characterize each important aspect of the affected environment and summarizes the affected environment at the 17 major sites. The chapter includes short descriptions of other DOE sites with waste management activities considered part of the overall WM program. Detailed information on the affected environments at the DOE sites is provided in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) Technical Report on Affected Environment (DOE, 1996).

4.1 Introduction

In accordance with the Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations (40 CFR 1508.14) on preparing an environmental impact statement, the affected environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." Characterization of the affected environment defines the baseline conditions against which the impacts of the various alternatives—including the No Action Alternative—are assessed. All data presented in this chapter are in summary form. Therefore, the length of the discussion is not intended to indicate the significance of the potential effects.

4.2 Approach to Defining the Affected Environment

In this PEIS DOE examines a range of broadly defined waste management alternatives potentially affecting many DOE sites located throughout the country. DOE focused the analysis of environmental impacts on the environment of and around individual sites that would have major roles in the DOE waste management program and defined the regions at each of these sites where different types of impacts were likely to occur.

Shipping wastes for treatment or disposal between sites, as well as shipping HLW and TRUW to their respective repositories, as proposed under the alternatives may affect the environment along connecting road or rail corridors. However, specific waste shipping routes are not being selected in this PEIS, so the

ultimate shipping routes are not known at this time and could not be analyzed. As a basis for estimating the human health risks of transportation, DOE used representative road and railway routes. Human population densities along the representative routes were used to estimate population doses in the transportation risk assessment, but DOE did not otherwise attempt to characterize the affected environment along transportation routes.

4.2.1 MAJOR SITES

To determine the scope of the environmental impacts analysis for the WM PEIS, DOE reviewed the quantities of waste expected to be generated or currently in inventory at all the sites where DOE has management or other contractual responsibility for wastes. DOE determined that 54 sites (Figure 4.2–1) generate or have in inventory substantial quantities of radioactive or hazardous waste. These 54 sites constitute the set of sites at which waste management activities would be conducted under the proposed action. For a list of the waste types managed at each site, see Table 1.6–1 in Chapter 1. The Waste Isolation Pilot Plant (WIPP), although not yet in operation, is counted as one of the 54 sites because DOE plans to use WIPP to provide permanent disposal for TRUW. For a list of estimated quantities of LLMW, LLW, TRUW, HLW, and HW to be managed at each site, see Table 1.6–2 in Chapter 1.

Of the 54 sites, 17 were designated as major sites (see Figure 4.2–1) for detailed impacts analysis in this WM PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite, (2) they are candidates to host disposal facilities, (3) they manage HLW, or (4) they were included to be consistent with the Federal Facility Compliance Act process. The major sites contain the bulk of the five waste types, have capability for future disposal of LLW or LLMW, or have existing or planned major waste management facilities. The potential environmental impacts that could arise from treating, storing, and disposing of wastes at these major sites are considered in detail in this WM PEIS. Actions at the remaining sites are not evaluated in detail. Although WM actions will occur at the other 37 sites, DOE does not expect significant impacts to occur from those actions nor would those actions otherwise affect the programmatic decisions to be made subsequent to the PEIS.

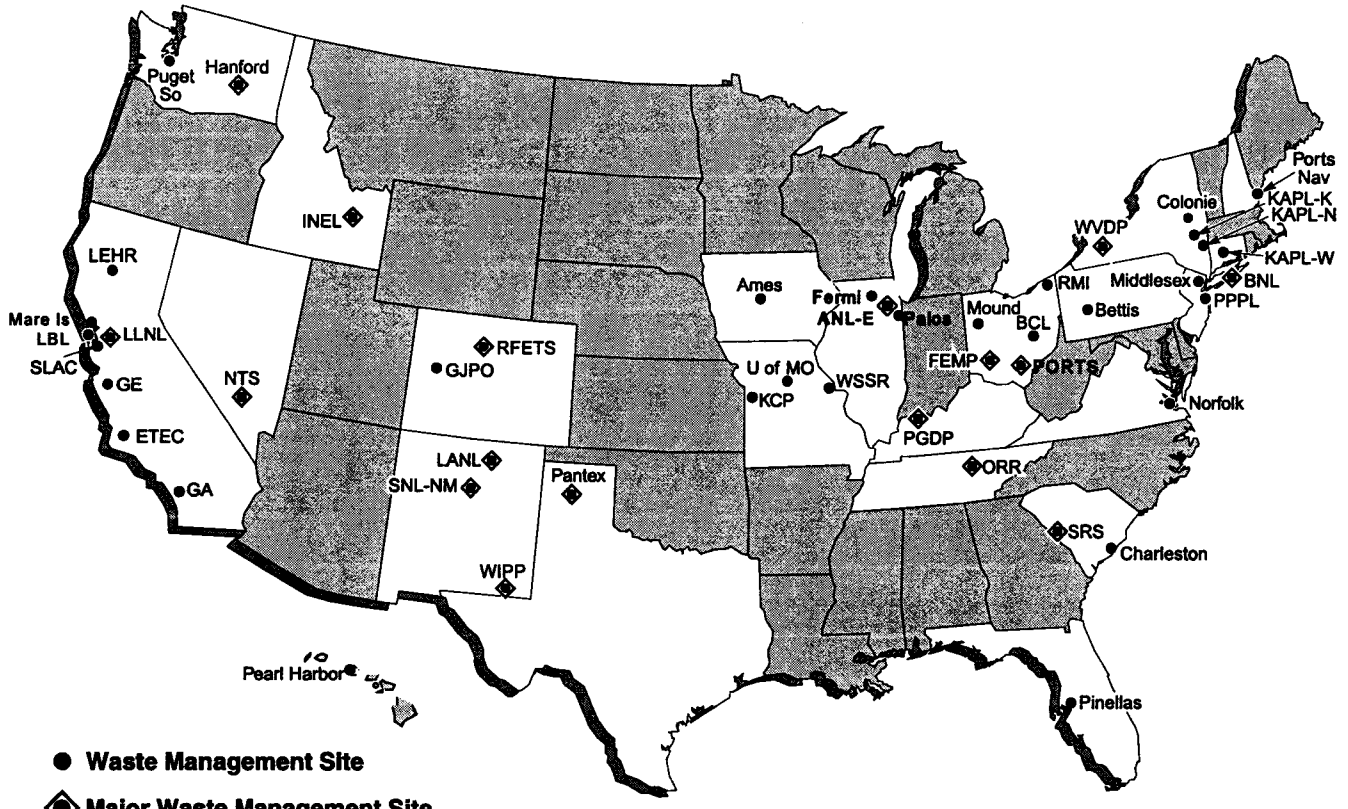

Figure 4.2–1. Waste Management Sites Considered in the WM PEIS

4.2.2 REGIONS OF INFLUENCE

DOE evaluated the direct, indirect, and cumulative environmental impacts of the waste management alternatives within defined regions of influence (ROIs) or regions of impact at each of the 17 major sites and along waste transportation routes. ROIs at each site were specific to the type of effect evaluated and encompassed geographic areas within which DOE could reasonably expect to capture in its PEIS analysis any potentially significant impact of the WM program actions that might occur. For example, human health risks to the general public from exposure to waste management facility airborne contaminant emissions were assessed for an area either within a 50-mile radius of a generic WM facility assumed to be centrally located at each smaller DOE site or within a 50-mile radius of an existing WM location at each larger DOE site (i.e., Hanford, INEL, LANL, NTS, ORR, and SRS). The human health risks of shipping wastes between sites were evaluated for populations living along the road and railway corridors linking the DOE sites. Economic effects, such as job and income growth, in the regions surrounding each site were evaluated within a socioeconomic ROI that included the site host county, adjacent counties, and other nearby counties in which a substantial portion of each site's work force resides. The overall economic impact of DOE expenditures for all site activities and all waste shipments under each WM alternative was evaluated within the national economy. Brief descriptions of the impact-specific ROIs are given in Table 4.2–1.

At each of the 17 major sites, a baseline condition for each environmental resource area was determined from existing data and from information provided in previous environmental studies, relevant laws and regulations, and other government reports and databases (see Section 4.3). Table 4.2–2 summarizes certain data related to the ROI features at the 17 major sites used in the waste management impact analyses.

The health risk ROI populations differ from the socioeconomic ROI populations in Table 4.2–2 because they are based on different areas; the former are estimates of population within a 50-mile radius of each site's center and the latter are calculated by summing county populations for all counties in the socioeconomic ROI.

4.3 Affected Environment Resources Areas

The environmental features that may be affected by the waste management alternatives described in Chapter 3 include human health as it is related to the level of radionuclide and radiation exposure; air

Table 4.2-1. WM PEIS General Regions of Influence

Environmental Feature	WM PEIS Region of Influence (ROI)
Human health	Includes the site and nearby offsite areas (within 50 miles of the site and the transportation corridors between the sites) where worker and general population radiation, radionuclide, and hazardous chemical exposure is likely to occur
Air quality	Includes the site and nearby offsite areas within local air quality control regions and the transportation corridors between the sites that could be affected by airborne emissions generated from WM activities
Water resources	Includes onsite and adjacent surface water bodies and groundwater that could be affected by WM activities
Geology	Includes geologic resources within the DOE site and offsite areas where geology may influence or be influenced by WM activities
Soils	Includes soils within the DOE site and offsite areas where soils may be affected by WM activities
Ecological resources	Includes the site, adjacent resource areas, and the transportation corridors between the sites where ecological communities, including sensitive habitats and sensitive species, could be affected by WM activities
Socioeconomic conditions	Includes the counties that contain or are contiguous to the site or part of the site, and counties in the area where at least 90% of site employees reside
Environmental justice	Includes the regions of influence for all health, environmental, and socioeconomic impacts as defined in this table, although the WM PEIS environmental justice analysis focused primarily on human health risks within 50 miles of the sites
Land use	Includes the site and the area immediately adjacent to the site
Infrastructure	Includes power, water supply, sanitary wastewater treatment facilities, and road systems on the site, those offsite utilities that currently provide support to the site, and local offsite infrastructure
Transportation (national)	Includes the population and areas of the road and rail network that would be affected by shipping radiological and hazardous waste between the 54 sites
Transportation (local)	Includes the road and rail network connections to the site from the national road and rail networks
Cultural resources	Includes the area within and adjacent to the site boundary that may be affected by the proposed action

Table 4.2–2. Summary Data for Waste Management Sites

Site	Symbol	Acreage	MEI Dose[a] (mrem)	Population Dose[b] (person-rem)	Site Work Force[c]	Health Risk ROI Population[d]	Socioeconomic ROI Population[e]
1. Argonne National Laboratory-East	ANL-E	1,500	0.0085	17.0	4,455	7,939,785	6,568,800
2. Brookhaven National Laboratory	BNL	5,263	0.11	2.7	3,557	5,738,554	2,609,212
3. Fernald Environmental Management Project	FEMP	1,050	0.0021	1.30	1,939	2,764,589	1,313,000
4. Hanford Site	Hanford	358,309	0.0037	0.60	14,394	377,645	409,200
5. Idaho National Engineering Laboratory	INEL						
Idaho National Engineering Laboratory	INEL	569,588	0.0015	0.030	11,813	153,061	196,039
Argonne National Laboratory-West	ANL-W	f	f		f		f
Naval Reactor Facility	NRF	f	f		f		f
6. Lawrence Livermore National Laboratory	LLNL						
Lawrence Livermore National Laboratory	LLNL	8,172	0.690	1.70	8,713	6,324,234	2,934,064
Sandia National Laboratory (California)	SNL-CA	g	g		g		g
7. Los Alamos National Laboratory	LANL	27,520	7.90	1.40	6,199	159,152	151,408
8. Nevada Test Site	NTS	864,000	0.012	0.0290	7,086	14,266	759,240
9. Oak Ridge Reservation	ORR	35,000	1.400	43.0	21,544	881,652	482,481
K-25 Site	K-25	1,500	h		h		h
Oak Ridge Institute for Science and Education	ORISE	340	h		h		h
Oak Ridge National Laboratory	ORNL	2,900	h		h		h
Y-12 Plant	Y-12	811	h		h		h
10. Paducah Gaseous Diffusion Plant	PGDP	3,425	0.0045	0.017	1,740	500,502	151,526
11. Pantex Plant	Pantex	10,080	i		2,891	265,185	194,123

Table 4.2–2. Summary Data for Waste Management Sites—Continued

Site	Symbol	Acreage	MEI Dose[a] (mrem)	Population Dose[b] (person-rem)	Site Work Force[c]	Health Risk ROI Population[d]	Socioeconomic ROI Population[e]
12. Portsmouth Gaseous Diffusion Plant	PORTS	4,003	0.260	3.0	2,386	639,602	204,136
13. Rocky Flats Environmental Technology Site	RFETS	6,500	0.0002	0.140	7,365	2,171,877	1,790,600
14. Sandia National Laboratories	SNL-NM						
Sandia National Laboratories (New Mexico)	SNL-NM	2,820	0.0034	0.020	8,596	610,714	722,138
Inhalation Toxicology Research Institute	ITRI	135	j		218		726,200
15. Savannah River Site	SRS	198,000	0.140	6.40	17,492	620,618	460,028
16. Waste Isolation Pilot Plant	WIPP	10,245	—	—	932	99,889	217,661
17. West Valley Demonstration Project	WVDP	220	0.0003	0.011	1,100	1,698,391	1,052,766

[a] Dose to maximally exposed individual (MEI) from emissions of airborne radionuclides excluding radon-220, which is not subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) limits (DOE, 1994a). Exposure at ANL-E including radon-220 = 0.24 mrem; exposure at FEMP including radon-220 = 51 mrem.
[b] Collective dose to health risk ROI population.
[c] The number shown represents only that portion of the site workforce residing in the socioeconomic region of influence.
[d] The population within 80 km (50 miles) of a site (ROI) which is considered at risk for health impacts.
[e] The population of the site host county, adjacent counties, and nearby counties which supply in aggregate 90% or more of the site workforce.
[f] Data included in INEL.
[g] Data included in LLNL.
[h] Data included in ORR.
[i] Exposure less than 0.0001 mrem/year.
[j] Data included in SNL-NM.

quality; water resources and water quality; geology and soils; ecological resources; socioeconomic conditions; land use; infrastructure; transportation; and cultural resources. The approach used for characterizing the affected environment for these resource areas at the 17 major sites is summarized below. The baseline year for the affected environment in this PEIS is the end of the 1992 calendar year. Some exceptions do exist for certain resource features, such as socioeconomic or population data, which are based on 1990 census data. These exceptions are based on the requirement to incorporate the best available data that are consistent for the 17 sites in the analysis. These exceptions are noted where applicable. In some instances there have been significant changes since 1992; for example, in "Site Work Force" data. Wherever more current data have been recommended by the site(s) concerned, an evaluation of the analytical affects of the difference(s) was made. If no substantive change in the impacts analysis would result, the data have not been changed. Additional information is contained in the WM PEIS Technical Report on Affected Environment (DOE, 1996).

4.3.1 HUMAN HEALTH

The release of radionuclides to the atmosphere from existing site actions and the potential exposure of the offsite public to these contaminants are the focus of the human health affected environment section. Data reported in this section include (1) the ROI population based on 1990 Census data, which consists of individuals living within a 50-mile (80-kilometer) radius of the sites; (2) the estimated existing condition collective radiological dose (in person-rem) for the ROI population; and (3) the estimated existing condition radiological dose (in rem) for a hypothetical maximally exposed individual (MEI) living within the offsite population. The MEI is an individual whose estimated dose is higher than that received by most members of the general population. The exposure estimates are presented in units of person-rem for population risk and rem for individual risk. The rem (roentgen equivalent man) is a measure of biological damage to living cells caused by radiation in any form. A millirem (mrem) is one-thousandth of a rem.

The airborne radiation dose estimates for the offsite populations and MEIs presented in this chapter were compiled from a DOE report entitled *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a). Note that these exposure estimates were developed using air dispersion models; they do not represent actual monitored or measured exposures. Additional exposure estimates, including monitored exposures and multimedia MEI exposure estimates presented in annual site environmental reports, are not included. However, this information is presented in the technical report on the affected environment (DOE, 1996). Only the airborne pathway exposure estimates are presented in this

chapter, because inhalation of airborne contaminants released from waste treatment facilities is assumed to be the most important exposure pathway for the greatest number of individuals in offsite populations. Note also that only the air pathway exposure estimates presented in Chapter 4 are used in the cumulative impact analyses in Chapter 11 to characterize existing site conditions. The health risk estimates presented in Chapters 6 through 10 represent the incremental risk from the proposed waste management actions that would be added to the existing baseline risks at the sites. The cumulative health risks estimated in Chapter 11 include risks from existing operations, the incremental risks from WM actions, and risks from other DOE actions proposed at the sites. Risks from past DOE operations are not included in the cumulative risk analysis because only a limited amount of data are available. Although dose reconstruction studies are being conducted at a number of DOE sites, study results are available only for three sites: Hanford (Shipler et al., 1996), NTS (Thompson and McArthur, 1996), and RFETS (Ripple et al., 1996).

All members of the public are exposed to a variety of radiation sources, both natural and manmade, called background radiation. The average background radiation level in the United States is estimated to be 360 mrem per year. The natural sources include radon (55% of the total radiation exposure), cosmic rays (8%), terrestrial (8%), and internal (11%). The manmade sources are x-rays (11%), nuclear medicine (4%), consumer products (3%), and other sources (less than 1%). Natural background radiation is the largest contributor to the average radiation dose to individuals and is the most variable component of background radiation. The total annual dose from background radiation can range from 100 mrem per year for people who live on sandy soil at sea level, to nearly 1,000 mrem per year for people who live in stone houses at high elevations (NCRP, 1987; NRC, 1994).

The U.S. Environmental Protection Agency (EPA) regulations (40 CFR 61, Subpart H) set the National Emission Standards for Hazardous Air Pollutants (NESHAPs) for public exposure to airborne radioactive materials (other than radon), including emissions from DOE sites. The nonradon limit for airborne exposure is 10 mrem per year from all sources. DOE has established a 100 mrem dose for annual exposure to members of the general public from all sources and through all pathways as part of DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE, 1990). DOE radon emissions are regulated by 40 CFR 61, Subparts Q and T. To ensure that such limits are observed, filtration systems are installed. For example, high-efficiency particulate air (HEPA) systems are routinely used that are capable of trapping and retaining at least 99.97% of all nondispersed particulates of 0.3 μm in diameter or larger.

DOE issued a report summarizing the emission reports submitted by 38 DOE sites to EPA for calendar year (CY) 1992 (DOE, 1994a). The total atmospheric release of radioactivity from radionuclides from the 38 DOE sites subject to the EPA reporting requirement was approximately 250,000 curies during 1992 (248,000 curies, or 99% of the total emissions, were emitted from the 17 major waste management sites analyzed in the WM PEIS). This was a 44% reduction from the 1991 releases. Most sites demonstrated compliance with the 10 mrem per year "effective dose equivalent" (EDE) standard of 40 CFR 61, Subpart H, including contributions from radon emissions regulated separately under subparts Q and T. More than 70% of the sites reported doses to the MEI that were less than 1% of the standard. Los Alamos National Laboratory (LANL) reported the highest estimated dose, about 80% of the standard. Doses received by the MEI from the airborne pathway are included in Table 4.2–2.

4.3.2 AIR QUALITY

In support of the air quality impact assessment, affected environment data were obtained to establish background pollutant concentrations, local meteorological conditions, and local air quality requirements. In addition to the air quality impact assessment, the data on local meteorology were used to support the emissions deposition modeling for health risk studies and studies to determine the toxicity to terrestrial wildlife from airborne releases.

The affected environment was characterized in terms of EPA primary and secondary ambient air quality standards for criteria air pollutants and other ambient standards established by each State. The criteria air pollutants are carbon monoxide, sulfur dioxide, particulate matter (particles with a diameter less than or equal to 10 micrometers), ozone, nitrogen dioxide, and lead. In addition to the national criteria pollutants, certain states have adopted State-regulated criteria pollutants, which are listed in the technical report on affected environment, for each of the DOE sites (DOE, 1996). In addition to the criteria air pollutants, National Emission Standards for Hazardous Air Pollutants (NESHAP) established by EPA were also considered. These hazardous pollutants include radionuclides and hazardous materials that may be associated with DOE operations. Applicability of EPA regulations for the prevention of significant deterioration (PSD) was also considered. The PSD regulations are established to maintain air quality in areas already in attainment of the National Ambient Air Quality Standards (NAAQS). Some DOE sites in PSD areas have obtained PSD permits.

The ROI for air quality includes the site, nearby offsite areas, and the transportation corridors between the sites that could be affected by airborne emissions generated from WM activities. For most air quality impacts, the ROI includes areas within a 50-mile (80-kilometer) radius of the site. Data on the existing air quality environment were obtained from monitoring stations located on the site, or as close to the site as possible. Sites within 62 miles (100 kilometers) of a national park, monument, seashore, wildlife refuge, or wilderness area were noted in order that a screening assessment of impacts to visibility in these Class I areas could be performed.

Another important aspect of the ROI is the attainment status of the EPA-designated air quality control region(s) in which the site is located. The EPA air quality control region does not necessarily correspond to the ROI and may be larger or smaller. The ROI itself may contain portions of more than one EPA region. To be conservative, if the site could affect the air quality in more than one air quality control region, the data from the region with the worst air quality were used.

Table 4.3–1 presents the criteria air pollutant attainment status within the EPA-defined air quality regions where the 17 major sites are located. In general, the region is in attainment for a particular criteria pollutant if monitored ambient levels are below the NAAQS for that pollutant. The region is a nonattainment area for a particular criteria air pollutant if monitored ambient levels are at or exceed the NAAQS for that pollutant. The fact that criteria air pollutant standards are exceeded in the region of many DOE sites is not presumed to be directly attributable to DOE activities, but represents a condition that exists in the region as a whole. As indicated in Table 4.3–1, pollutants of particular concern include carbon monoxide, ozone, and particulate matter. New projects, including DOE facilities, must conform with the attainment plans contained in the State Implementation Plans, which describe the procedures to attain and maintain compliance with EPA criteria air pollutant levels.

4.3.3 WATER RESOURCES

Surface and groundwater affected by or used in conjunction with site activities define the affected environment in terms of water resources. Water resource elements include surface water bodies and their watersheds, stormwater runoff, groundwater resources, aquifers, floodplains, and potable drinking water sources. EPA designated sole-source aquifers and Federal Wild and Scenic Rivers are identified when near a DOE site.

Table 4.3–1. Criteria Pollutant Attainment Status at the 17 Major Sites

Site	State	NAAQS Attainment Status[a]					
		CO	NO_2	O_3	Pb	PM_{10}	SO_2
ANL-E	IL	A	A	S-17	A	MOD	A
BNL	NY	A	A	S-17	A	A	A
FEMP	OH	A	A	MOD	A	A	A
Hanford	WA	A	A	A	A	A	A
INEL	ID	A	A	A	A	A	A
LANL	NM	A	A	A	A	A	A
LLNL	CA	A	A	A	A	A	A
NTS	NV	MOD-2	A	A	A	MOD	A
ORR	TN	A	A	A	A	A	A
PGDP	KY	A	A	MAR	A	A	A
PORTS	OH	A	A	A	A	A	A
Pantex	TX	A	A	A	A	A	A
RFETS	CO	MOD-2	A	TRANS	A	MOD	A
SNL-NM	NM	MOD-1	A	A	A	A	A
SRS	SC	A	A	A	A	A	A
WIPP	NM	A	A	A	A	A	A
WVDP	NY	A	A	A	A	A	A

Notes: CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; PM_{10} = particulate matter ≤10 micrometers; SO_2 = sulfur dioxide; A = attainment; nonattainment codes: S-17 = severe-17; MOD-2 = moderate-2; MOD-1 = moderate-1; MOD = moderate; MAR = marginal; TRANS = transitional.

[a] Attainment status based on 1992 data except for LLNL, which were updated with 1995 data.

In support of the water resources impact assessment, data were obtained to establish baseline water usage, including use of municipal water, surface water and groundwater, as appropriate. Major stream flows were identified where they were used as a water source or received effluent discharge from the site. The site National Pollutant Discharge Elimination System (NPDES) permits, where applicable, are briefly described and the status of compliance with permit limits is summarized. Significant known surface water, sediment, and groundwater contamination are also described.

Contamination of surface water, stream sediment, and groundwater has occurred to varying degrees at most of the DOE sites; however, contamination is usually limited to onsite areas. Most contamination is related

to past practices that have been discontinued. The type of contamination varies by site, depending on the activities that occurred. The following is a partial summary of the known water resource contamination:

Known surface water contaminants include:

- Cesium at NTS and ORR
- Plutonium at LANL, NTS, and ORR
- Strontium at the Hanford Site, LANL, ORR, and WVDP
- Tritium at the Hanford Site, NTS, ORR, and SRS
- Uranium at FEMP. the Hanford Site, and ORR

Known sediment contaminants include:

- Cesium at the Hanford Site, ORR, and SRS
- Mercury at ORR
- Plutonium at LANL and SRS
- Uranium at ORR, Paducah, FEMP, and Portsmouth

Known groundwater contaminants include:

- Cesium at the Hanford Site and SRS
- Plutonium at the Hanford Site, NTS, and RFETS
- Strontium at BNL, the Hanford Site, INEL, ORR, and SRS
- Technetium at the Hanford Site, ORR, and Paducah
- Tritium at BNL, the Hanford Site, INEL, LBL, LLNL, ORR, and SRS
- Uranium at FEMP, RFETS, and SRS
- Solvents at BNL, the Hanford Site, INEL, LBL, LLNL, ORR, Paducah, Portsmouth, RFETS, and SRS

4.3.4 GEOLOGY AND SOILS

Geology and soils are not likely to be affected by the WM actions. However, geologic and soil characteristics will factor into siting decisions when specific facility locations are selected. Elements of geology include topography, geologic formations, geologic structures, volcanic hazards, seismicity, and mineral deposits. Soil characteristics include type, permeability, porosity, susceptibility to subsidence, and

erodibility. The geology and soils baseline assessment included identification of (1) the seismic risk, (2) soil characteristics, and (3) soil contamination that could affect health risk.

Most of the DOE sites are in stable geologic areas. The greatest seismic risks at the 17 major sites are believed to be at LLNL and Paducah. No DOE site is in an area of known substantial volcanic hazards. Subsidence (soil instability) is generally not a problem at the DOE sites, although slope failures may occur in association with seismic events.

For most DOE sites, the site's topography is such that sufficient buildable area exists without limiting construction and operation of new facilities. Most DOE sites have soils that are adequate for normal bearing loads encountered with limited height facilities; these soils are not prone to liquefaction or excessive erosion. In general, no unique deposits of minerals have been identified or are expected to be found at any DOE site; sand and gravel deposits occur at some sites. The Acquired Lands Act of 1947 prohibits mineral exploration and development at DOE sites, and most lands under DOE control have been closed to mineral exploration.

Varying degrees of soil contamination occur at many DOE sites. Most soil contamination is related to accidental spills or past practices that have been discontinued, and contamination is usually confined to onsite areas. The type of contamination varies by site and depends on the activities that occurred and the materials handled. Contaminants include radionuclides, organic compounds, and metals. Examples of known soil contamination include:

- Cesium contamination at the Hanford Site and ORR
- Plutonium contamination at the Hanford Site, NTS, INEL, and RFETS
- Strontium contamination at the Hanford Site
- Uranium contamination at FEMP, NTS, Paducah, the Pantex Plant, and Portsmouth
- Solvent (organic) contamination at LBL, LLNL, the Pantex Plant, and SRS

4.3.5 Ecological Resources

Ecological resources include terrestrial communities (including recreational wildlife and significant forestry), aquatic communities (including recreational fishing), wetlands, threatened and endangered species, and biodiversity. Many sites, particularly the larger sites, such as the Hanford Site and SRS, support diverse communities of plants and animals. Some sites, such as RFETS, support habitats that are

biologically more diverse than the surrounding landscape because they have remained protected from grazing, farming, and development. Construction site clearing, excavation, and access road building for new waste treatment, storage, and disposal facilities may disturb or remove portions of the natural habitats at the sites, depending on where the new facilities are located. In support of the ecological resources impact assessment, affected environment data were obtained from site environmental reports to determine the presence of Federal and State threatened and endangered (sensitive) species on the sites. Table 4.3-2 provides a summary of the threatened and endangered species that have been identified at the major DOE waste management sites. Additional information is presented in the affected environment technical report (DOE, 1996).

4.3.6 SOCIOECONOMIC CONDITIONS

Socioeconomic elements include population size, demographics (age, sex, and race), site employee residence patterns, current employment, unemployment, and income and earnings by industry. The variables used as baseline data to calculate impacts include employment, per capita income, and population for 1990. Per capita income is multiplied by population to calculate total personal income. Employment and personal income are used as baseline variables from which percent changes due to waste management activities are calculated. Regional industry multipliers (the change in the economy in response to a change in expenditure) were determined for the socioeconomic ROIs of the major sites. In support of the socioeconomic impact analysis, data were also obtained to establish employee residence patterns and housing and demographic characteristics. The housing data considered are occupancy and vacancy rates, and number of housing units. Baseline socioeconomic data were obtained from the U.S. Department of Commerce (DOC), Bureau of the Economics Analysis (BEA), and the Bureau of the Census (DOC, 1991, 1992a-c).

As noted in Table 4.2-1, the ROI for socioeconomics consists of the site host county, all contiguous counties, and those nearby counties where, in aggregate, at least 90% of the site workforce currently resides. In addition, baseline data were collected for the nation as a whole. The nationwide data were developed to provide a baseline for the comparison of employment, income, and industrial output by alternative nationally.

Table 4.3-2. Federal and State Threatened and Endangered Species at the 17 Major Sites

Site	Federal and State Threatened and Endangered Species[a]
ANL-E	Species potentially occurring—1 Federal Endangered (mammal), 1 Federal Threatened (insect), 3 State Endangered (1 bird, 1 mammal, 1 plant), 2 State Threatened (1 reptile, 1 plant)
BNL	Species occurring onsite—1 Federal Endangered (bird), 1 Federal Threatened (bird), 2 State Endangered (1 bird, 1 amphibian), 4 State Threatened (birds)
FEMP	Species occurring or potentially occurring—2 Federal Endangered (1 mammal, 1 plant), 3 State Threatened (1 bird, 1 crustacean, 1 plant), 7 State Endangered (1 amphibian, 3 birds, 1 mammal, 2 plants)
Hanford[b]	Species occurring—1 Federal Endangered (bird), 2 Federal Threatened (2 birds), 7 State Endangered (4 birds, 2 plants, 1 mammal), 4 State Threatened (2 birds, 2 plants)
INEL	Species occurring—1 Federal Endangered (bird), 1 Federal Threatened (bird), 2 State Endangered (2 birds)
LLNL[c]	Species potentially occurring—5 Federal Endangered (2 invertebrates, 1 mammal, 1 bird, 1 plant), 1 Federal Threatened (1 invertebrate), 2 State Endangered (1 bird, 1 plant), 3 State Threatened (1 reptile, 1 mammal, 1 bird)
LANL	Species occurring—1 Federal Endangered (bird), 1 Federal Threatened (bird), 4 State Endangered (1 plant, 2 birds, 1 amphibian)
NTS	Species occurring—1 Federal Endangered (bird), 1 Federal Threatened (reptile), 2 State Endangered (1 bird, 1 plant-critically endangered)
ORR	Species occurring—1 Federal Threatened (bird), 4 State Endangered (3 birds, 1 plant), 7 State Threatened (5 birds, 2 plants)
PGDP	Species occurring or potentially occurring in the vicinity—7 Federal Endangered (1 bird, 5 mollusks, 1 mammal), 2 Federal Threatened (1 bird, 1 mammal), 9 State Endangered (3 birds, 1 fish, 1 mammal, 4 mollusks), 3 State Threatened (2 plants, 1 reptile)
Pantex	Species occurring or potentially occurring in the vicinity—3 Federal Endangered (3 birds), 2 Federal Threatened (2 birds), 5 State Endangered (4 birds, 1 reptile), 3 State Threatened (2 birds, 1 reptile)
PORTS	Species occurring or potentially occurring in the vicinity—1 Federal Endangered (mammal), 4 State Endangered (1 mammal, 2 mollusks, 1 plant), 5 State Threatened (1 fish, 4 mollusks)
RFETS	Species potentially occurring—1 Federal Endangered (bird), 1 Federal Threatened (bird), 2 State Endangered (2 birds)
SNL-NM	Species potentially occurring—1 Federal Endangered (bird), 8 State Endangered (5 birds, 3 plants)
SRS	Species potentially occurring—6 Federal Endangered (4 birds, 1 fish, 1 plant), 2 Federal Threatened (1 reptile, 1 bird), 7 State Endangered (5 birds, 1 fish, 1 mammal), 1 State Threatened (bird)
WIPP	Species potentially occurring—1 Federal Endangered (1 bird), 1 Federal Threatened (1 bird), 4 State Endangered (4 birds), 1 State Threatened (reptile)
WVDP	Species potentially occurring—1 Federal Endangered (mammal), 4 State Endangered (1 bird, 1 mammal, 1 plant, 1 reptile), 4 State Threatened (2 birds, 1 plant, 1 reptile)

[a] This list covers species that are known to occur or may occur on the site or in the vicinity. Listings of common and scientific names are provided in the WM PEIS Technical Report on Affected Environment (DOE, 1996).
[b] Hanford policy is to treat 11 candidate species as if they were endangered (see site description).
[c] Includes Federal and State listed species from Site 300.

The site work force estimates and ROI population size data presented in Table 4.2–2 are used only in evaluating socioeconomic and site transportation infrastructure impacts. The health risk analyses use separate estimates of population sizes for the offsite population (based on a 50-mile radius for aerial dispersion of facility release), noninvolved worker population, and waste management worker receptor groups (see Sections 5.4.1 of Volume I and D.2.2 of Volume III).

4.3.7 ENVIRONMENTAL JUSTICE

Executive Order 12898, titled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to incorporate environmental justice as part of their missions. As such, Federal agencies are specifically directed to identify and address as appropriate disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. The approach used to address the potential for these impacts in the WM PEIS first identified minority and low-income populations residing within 50 miles of the DOE sites, and then determined where and under what circumstances waste management impacts might be disproportionately high and adverse.

For each of the 17 major waste management sites, demographic maps were generated through a geographic information system that used 1990 census data available from the U.S. Bureau of the Census. These maps, which appear in Appendix C, are based on an analysis of 1990 United States Bureau of the Census Tiger Line files, which contain political boundaries and geographical features, and Summary Tape Files 1 and 3, which contain demographic information (DOC, 1992d,e). Data were resolved to the census tract level. A census tract is an area defined for the purpose of monitoring census data that is usually composed of between 2,500 and 8,000 persons. Figures C.4–1 through C.4–34 in Appendix C illustrate census tract distributions for minority and low-income populations residing within 50 miles of the 17 DOE sites being considered for the management of the five waste types.

Federally recognized Native American tribal lands within 50 miles of each site were also identified and mapped and are included in Appendix C, where applicable, with the minority distribution maps C.4–1 through C.4–17. Although not identified in the site summary section of this chapter (Section 4.4), nonfederally recognized Native American groups may also be present near DOE sites. DOE would consult with concerned Native American groups before taking actions under the WM PEIS at sites that have tribal

involvement. Specifically, DOE will consult with tribal governments to assure that tribal rights, including treaty rights, are considered prior to making any site-specific decisions.

A ***minority population*** consists of persons classified by the U.S. Bureau of the Census as Negro/Black/African-American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, or other nonwhite, based on self-classification by the people according to the race with which they most closely identify. In order to avoid double-counting minority Hispanic persons (Hispanics can be of any race), only white Hispanics were included in the tabulation of racially based minorities. Nonwhite Hispanics had already been counted under their respective minority racial classification (e.g., Black, American Indian). For purposes of this analysis, a minority population consists of any census tract within the 50-mile zone of impact with a minority population proportion greater than the national average of 24.4%. A ***low-income population*** refers to U.S. Census Bureau data definitions of individuals living below the poverty line. The poverty line is defined by a statistical threshold that considers family size and income (see Appendix C). For purposes of this analysis, a low-income population consists of any census tract within the 50-mile zone of impact with a low-income population proportion greater than the national average of 13.1%.

Table 4.3-3 summarizes minority and low-income population data for the 50-mile zone of impact at each site. The percentage of population that is minority and low-income was calculated from actual counts that include, but are not limited to, the census tracts depicted in Appendix C. As the table indicates, 7 of the 17 sites have census tracts containing minority population proportions in their respective 50-mile zone of impact that exceed the national average of 24.4%. Of the 7 sites, 6 had minority proportions larger than 5% above the national average. However, 4 of these sites are in states (California and New Mexico) with minority population proportions well above the national average. For low-income populations, 8 of the 17 sites have census tracts containing low-income population proportions that exceed the national average of 13.1%. Of the 8 sites, 4 had low-income proportions larger than 5% above the national average. The site fact sheet sections on environmental justice in this chapter refer to Appendix C for the maps of minority and low-income populations that surround the sites. Appendix C also provides the data definitions and methods used to develop the maps.

Table 4.3–3. Demographic Data Related to Environmental Justice

Site	Population in the 50-Mile Impact Zone (millions)	Percent Minorities	Federally Recognized Native American Groups	Percent Below Poverty Level
ANL-E	8.03	33.5	None	11.4
BNL	5.26	21.4	None	5.4
FEMP	2.64	13.2	None	11.8
Hanford	0.35	25.8	Yes	18.8
INEL	0.11	10.2	Yes	12.5
LLNL	6.31	40.9	None	9.5
LANL	0.27	48.1	Yes	13
NTS	0.01	12.8	Yes	12.6
ORR	0.88	6.1	None	16.2
PGDP	0.50	9.1	None	19.1
Pantex	0.27	19.8	None	15.2
PORTS	0.61	3.2	None	20.8
RFETS	1.98	19.7	Yes	9.8
SNL-NM	0.61	45.1	Yes	14.8
SRS	0.59	37.8	Yes	18
WIPP	0.10	30.9	Yes	21.6
WVDP	1.54	11.6	Yes	12.2

4.3.8 Land Use

In support of the land use impact assessment, information on total site acreage, land utilized for existing structures, land suitable for waste management operations (excluding land set aside for sensitive species, wetlands, floodplains, or land with other limitations or designated uses), land designated for future waste management operations, and site development plans were obtained. The land use baseline for each site was defined by using U.S. Geological Survey maps, and DOE environmental reports and development plans.

Table 4.3–4 presents the total acreage at each site and the estimated acreage available for the 17 major sites. Site acreage data were compiled from *DOE Real Property: A Yearly Statistical Handbook Fiscal Year 1993*, (DOE, 1994b). The "Available Acres for Waste Management Facilities" (column 3) were obtained from site development reports when available. For those sites without a designated waste management area, this value was computed by subtracting the land currently used and the land unavailable from the total acreage.

Table 4.3–4. Land Available for Facilities at the 17 Major Waste Management Sites

Site	Total Acreage	Available Acres for Waste Management Facilities
ANL-E	1,500	1,190[a]
BNL	5,263	2,900
FEMP	1,050	275
Hanford	358,309	6,000
INEL	569,588	22,330
LLNL	8,172	7,849
LANL	27,520	16,187
NTS	864,000	640,000
ORR	35,000	5,629
PGDP	3,425	2,675[a]
Pantex	10,080	7,713
PORTS	4,003	3,203
RFETS	6,500	5,753
SNL-NM	2,820	206
SRS	198,000	145,400
WIPP	10,245	10,210
WVDP	220	165

[a] Data shown were available at the time of computations. The Chicago Operations Office has since reported that fewer acres are available for waste management facilities and that much of the operations will be performed in existing facilities which will be converted to the required technologies. Subsequent information also indicates that fewer acres would be available for waste management facilities at PGDP.

Established buffer zones, untenable terrain (e.g., wetlands, canyons), and land committed to planned projects are examples of land unavailable. These exceptions are noted in further detail on a site-specific basis in Section 4.4. Specific site selection for facilities proposed by this PEIS would be addressed by project-level EISs prepared for the sites concerned.

4.3.9 INFRASTRUCTURE

Infrastructure elements include the site's potable water supply, wastewater treatment system, electrical power systems, and transportation network. In support of the infrastructure impact analysis, data were

obtained to establish baseline capacities for the site potable and process water supply, process and sanitary wastewater treatment, and electrical power. The site hazardous and toxic waste treatment and disposal systems (nonradiological) are considered as part of the hazardous waste alternatives analyses and are not discussed here.

In general, water and wastewater treatment systems are located on site. Potable water is supplied from deep wells or from surface water systems, which frequently require some type of chemical treatment. A few sites dispose sewage in a municipal system. However, most DOE sites have their own disposal facilities. Many of the onsite landfills for the DOE sites have closed, and the sites have contracts with public or private landfills. In many cases, offsite electrical power companies are connected to onsite substations. For example, the Hanford Site is supplied by the Bonneville Power Administration. Some sites have limited onsite electrical power generation capability; however, the equipment is usually used only for backup or in emergency situations.

Table 4.3–5 lists the water, wastewater, and power infrastructure features at the 17 major sites that have potential limitations on increased usage related to implementing the waste management alternatives. The transportation infrastructure at each site is briefly described in Section 4.4.

4.3.10 TRANSPORTATION

4.3.10.1 National Transportation

Transportation elements include the number of rail and truck shipments to and from DOE sites and the local transportation network in the vicinity of the individual sites. In support of the impact analysis, data on DOE's rail and truck shipment traffic were obtained.

In addition, the national transportation environment was established in terms of the applicable government regulations and DOE policy related to transporting radiological and other hazardous material, general risk criteria, and the methodology for determining national transportation routes. The current DOE traffic volumes and associated accidents, packaging of materials, and emergency response preparedness are also presented.

Table 4.3-5. Infrastructure Use and Capacities[a]

Site	Water		Wastewater		Power	
	Total Capacity (mgd)	Total Current Use (mgd)	Total Capacity (mgd)	Total Current Use (mgd)	Total Capacity (MW)	Peak Load (MW)
ANL-E	1.8	0.645	1.8	1.08	*	23
BNL	6	4.5	2.3	1.0	47	35
FEMP	1.6	0.4	2.27	2.18	33	30
Hanford	79.06	9.51	0.2	0.158	352	59
INEL	30.96	5.242	1.0	0.254	55	42
LLNL	2.52	0.717	1.68	0.4	100	61
LANL	10	4.1	1	*	120	68
NTS	2.78	1.36	0.338	0.14	45	30
ORR	40.2	18.3	0.92	0.64	660	116
PGDP	30	15	1.75	0.4	3,040	1,564
Pantex	1.5	0.5	0.545	0.275	1,523	13
PORTS	37	14	1.2	0.35	1,929	1,537
RFETS	1.0	0.272	0.5	0.15	35	18
SNL-NM	4.03	1.0	*	0.548	50	35
SRS	5.0	1.6	0.75	0.5	*	130
WIPP	0.54	0.075	0.0185	0.012	9.4	4.6
WVDP	0.11	0.07	0.07	0.07	6.5	2.9

Notes: mgd = million gallons per day; MW = megawatts; * = value unknown.
[a] Data for baseline infrastructure represent onsite use only. Wastewater use and capacity are based on sanitary waste. No process wastes are involved.

Shipping radiological and other hazardous material from DOE sites to interstate highways or a rail terminus is described for each site in the WM PEIS Technical Report on Affected Environment (DOE, 1996). Air and barge transport are not considered in this PEIS.

The selection of a regional or centralized waste management alternative will potentially result in the transport of large quantities of radioactive waste on the nation's highways. In conducting transportation campaigns, DOE will adhere to applicable Federal regulations to ensure that the waste is transported safely and that the potential for impacts to the public and environment is minimized. These regulations cover the packaging, handling, and transporting of radioactive and hazardous material. DOE has adopted these regulations as part of DOE Order 1450.1C.

All transportation routes used for shipping radiological and other hazardous material have been derived from the HIGHWAY program model (ORNL, 1993a) and the INTERLINE model (ORNL, 1993b), which consider population densities along the routes. These models choose transportation routes between shipping-receiving combinations in accordance with U.S. Department of Transportation (DOT) routing constraints for transporting radiological and other hazardous materials, with maximum use of interstate highways and rail lines and minimum travel time and distance. Population density distributions were calculated along the routes used in this PEIS to compute health risk consequences. Results of transportation analyses are contained in the chapter for each waste type, Chapter 11, and Appendix E.

Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with states, regional entities, and carriers during large shipping campaigns to ensure that safe routing alternatives and safe havens are utilized.

Data for DOE radiological and hazardous materials shipments were obtained from the DOE Shipment Mobility/Accountability Collection (SMAC) information system (Morris, 1994, 1995). These data represent most, but not all, of the DOE transportation activities related to the shipment of radioactive waste material.

On the national level, about 100 million packages classified as hazardous materials (flammables, explosives, poisons, and radioactive material) are shipped each year (NRC, 1977). A more recent radioactive materials transport study stated that, excluding DOE shipments, approximately 2 million shipments of radioactive materials consisting of 2.79 million packages are made each year (SNL, 1985).

For FY 1993, radioactive and other hazardous material shipments accounted for 4.5% (27,698) of all DOE shipments and 32.6% of the tonnage. Of these shipments, 33.3% (9,231) contained radioactive material, and 13.3% (3,695) contained a combination of radioactive and other hazardous material.

For more than 40 years, radioactive materials have been shipped in the United States with no known adverse health effects due to accidental releases. Information about accidents involving radioactive materials has been collected over a 23-year period through September 1993 (SNL, 1993). During that period, 349 air, highway, and rail transportation accidents occurred. Of these accidents, 307 were highway, 20 were rail-related, and the remaining 22 were air-related. Packages used for shipping quantities or types of radioactive

materials that could have serious consequences if released are designed to withstand accident conditions. Accidents involving these packages have resulted in no release of radioactive materials. The Nuclear Regulatory Commission (NRC) has concluded that at least half of the radiation exposure resulting from shipments of radiological materials would be received by transportation workers, but the doses would be below allowable limits (NRC, 1977). The NRC also concluded that exposure from accidents was about 10 times less significant than the normal operational exposure (as determined by a statistical prediction of the number of latent cancer fatalities).

Because health and safety consequences may possibly result from an accident involving radioactive or other hazardous material, DOE will allocated resources and has established training on emergency response under the overall Federal Emergency Response Program to mitigate the effects of such an accident. Under this program, DOE was directed by Congress in Section 180 of the Nuclear Waste Policy Act (42 USC 10101-10270) to provide assistance and funds to States training public safety officials of local governments. The Federal Emergency Management Agency (FEMA) coordinates peacetime radiological accident response (as directed in the FEMA regulation 44 CFR 351).

The ROI for transportation is the ROI for the national transportation environment which is the population and areas associated with the road and rail network that would be affected by shipping radiological and hazardous material between the 54 sites that could be affected by implementing the waste management alternatives discussed in Chapter 3.

Tables 4.3-6 and 4.3-7 provide the number of current rail and truck shipments to and from the major DOE sites on the basis of the 1993 Shipment Mobility/Accountability Collection (SMAC) and the Waste Manifest System FY 1993 (Morris, 1994, 1995). This database includes all radioactive material shipments, not just waste shipments. The sites report the data for incoming and outgoing shipments of all hazardous material. Hazardous materials containing a radioactive component are listed as "radioactive" and provided in both the "Incoming" and "Outgoing" columns. The remaining hazardous materials not containing a radioactive component are shown in the "Other Hazardous" columns.

Table 4.3-6. DOE Truck Shipments of Hazardous Materials to or From Major Waste Generating and Storage Sites During Fiscal Year 1993

Site	Incoming				Outgoing			
	Radioactive[a]		Other Hazardous[b]		Radioactive[a]		Other Hazardous[b]	
	Shipments[c]	Wt (lb)[d]	Shipments[c]	Wt (lb)[d]	Shipments[c]	Wt (lb)[d]	Shipments[c]	Wt (lb)[d]
ANL-E	15	244,013	0	0	93	1,089,798	2	646
BNL	3	1,860	0	0	5	95,560	0	0
ETEC	1	150	0	0	25	981,643	0	0
FEMP	1	5,787	3	20,000	445	16,454,993	3	96,068
Hanford	113	3,063,760	0	0	18	358,682	2	4,830
INEL	22	317,828	2	646	36	881,145	4	1,167
KAPL-K	24	388,347	0	0	25	452,810	1	14
LBL	1	4,820	0	0	12	250,166	0	0
LLNL	9	6,872	8	7,544	5	8,875	9	12,309
LANL	18	20,491	8	43,759	9	8,059	2	43
Middlesex	0	0	0	0	0	0	0	0
NTS	449	16,518,680	2	886	5	15,303	5	32,153
ORR	197	387,269	49	1,216,790	843	23,140,823	44	548,573
PGDP	895	22,621,065	16	284,341	101	3,610,839	9	93,728
Pantex	72	971,011	9	1,627	163	353,142	8	8,248
PORTS	107	3,831,089	24	199,232	153	1,130,976	31	979,820
RFETS	4	5,418	2	641	17	144,100	1	70
SNL-NM	5	25,470	2	4,794	1	1,035	3	2,164
SRS	39	676,679	0	0	19	112,660	1	5
WIPP[e]	0	0	0	0	0	0	0	0
WVDP	0	0	0	0	0	0	0	0
Total	1,975	49,090,609	125	1,780,260	1,975	49,090,609	125	1,779,838

[a] Includes all types of radioactive materials, as well as any radioactive waste.
[b] "Other hazardous" refers to all hazardous materials except those that are radioactive.
[c] Reflects shipments to and from DOE sites.
[d] Weight includes shipping containers.
[e] Site not reporting to SMAC in fiscal year 1993.

Source: Based on DOE waste shipments as reported to the Shipment Mobility/Accountability Collection (SMAC) (Morris, 1994, 1995).

Table 4.3–7. DOE Rail Shipments to or From Major Waste Generating and Storage Sites During Fiscal Year 1993

Site	Incoming				Outgoing			
	Radioactive[a]		Other Hazardous[b]		Radioactive[a]		Other Hazardous[b]	
	Shipments[c]	Wt (lbs)[d]	Shipments[c]	Wt (lbs)[d]	Shipments[c]	Wt (lbs)[d]	Shipments[c]	Wt (lbs)[d]
ANL-E	0	0	0	0	0	0	0	0
BNL	0	0	0	0	0	0	0	0
ETEC	0	0	0	0	0	0	0	0
FEMP	0	0	0	0	0	0	0	0
Hanford	0	0	0	0	0	0	0	0
INEL	0	0	0	0	0	0	0	0
KAPL-K	0	0	0	0	0	0	0	0
LBL	0	0	0	0	0	0	0	0
LLNL	0	0	0	0	0	0	0	0
LANL	0	0	0	0	0	0	0	0
Middlesex	0	0	0	0	0	0	0	0
NTS	0	0	0	0	0	0	0	0
ORR	0	0	0	0	8	995,658	13	2,307,000
PGDP	106	8,566,763	7	1,217,100	117	18,992,927	0	0
Pantex	0	0	0	0	0	0	0	0
PORTS	117	18,992,927	6	1,089,900	98	7,571,105	0	0
RFETS	0	0	0	0	0	0	0	0
SNL-NM	0	0	0	0	0	0	0	0
SRS	0	0	0	0	0	0	0	0
WIPP[e]	0	0	0	0	0	0	0	0
WVDP	0	0	0	0	0	0	0	0
Total	223	27,559,690	13	2,307,000	215	27,559,690	13	2,307,000

[a] Includes all types of radioactive materials and radioactive waste.
[b] "Other hazardous" refers to all hazardous materials except those that are radioactive.
[c] Reflects shipments to and from DOE sites.
[d] Weight includes shipping containers.
[e] Site not reporting to SMAC in FY 93.

Source: Based on DOE waste shipments as reported to the Shipment Mobility/Accountability Collection (SMAC) (Morris, 1994, 1995).

4.3.10.2 Local Transportation

All major sites analyzed in the WM PEIS have local road and, in some cases, rail connections to the site. Details of these road and rail connections are described in the WM PEIS Technical Report on Affected Environment (DOE, 1996) and summarized in Section 4.4 for each site.

4.3.11 CULTURAL RESOURCES

Cultural resources include archaeological remains, historically significant architecture, traditional cultural properties, and a variety of resources significant to contemporary Native American cultures. Paleontogical resources, although not cultural in origin, are also included because of their recognized value and similar need for protection. Information regarding known cultural resources at the 17 major DOE sites is presented in Table 4.3–8. Information on the extent to which each site has been surveyed is also provided. No assumption with respect to the presence or absence of additional resources is made for areas not surveyed. Additional cultural resource surveys would be required for this purpose. For additional information regarding Native American cultural resources, see Sections 1.4.1 and 5.4.10.

Archaeological remains include both prehistoric and historic sites and both buried and standing remains, including artifacts, architecture, and botanical and zoological remains associated with Old-World-derived and Native American cultures.

In the United States, historic resources date to the period after European contact. Archaeological and architectural properties of sufficient significance and integrity are eligible for inclusion in the National Register of Historic Places (NRHP). Impacts to eligible sites located on Federal land must be considered, whether or not they are listed on the NRHP.

Cultural resources important to Native American groups include burials, artifacts, structures, areas of religious importance, and traditional natural resources including plants, animals, and land forms such as mountains or bodies of water. Impacts to these resources located on Federal land must also be considered.

The cultural resource baseline was based on DOE environmental reports. Inquiries were also sent to the State Historic Preservation Officers (SHPOs) with jurisdiction over the 17 major sites. Many of these sites

Table 4.3–8. Status of Known Sites With Regard to the National Register of Historic Places

Site	Acreage in FY 1995 FAAQ	Acres Inventoried[a]	Percent Inventoried	Historic and Archeological Sites				
				NRHP	NRHP Eligible	NRHP Ineligible	Awaiting Determination	Not NRHP Evaluated
ANL-E	1,700	1,700	100	0	3	20	23	ND
BNL	5,325	0	0	0	3	0	0	0
FEMP	1,150	700	61	0	3	39	ND	ND
Hanford	358,400	21,358	6	49	84	15	0	883
INEL	568,820	26,237	5	1	1	2	0	1,708
LLNL[b]	7,640	ND	ND	0	0	0	0	28
LANL	27,869	15,327	55	0	280	95	777	253
NTS	864,812	53,395	6	1	150	652	1,160	x
ORR	34,700	5,882	17	0	15	31	0	0
PGDP	3,423	1,361	40	0	0	3	1	2
Pantex	15,936	7,100	45	0	0	0	23	64
PORTS	3,714	0	0	0	0	0	0	0
RFETS	6,550	6,550	100	0	0	64	0	0
SNL-NM	2,830	2,830	100	0	0	0	0	0
SRS	298,000	51,818	17	0	55	116	208	827
WIPP	10,240	3,416	33	0	0	ND	33	ND
WVDP[c]	X	X	X	X	X	X	X	X

Notes: FAAQ = Federal Archaeological Activities Questionnaire; ND = no data provided by the facility in the FY 1995 FAAQ; X = no response provided by the facility in the FY 1995 FAAQ.

[a] Acres inventoried sufficiently to identify all readily apparent archaeological properties.

[b] Most recent data available are from FY 1992.

[c] While the West Valley Demonstration Project has not responded to the Federal Archaeological Activities Questionnaire, an archaeological survey covering 360 acres was conducted in 1990. As a result of this survey, nine archaeological sites were discovered, none of which has been listed in the National Register (NRHP), and a model predicting the likelihood of sites over the remainder of the site has been developed (DOE, 1996).

Source: Information provided by DOE's Federal Preservation Officer, Office of Environmental Policy and Assistance (based on the FY 1995 Archaeological Activities Questionnaire) (FAAQ).

have not been completely surveyed for cultural resources. These surveys would be required for any new construction associated with waste treatment, storage, and disposal facilities.

4.3.12 SAFEGUARDS AND SECURITY

DOE has a Safeguards and Security (S&S) Program to protect DOE interests from theft or diversion of special nuclear material; sabotage, espionage, loss or theft of classified matter or government property; and other hostile acts that may cause unacceptable adverse impacts on national security or on the health and safety of employees, the public, or the environment. Because radioactive and hazardous waste mishandled with malicious intent could cause adverse safety and health impacts, the Safeguards and Security Program applies to waste management, in addition to other material that presents greater safeguards and security risks. DOE's planning and preparedness for operational emergencies recognizes hostile attack, terrorism, sabotage, and malevolent acts as events that should be considered as possible initiators of operational emergencies. Operational emergency plans address coordination with Federal, state, tribal, and local organizations to locate and recover materials, especially those with national security implications. Of the types of waste considered in this PEIS, transuranic waste probably has the greatest safeguards and security implications because it contains plutonium, a special nuclear material.

4.4 Affected Environment at the Major Sites

This section contains a summary of the most pertinent facts characterizing the affected environment and defining the ROI for each of the 17 major sites. Each site is first described in terms of its location, mission, and brief history. This is followed by resource area-specific information. While useful at the programmatic level, this information will be supplemented by detailed analyses in sitewide or project-level NEPA reviews. Tables 3.6–1 through 3.6–5 provide a summary of which sites are considered under each alternative for each waste type.

4.4.1 ARGONNE NATIONAL LABORATORY-EAST—CHICAGO, ILLINOIS

Argonne National Laboratory-East (ANL-E), a 1,500-acre site located 22 miles southwest of downtown Chicago in northeast Illinois, is an outgrowth of the Metallurgical Laboratory established in 1942 as part

of the Manhattan Project. The mission of this 4,670-employee research and development laboratory is to conduct programs in basic energy and related sciences. ANL-E is an important engineering center for the study of nuclear and nonnuclear energy sources. ANL-E is shown in Figure 4.4-1.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 7,939,785 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0085 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a). If radon is included, the dose is 0.24 mrem.
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 16.8 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- ANL-E and the counties surrounding it are classified by EPA as severe nonattainment areas for the criteria pollutant ozone. Lyons Township in southeast Chicago is listed as a moderate nonattainment area for particulate matter less than 10 micrometers in diameter (PM_{10}). The areas are in attainment for the other criteria air pollutants.
- Major sources of air pollution at the site include a steam plant, oil-fired boilers, gasoline and methanol dispensing facilities, two alkali metal reaction booths, a small vapor degreaser, a number of bulk chemical tanks, a dust collection system, a medical equipment sterilization unit, fire training activities, a combustion and power generation research facility, laboratory ventilation systems for hot cell facilities, and ventilation systems for active and inactive reactors and particulate accelerators.
- Prevailing winds are from the south and southwest with a significant northeast component. The frequency of calm winds is 3%. Average monthly temperatures of 27.9 to 68.5 degrees Fahrenheit (°F) were recorded in 1992. Precipitation for the year was 31.5 inches.

Water Resources

- Major surface water features include Lake Michigan (24 miles east), the Des Plaines River (1.25 miles southeast), and the onsite Sawmill Creek. The Freund Brook drains most of the site.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- Sanitary and laboratory wastewaters are combined, treated, and discharged to Sawmill Creek, which drains into the Des Plaines River.

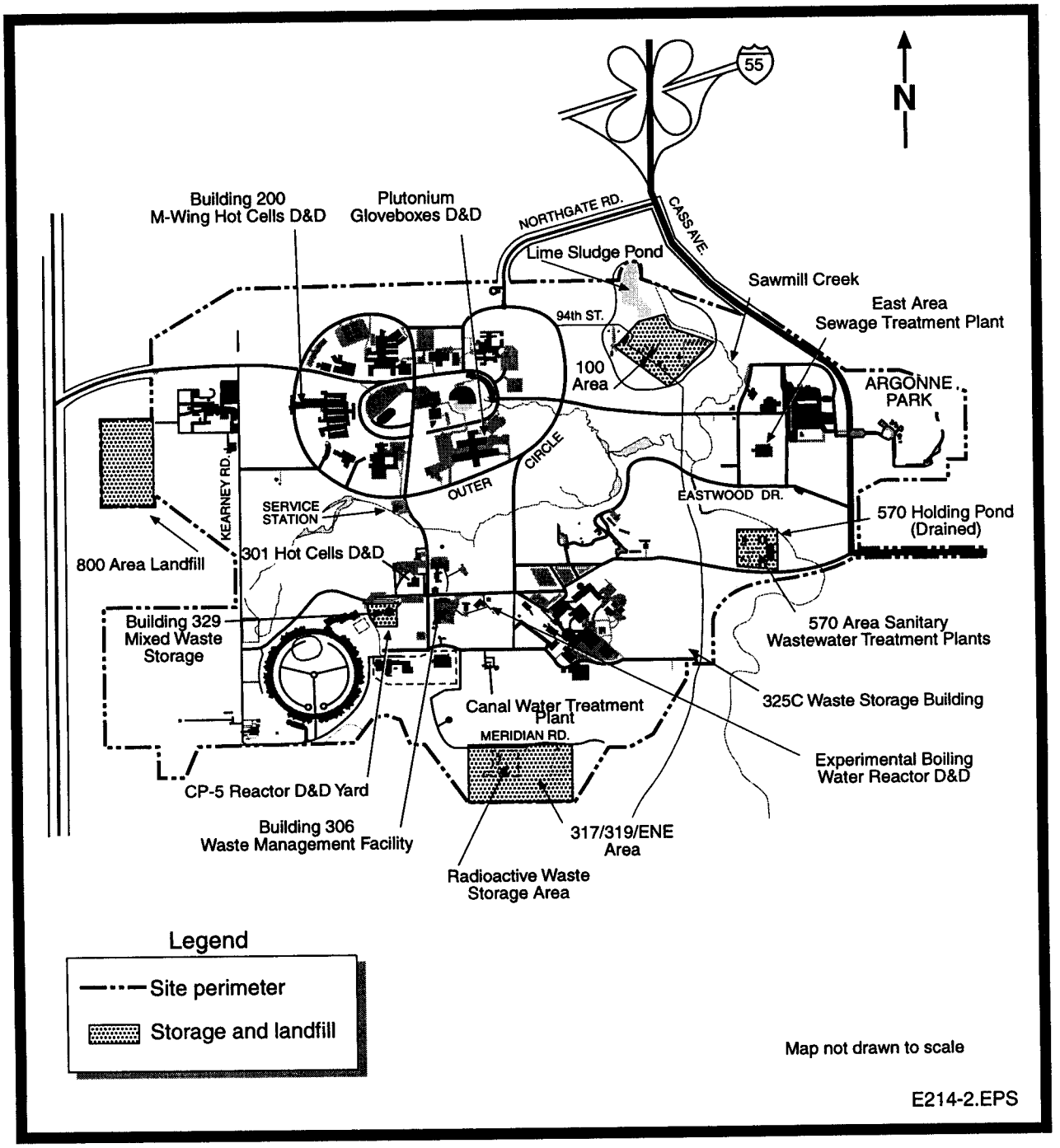

Figure 4.4–1. Argonne National Laboratory-East

- In 1993, all radionuclides measured in Sawmill Creek were a small fraction of the DOE-derived concentration guides.
- Water for the site is supplied by groundwater from the Niagara Aquifer.
- Major groundwater units include, from deep to shallow, the Galesville Sandstone, the Maquoketa Shale aquitard, and the Niagara and Alexandria Dolomite. No sole source aquifers exist beneath the site.
- Five commonly monitored groundwater contaminants exceeded comparison criteria in 1990.
- Site facilities are outside of the 500-year floodplain.

Geology and Soils

- The topography of the site is gently rolling, with an average elevation of about 725 feet above sea level.
- Major rock units include, from oldest to youngest, the Galesville Sandstone, the Maquoketa Shale, and the Niagara and Alexandria Dolomite.
- Glacial till is approximately 30 to 100 feet thick and overlies nearly horizontal sedimentary rocks.
- Most soils at the site are moderately well-drained silt loams with slopes ranging from 2% to 10%.
- Geologic hazards include little or no risk from earthquakes or volcanos. A few minor earthquakes have occurred in the northern Illinois area; these are believed to be caused by isostatic adjustments of the Earth's crust in response to glacial unloading.

Ecological Resources

- Vegetation communities are a mixture of open field, deciduous forest, pine plantation, and tall-grass prairie. Much of the natural vegetation in the ANL-E area has been altered by clearing and tillage. The 2,040-acre Waterfall Glen Forest Preserve surrounds ANL-E.
- Wetlands total 3.56 acres and consist of cattail marsh and wooded swamp. Adjacent wetlands are present in Waterfall Glen Forest Preserve.
- Federally listed threatened or endangered species are not known to reside on the ANL-E site. The Black Crowned Night Heron (*Nycticorax nycticonax*) is a State-listed endangered species residing onsite. The Federally endangered Indiana Bat (*Myotis sodalis*) and the Federally threatened Hine's Emerald Dragonfly (*Somatochlova hineana*) reside in the area and may possibly reside on the ANL-E site. Two State-endangered species, River Otter (*Lutra canadensis*) and White Lady's Slipper (*Cypridedium candidum*), and two State-threatened species, Kirtland's Snake (*Clonophis kwitlandi*) and Sedge (*Carex crawei*) reside in the area and may possibly reside on the ANL-E site.

Socioeconomic Conditions

- The ROI for ANL-E comprises Du Page, Cook, Kane, and Will Counties. Approximately 95% of the site's employees reside in these counties.
- Total site employment in 1990 was 4,455. Total ROI employment by place of work in 1990 was 3,883,841.
- The ROI unemployment rate in 1991 was 6.7%.
- The ROI per capita income in 1990 was $22,169.
- The total population in the ROI in 1990 was 6,568,800. Population demographics: Native Americans—0.2%; urban—97.4%.
- Housing: owner-occupied—59.4%; renter-occupied—40.6%.
- Sensitive populations: children (under 15 years old)—21.7%; women of child-bearing age (ages 15 to 44)—24.2%, adults over 65—11.6%.

Environmental Justice

- Minorities—Figure C.4-1.
- Below poverty level—Figure C.4-24.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site covers an area of 1,500 acres, of which about 30% is developed; approximately 1,190 acres are available for development.
- The Waterfall Glen Forest Preserve, adjacent to the site, is used for skiing, hiking, and equestrian sports.
- The area immediately outside the preserve is predominantly single-family residential.

Infrastructure

- Four onsite wells provide an average of 0.645 million gallons of water per day.
- An onsite facility receives an average of 1.08 million gallons of sewage per day.
- Commonwealth Edison Company supplies power to the site; the current site load is 23 megawatts.
- Interstate I-55 provides direct access to the site from Chicago and Joliet. Interstates I-88, I-355, I-80, and I-294 are other major roads providing access to ANL-E. Local roads include Illinois Route 83, U.S. Route 45/20, and U.S. Route 34. The Santa Fe, Burlington Northern, Conrail Corporation, Union Pacific, Illinois Central, and CSX are among the major rail lines that ANL-E has access to.

Cultural Resources

- Native American groups lived in the region surrounding ANL-E from approximately 10,000 years ago until the beginning of Euro-American settlement during the early 19th century.
- Within ANL-E, 46 archaeological sites have been recorded. Of these, 23 await determination of eligibility for the National Register of Historic Places.
- Three archaeological sites within ANL-E are eligible for the National Register.

4.4.2 BROOKHAVEN NATIONAL LABORATORY—UPTON, NEW YORK

Brookhaven National Laboratory (BNL) is located in Upton, New York, 60 miles east of New York City, in the center of Suffolk County. The contract for the 5,263-acre site was approved by the Manhattan District of the Army Corps of Engineers in 1947, and BNL was established on the former Upton Army camp. The mission for this 3,557-employee site is to conceive, design, construct, and operate large, complex-research facilities for fundamental scientific studies and to conduct basic and applied research in the physical, biomedical, and environmental sciences and selected energy technologies. BNL is shown in Figure 4.4–2.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 5,738,554 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.11 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 2.7 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Suffolk County, in which BNL is located, is classified by EPA as a nonattainment area for the criteria pollutant ozone. The county is in attainment for the other five criteria air pollutants.
- Primary sources of air emissions at the site include furnaces, vehicle refueling stations, and surface coating and surface preparation operations.

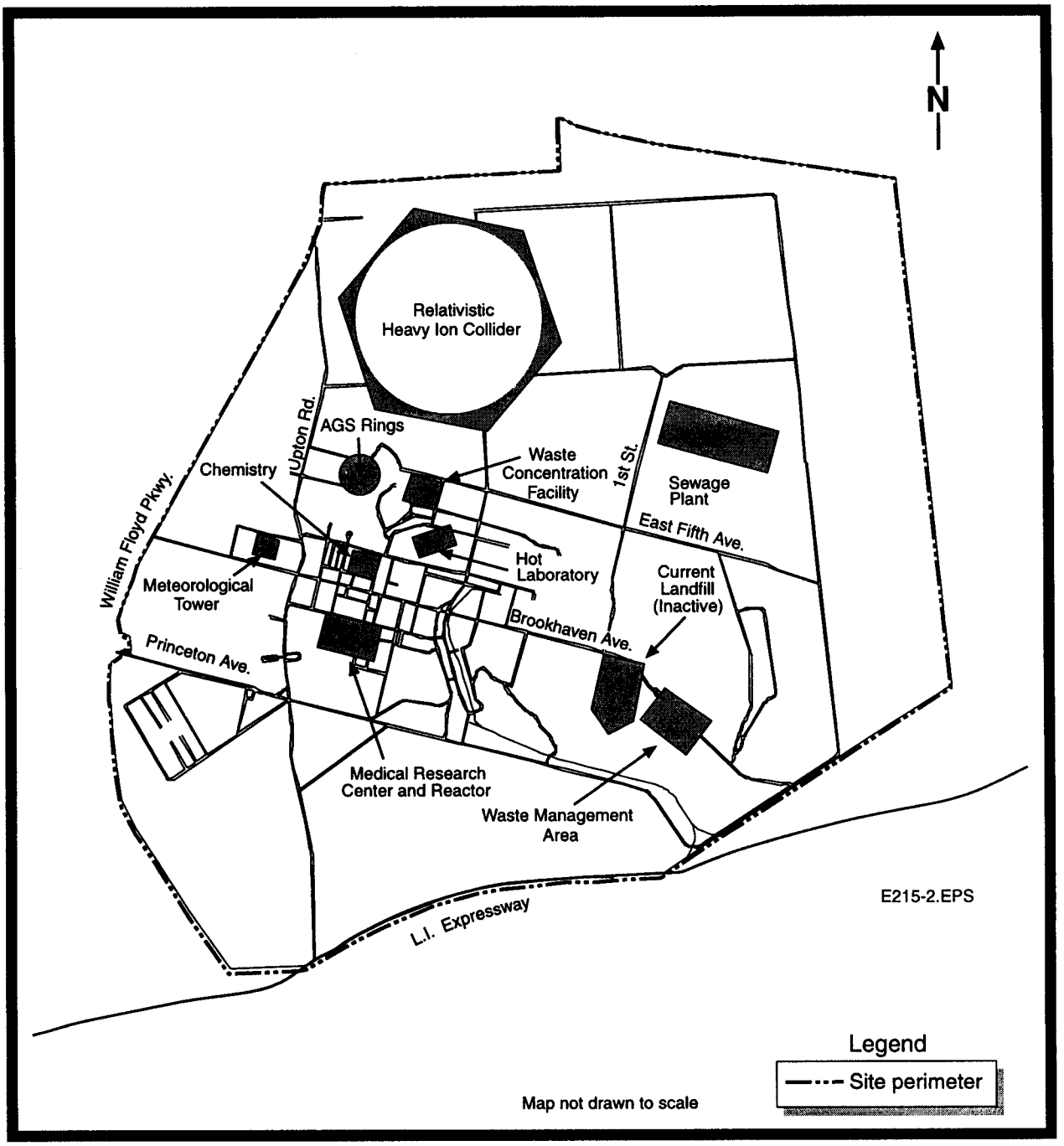

Figure 4.4–2. Brookhaven National Laboratory

- Prevailing winds in 1991 were from the south and southwest with a frequency of 12%. Dominant windspeed ranged from 8 to 11 miles per hour (mph) and occurred almost 34% of the time during 1991. The frequency of calm winds was 14%. Average monthly temperatures of 21.2 to 83.8 °F were recorded in 1991. Precipitation for the year was 45.3 inches.

Water Resources

- Major surface water features include the onsite Peconic River and its intermittent tributary.
- No federally designated Wild and Scenic Rivers exist in the ROI. A portion of the Peconic River that flows through the site has been designated "scenic" by the State of New York.
- Onsite streams and the Peconic River receive treated wastewater.
- Discharge monitoring in 1991 showed that all concentrations were within applicable standards, except for trichloroethylene.
- The Upper Glacial Aquifer and the Magothy Aquifer supply water for the site through 12 onsite wells.
- The major groundwater units are the lower aquifer system (Magothy and Raritan Formations) and the Pleistocene Upper Glacial Aquifer. These aquifers are considered sole source aquifers.
- Groundwater monitoring in 1991 showed that 8 parameters exceeded New York State Drinking Water Standards.
- Some groundwater contamination has migrated off site at concentrations that exceed drinking water standards.
- A portion of the BNL site is in the 100-year floodplain.

Geology and Soils

- The topography of the site is generally gently rolling, with elevations ranging from 43.6 to 120 feet above sea level.
- Major geologic units include, from oldest to youngest, the basement rocks, the Raritan Formation, the Magothy Formation, and surface glacial deposits.
- Glacial deposits include the Gardiners Clay, overlain by 170 feet of sand.
- Soils on the site consist of deep, well-drained to excessively drained, coarse-textured soils.
- Geologic hazards include little or no risk from earthquakes or volcanos.

Ecological Resources

- Vegetation at BNL includes pine plantation, moderately mature pitch pine/oak forest, predominantly deciduous forest, early successional shrub/sapling community, pine barren, shrub/sapling wetland, and

lawn area. Approximately 75% of BNL is primarily woodland. Old-growth hardwood trees that are unusual in the region are located next to BNL. Unique habitats include coastal plain ponds and a coastal plain stream.

- Wetlands include palustrine forested, herbaceous, and lacustrine wetlands.
- Based on a survey of 15 ecological communities identified on or adjacent to BNL, the peregrine falcon is the only Federal and State-listed endangered species reported to occur onsite at BNL. The bald eagle, Federally listed as threatened, is also reported at BNL. State-listed species include 4 threatened (osprey, red-shouldered hawk, northern harrier, and common tern), 1 endangered (eastern tiger salamander), and 12 species of special concern. A wetland on BNL is a breeding area for the eastern tiger salamander. No Federal or State-listed endangered, threatened, or special concern plants are found on site at BNL. However, one Federal endangered plant, the sandplain gerardia, has been reported in the Brookhaven area (though not on or adjacent to the site), and five flowering plants and eight fern species found at BNL are protected under State law.

Socioeconomic Conditions

- The ROI for BNL comprises Suffolk and Nassau Counties. Ninety percent of the site's employees reside in these counties.
- Total site employment in 1990 was 3,557. Total ROI employment by place of work in 1990 was 1,419,040.
- The ROI unemployment rate in 1991 was 6%.
- The ROI per capita income in 1990 was $27,919.
- The total population in the ROI in 1990 was 2,609,212. Population demographics: Native Americans—0.2%; urban—97.9%.
- Housing: owner-occupied—80.28%; renter-occupied—19.72%.
- Sensitive populations: children (under 15 years old)—19.9%; women of child-bearing age (ages 15 to 44)—23.2%; adults over 65—12.4%.

Environmental Justice

- Minorities—Figure C.4-8.
- Below poverty level—Figure C.4-25.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site covers an area of 5,263 acres, of which 1,655 acres are developed. The site contains six designated, regulated wetlands and areas where the water table is close to the surface, that comprise an aggregate area of approximately 700 acres. Thus, approximately 2,900 acres are available for development.
- Land use surrounding the site is predominantly undeveloped private and public forest land but is experiencing intensified pressure for residential development. BNL is located in the Central Pine Barrens and within the Peconic Estuary system.

Infrastructure

- An onsite water treatment plant supplied by groundwater provides an average of 4.5 million gallons of water per day.
- An onsite plant receives an average of 1 million gallons of sewage per day, with the effluent discharged to the headwaters of the Peconic River.
- The Long Island Lighting Company supplies power to BNL; the current site load is 35 megawatts.
- Interstate I-495 provides direct access between BNL and New York City. The region surrounding BNL is served by the Long Island Railroad.

Cultural Resources

- BNL contains no recorded archaeological sites, standing structures, or traditional cultural properties. However, the site has not been the subject of a comprehensive cultural resource investigation.
- Three areas that have been identified as eligible for inclusion on the National Register of Historic Places.

4.4.3 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT—FERNALD, OHIO

The Fernald Environmental Management Project (FEMP), formerly Feed Materials Production Center, is just north of Fernald, Ohio, a small farming community in southwest Ohio (about 17 miles northwest of downtown Cincinnati). In operation since 1952, the primary mission of the 1,050-acre FEMP was to produce purified uranium metal and uranium compounds for use at other DOE defense facilities. A small amount of thorium processing has also been conducted at FEMP. FEMP is shown in Figure 4.4–3.

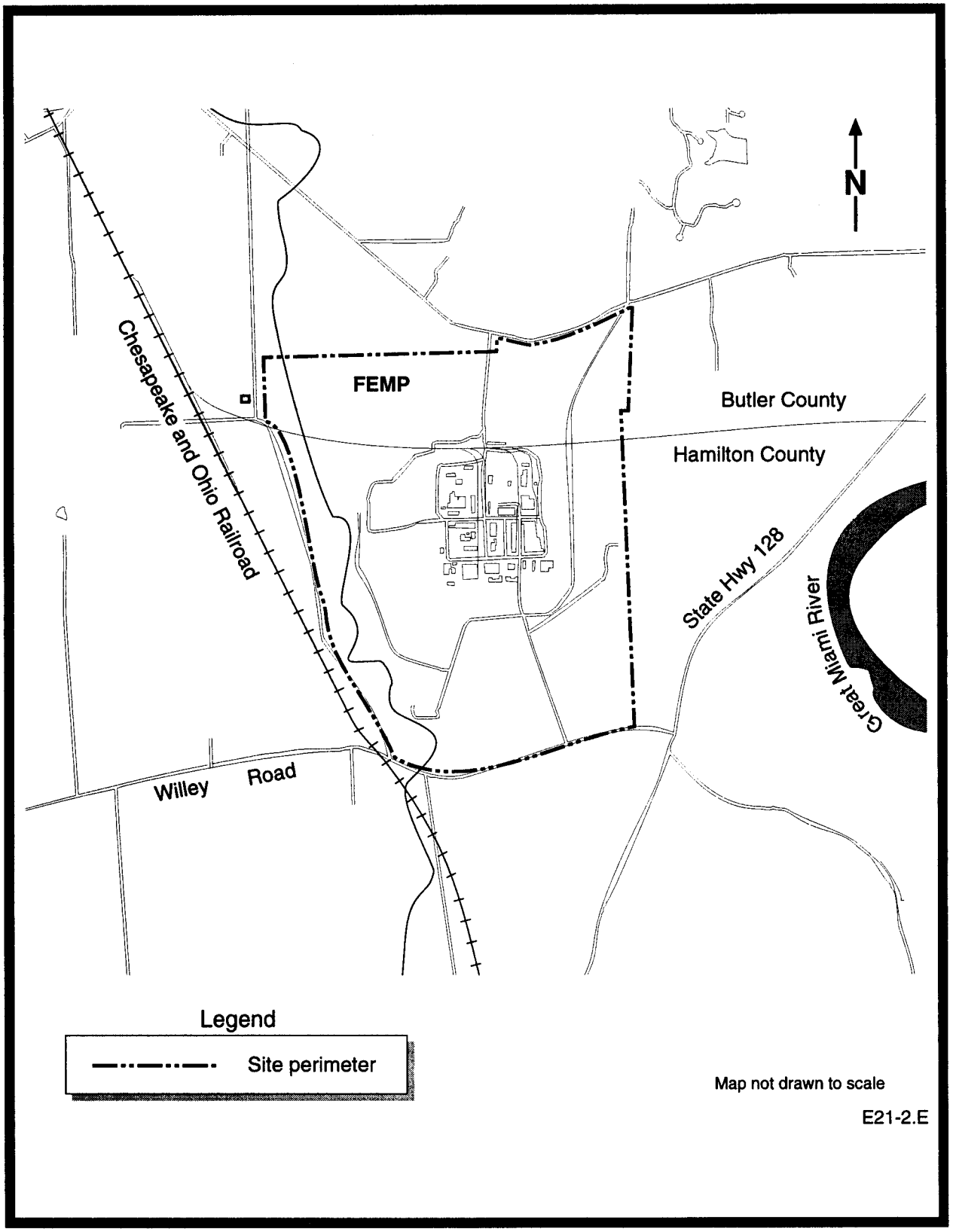

Figure 4.4-3. Fernald Environmental Management Project

By the late 1980s, production was suspended, and the site's mission was changed from uranium production to environmental restoration of the site. The 1,939 FEMP employees are now engaged in cleanup of the site and support of the waste management and base services activities.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 2,764,589 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0021 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a). If radon is included, the dose is 51 mrem.
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 1.30 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Hamilton and Butler Counties are classified as "moderate nonattainment" areas for ozone; these counties are in attainment for the remaining five criteria air pollutants.
- The major source of air pollution at the site is the boiler plant emissions.
- Prevailing winds are from the south southwest 12% of the time; calm winds occur 4% of the time. The annual average windspeed recorded at the Greater Cincinnati Airport was 9 mph with 1-minute sustained winds up to 46 mph. Average monthly temperatures of 32 to 88 °F were recorded in 1992. Precipitation for the year was 38 inches; the monthly maximum was 7 inches in July.

Water Resources

- Major surface water features include Paddy's Run, which drains the site to the Great Miami River, which then drains into the Ohio River.
- No federally designated Wild and Scenic Rivers exist downstream of the site.
- Wastewaters are discharged to onsite streams and the Great Miami River.
- Two parameters in the surface water exceeded comparison criteria in 1992.
- Groundwater from the Great Miami Buried Valley Aquifer supplies water for the site.
- The Great Miami Buried Valley Aquifer is a sole source aquifer.
- Eleven contaminants in the groundwater exceeded comparison criteria in 1992.
- The site is located above the 100-year floodplain of the Great Miami River.

Geology and Soils

- The site lies on a terrace remnant above the Great Miami River Valley. Glacial features dominate the landscape.
- Bedrock consists of sedimentary shales and limestone approximately 60 to 200 feet below the ground surface. The bedrock forms the floor and valley walls of the New Haven Trough.
- No major geologic faults have been mapped.
- The dominant soils at the site are silty loams of glacial origin. These soils are poorly drained, occur on relatively flat surfaces, have low permeability, and experience seasonal saturation.
- Geological hazards include little or no risk from subsidence, earthquakes, or volcanic eruptions.

Ecological Resources

- Vegetation consists of nonnative grasslands, pine plantations, deciduous woodlands, and riparian woodlands.
- Ecologically important habitat includes mature woodlands, pine for managed wildlife species, such as white-tailed deer and eastern cottontail rabbit, and riparian woodlands. Cattle grazing and brush clearing have resulted in habitat fragmentation and reduction in wildlife corridors.
- A total of 35.9 acres of freshwater wetlands (palustrine forested, drainage ditches/swales, and isolated persistent emergent and scrub/shrub wetlands) were delineated at FEMP.
- No Federally listed threatened or endangered plant or animal species are known at FEMP. However, potential habitat exists for the Indiana bat (Federal and State endangered). Running buffalo clover, a Federally listed endangered plant species, occurs near FEMP. Seven state-listed endangered species (including the Indiana bat) and three state-listed threatened species occur or potentially occur at FEMP.

Environmental Justice

- Minorities—Figure C.4–9.
- Below poverty level—Figure C.4–26.
- Presence of Federally recognized Native American Tribes: none.

Socioeconomic Conditions

- The ROI for FEMP comprises Hamilton, Butler, and Warren Counties in Ohio and Dearborn County in Indiana. Ninety percent of the site's employees reside in these counties.
- Total site employment in 1990 was 1,939. Total ROI employment by place of work in 1990 was 804,376.

- The ROI unemployment rate in 1991 was 6%.
- The ROI per capita income in 1990 was $19,275.
- The total population in the ROI in 1990 was 1,313,000. Population demographics: Native Americans—0.1%; urban—89.1%.
- Housing: owner-occupied—62.4%; renter-occupied—37.6%.
- Sensitive populations: children (under 15 years old)—23.8%; women of child-bearing age (ages 15 to 44)—23.9%; adults over 65—12.2%.

Land Use

- The site covers an area of 1,050 acres, of which 275 acres are developed; of the area that is undeveloped, 195 acres are considered environmentally sensitive. Land available for development is approximately 275 acres.
- Land use surrounding the site is predominantly agricultural.

Infrastructure

- An onsite well system provides an average of 0.4 million gallons of water per day. Connection to a public system is planned.
- An onsite wastewater treatment plant treats an average of 2.18 million gallons of sewage per day and discharges treated effluent into the Little Miami River.
- The Cincinnati Gas and Electric Company supplies power to the site; average loads are 33 megawatts.
- Transportation in the region consists of roads and interstates, such as nearby State Route 126. U.S. Route 27 provides access to Interstates 275 and 74. Rail access is by the Baltimore and Ohio Railroad, 3 miles to the west.

Cultural Resources

- Native American occupation of the FEMP area began about 14,000 years ago. European settlement began during the late 18th century.
- The site has 42 recorded archaeological sites, standing structures, or traditional cultural properties. Sixty-one percent of this site has been subject to a comprehensive cultural resources survey.
- Three areas are eligible for inclusion on the National Register of Historic Places.

4.4.4 HANFORD—RICHLAND, WASHINGTON

The Hanford Site occupies approximately 560 square miles of semi-arid desert land in southeastern Washington State, approximately 119 miles southwest of Spokane and 150 miles southeast of Seattle, and employs approximately 14,394 people. The Federal Government acquired the Hanford Site in 1943, and for almost 50 years, Hanford's facilities were dedicated to plutonium production and to the storage and disposal of the resulting waste products. Since the 1960s, however, programs at the Hanford Site have diversified to include research and development for advanced reactors, renewable energy technologies, waste disposal technologies, and cleanup of site contamination. The Hanford Site is shown in Figure 4.4–4.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 377,645 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0037 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.60 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Benton and Franklin Counties are classified as attainment areas for all six of the National Ambient Air Quality Standards criteria air pollutants. The southernmost portions of Benton, Franklin, and Walla Walla Counties (which do not include the Hanford Site) are suspected to be in nonattainment for particulate matter under 10 micrometers in diameter (PM_{10}), although they are not classified as nonattainment areas.
- Major sources of air pollution at the site are the 9 primary boiler units, the 300-Area incinerator, and fugitive emissions from the 200-East and 200-West coal piles.
- Prevailing winds are from the northwest during all months of the year, with monthly average speeds of 6 to 7 mph in the winter and 9 to 10 mph in the summer. Temperatures range from 36°F in early January to 95°F in late July. Annual average precipitation is 6.3 inches.

Water Resources

- Major surface water features include the onsite Columbia River and the nearby Yakima River. The Columbia River, which forms some of the site's eastern boundary, is regulated by a network of dams.

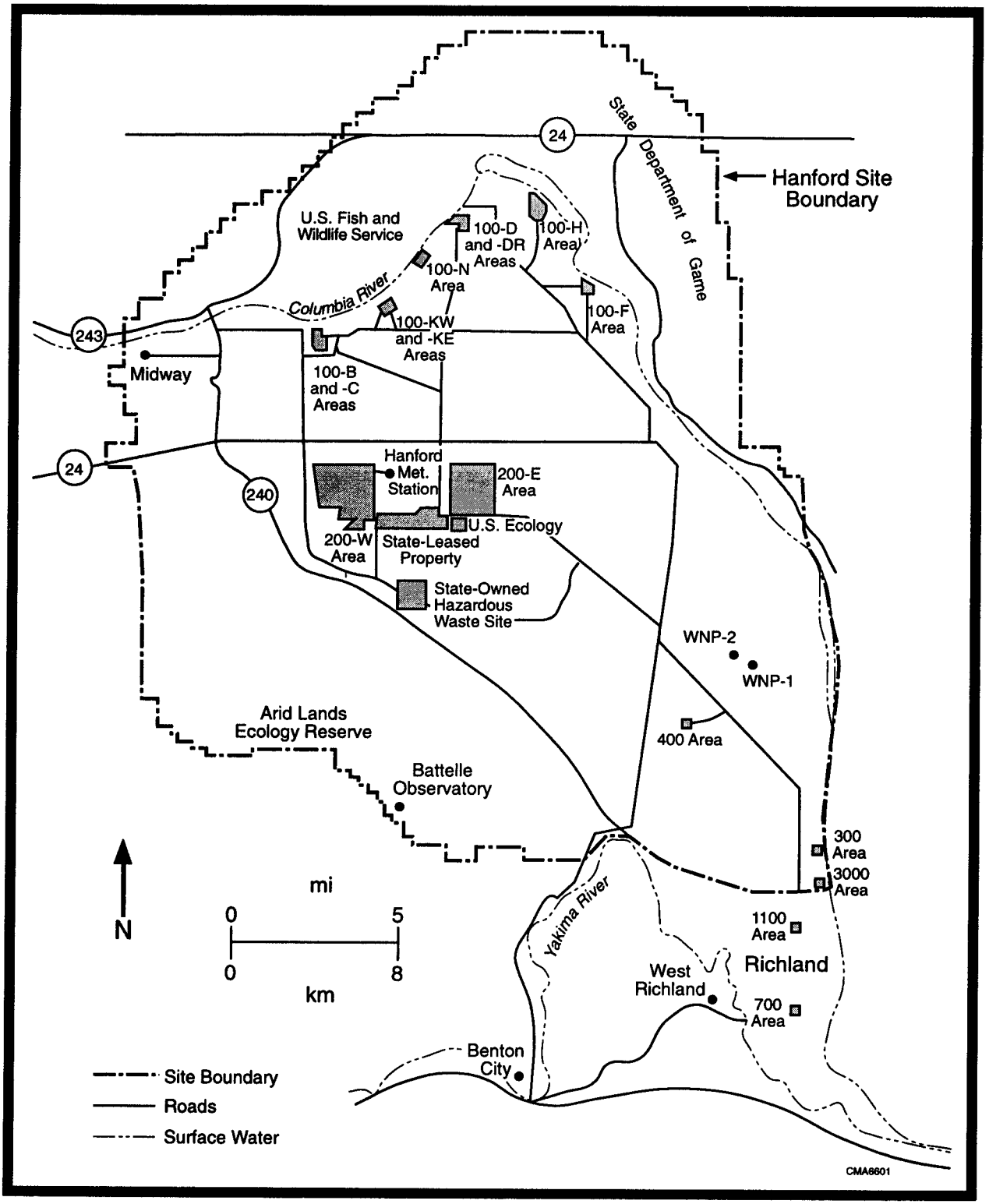

Figure 4.4–4. Hanford Site

- No federally designated Wild and Scenic Rivers exist in the ROI, although the Hanford Reach of the Columbia River has been recommended for inclusion in the Wild and Scenic Rivers System in the Record of Decision for the *Final Hanford Reach of the Columbia River Comprehensive River Conservation Study and Environmental Impact Statement* (DOI, 1994).
- The probable maximum flood would inundate parts of the 100-Area located adjacent to the Columbia River.
- The Columbia River and onsite wells supply water for the site.
- Treated wastewater is discharged to onsite drainfields and the Columbia River.
- Results from surface water monitoring in 1992 show five parameters exceeded comparison criteria.
- Unconfined aquifers contained within glaciofluvial sands and gravels and within the Ringold Formation and deeper confined aquifers within the Columbia River Basalts are the major groundwater units. No aquifers are considered sole source aquifers.
- Groundwater monitoring in 1992 showed that 14 parameters exceeded comparison criteria. Preliminary investigations have identified four major groundwater contaminant plumes, which have been found to enter the Columbia River in at least three locations.
- Lands susceptible to the 500-year flood on the Columbia River would be restricted to those areas of the site adjacent to the river. The 100-year flood on the Yakima River could extend into the southern section of the site.

Geology and Soils

- The site is on the intermontane Columbia Plateau, with the topography dominated by basalt plateaus, ridges, and buttes.
- Surface sediments consist of as much as 1,640 feet of unconsolidated sands, silts, gravels, and clays.
- Major rock units include—from oldest to youngest—flood basalts; the Ringold Formation consisting of unconsolidated fluvial sediments; the glacial Hanford Formation; and ash layers from Crater Lake, Oregon, Glacier Peak, Washington, and Mount St. Helens, Washington.
- Anticlines form surface highs in the region and are broken by faults on their crests. Steeply dipping shear zones are abundant in the region and extend to the northwest.
- Surficial soils vary from sand to silty and sandy loam but are predominantly deep, well-drained sandy loams. The Hanford formation near the Columbia River consists of coarse-grained soils composed mostly of the soil column above the basalt.

- The seismicity of the Columbia Plateau is relatively low. Shallow, low-intensity earthquakes occur throughout the Hanford Site area, although quakes of greater magnitude have occurred in the plateau region.

Ecological Resources

- The Hanford Site contains the largest tract of undisturbed native sagebrush steppe remaining in the State of Washington and is 6 linear miles from the second largest tract in the state, the Yakima Training Center. The National Biological Service has listed native shrub and grassland steppes in Washington and Oregon as an endangered ecosystem (Noss, 1995). This habitat also has been identified as a priority habitat by the State of Washington. There are 24 major plant communities (DOE, 1995). Big sagebrush and bitterbrush are important desert shrubs, and some plants have medicinal and dye value. Important terrestrial habitats include riparian areas, native shrub and grasslands, canyons, upland habitats, basalt outcroppings and cliffs, and trees that serve as nesting platforms for birds.
- Wetlands occur on the Hanford Site, with the largest wetland being the riparian zone bordering the Columbia River.
- The peregrine falcon (Federal and State endangered), the bald eagle (Federal and State threatened), and the Aleutian Canada Goose (Federal threatened, State endangered) are found on the Hanford Site. The peregrine falcon is a casual migrant to the Hanford Site and does not nest there. The bald eagle winters along the Hanford Reach. State-listed species include seven State endangered and four State threatened species. Eleven Federal candidate species (three are State threatened; two are State endangered; one is a State species of special concern; and two are State candidate species) have been observed. It is Hanford Site policy to treat candidate species in the same manner as listed species. An additional seven State candidate species have been found on the Hanford Site, as well as nineteen State plant species of concern. The Hanford Reach is the only significant mainstream spawning habitat remaining for Fall Chinook salmon. The Hanford Reach is the only significant remaining section of the inland Columbia River where White sturgeon are able to spawn. Three plant and seven insect species new to science have been discovered on the Hanford Site since 1994, indicating a very high-quality ecosystem.

Socioeconomic Conditions

- The ROI for the Hanford Site comprises Adams, Benton, Franklin, Grant, and Yakima Counties. Ninety-nine percent of the site's employees reside in these counties.

- Total site employment in 1990 was 14,394. Total ROI employment by place of work in 1990 was 214,298.
- The ROI unemployment rate in 1991 was 10.9%.
- The ROI per capita income in 1990 was $15,927.
- The total population in the ROI in 1990 was 409,200. Population demographics: Native Americans—2.5%; urban—50.1%.
- Housing: owner-occupied—63.1%; renter-occupied—36.9%.
- Sensitive populations: children (under 15 years old)—26.2%; women of child-bearing age (ages 15 to 44)—21.7%; adults over 65—11.8%.

Environmental Justice

- Minorities—Figure C.4-10a.
- Below poverty level—Figure C.4-27.
- Presence of Federally recognized Native American Tribes: Yakima Nation, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Confederated Tribes of the Warm Springs Indian Reservation.

  Tribal lands—Figure C.4-10b.

Land Use

- The site occupies approximately 560 square miles (358,300 acres) of arid desert land, of which 21,498 acres (6%) are developed. Of the undeveloped area, 77,000 acres have been set aside as an arid land ecology reserve, and an additional 89,000 acres (Wahluke Slope) are managed by the U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife as a National Wildlife Refuge and Wildlife Area. Land area recommended for future waste management activities is 6,000 acres.
- The predominant land uses in the ROI are agriculture, the Yakima Indian Reservation, the Yakima Training Center (Department of Defense), and the Hanford Site.

Infrastructure

- Onsite wells and the Columbia River provide an average of 9.51 million gallons of water per day.
- Onsite treatment facilities (such as septic tanks, subsurface soil absorption systems, and a sanitary treatment plant) treat an average of 0.158 million gallons of sewage per day.
- The Bonneville Power Administration supplies power; average loads are 59.36 megawatts.

- Transportation in the region consists of local access roads, such as State Routes 240 and 24 and Interstates 82 and 90. Rail lines, including the onsite U.S. Government railroad, also serve the region.

Cultural Resources

- Native American settlement of the region began approximately 10,000 years ago. Europeans occupied the region during the 19th century.
- The Hanford Site contains numerous recorded archaeological and may contain additional traditional cultural properties important to Native American groups.
- The Hanford Site contains several industrial and architectural properties, including the Hanford B Reactor, that are listed on the National Register of Historic Places.

4.4.5 IDAHO NATIONAL ENGINEERING LABORATORY—IDAHO FALLS, IDAHO

The Idaho National Engineering Laboratory (INEL) occupies 890 square miles (569,600 acres) of desert in the southeastern portion of Idaho, approximately 42 miles west of Idaho Falls. INEL was established in 1949 as a site where DOE could safely build, test, and operate various types of nuclear facilities. Currently, the focus of INEL is environmental restoration, waste management, and technology development. INEL is shown in Figure 4.4–5.

Included within the boundaries of INEL are two sites, Naval Reactors Facility (NRF) and Argonne National Laboratory-West (ANL-W), that are included in the analysis of the LLMW alternatives. The NRF site occupies 4,400 acres in the central portion of the INEL site, but only 84 acres are developed. The NRF is engaged in research and development for design and operation of naval nuclear propulsion plants as part of the joint DOE and Department of Navy Naval Nuclear Propulsion Program.

ANL-W is located on a 1,900-acre site on the southeastern portion of INEL. The primary mission of ANL-W is research and development in support of the Nation's fast reactor program. Approximately 850 persons are employed at ANL-W.

These two sites share the same environmental features with the INEL site and thus the summary descriptions presented below also apply to NRF and ANL-W.

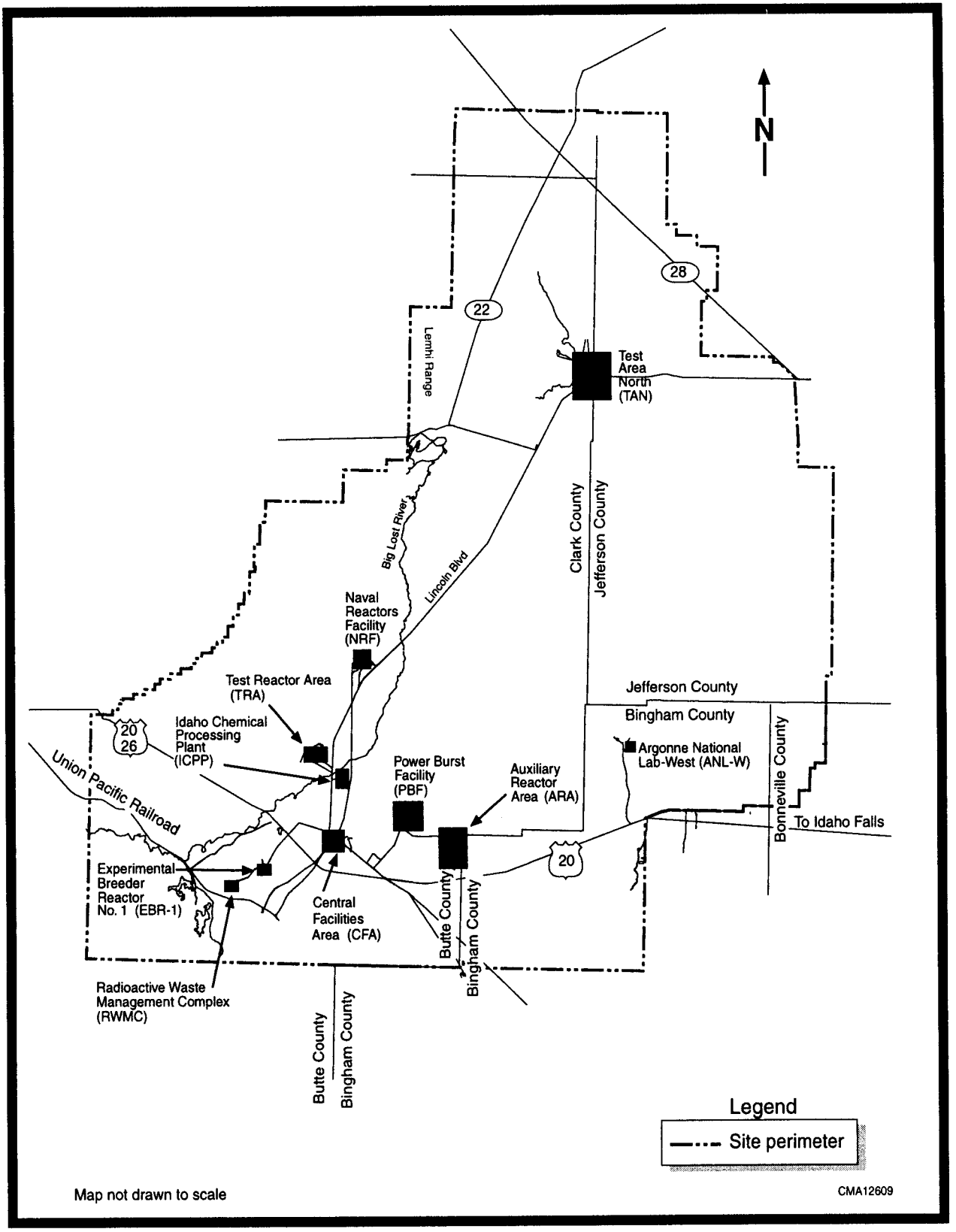

Figure 4.4–5. Idaho National Engineering Laboratory

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 153,061 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0015 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.030 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- The counties of Butte, Jefferson, Bonneville, and Bingham are classified as attainment areas for all six of the National Ambient Air Quality Standards criteria air pollutants.
- Major sources of air pollution at the site are the DOE programs, including irradiation services, calcination of liquid radioactive waste solutions, light-water-cooled reactor testing research, operation of research reactors, environmental restoration at the site, and storage and surveillance of solid transuranic waste.
- The prevailing wind directions are from the south to southwest and from northwest to northeast, with annual average speeds of 7 mph. Windspeeds are lowest during the winter months, averaging 5 mph, and highest during the spring months, averaging 8 mph. Annual temperatures average 42°F, ranging from -49 to 103°F.

Water Resources

- Major surface water features include the Big Lost River, the Little Lost River, and Birch Creek, all of which flow toward the INEL site, although only the Big Lost River actually flows onto the site in years of high precipitation. Because of infiltration, evaporation, and uptake by plants, none of the rivers flow off site.
- No Federally designated Wild and Scenic Rivers exist in the ROI.
- If Mackay Dam fails, the Idaho Chemical Processing Plant, the Naval Reactors Facility, and Test Area North would be flooded.
- Wastewater is discharged to onsite drainfields or evaporation/percolation ponds.
- Because creeks and rivers at INEL are ephemeral, surface water sampling can only be performed infrequently, after heavy precipitation events.
- Water is supplied by wells in the Snake River Plain Aquifer.

- The major groundwater unit is the Snake River Plain Aquifer, consisting of 1,000 to 2,000 feet of basaltic rocks and interbedded sedimentary sequences. It is considered a sole source aquifer.
- Groundwater monitoring for radioactive and nonradioactive parameters in 1992 showed levels above comparison criteria for four contaminants at onsite wells. No contaminants were found to exceed established EPA levels in offsite wells.
- Only one contaminant exceeded its comparison criterion in onsite wells in 1994.

Geology and Soils

- The topography is flat to gently rolling with frequent lava outcrops and an average elevation of 4,900 feet above sea level.
- The site is located in the Eastern Snake River Plain with the Lemhi, Lost River, and Bitterroot Mountain ranges bordering the site on the north and northwest.
- Underlying rock includes basaltic lava flows interbedded with sediments to a depth of several thousand feet.
- Soils beneath the southern part of the site are gravelly to rocky and generally shallow; the northern part is covered by lake and wind deposits, and most soils are composed of unconsolidated clay, silt, and sand.
- Geologic hazards include possible earthquakes with moderate to major probability of seismic damage. Historically, few earthquakes have occurred on the Eastern Snake River Plain, although two major earthquakes (Richter magnitude 7.5 and 7.3) have occurred within 100 miles of the site during the last 35 years. The most recent volcanism occurred about 2,100 years ago, 15 miles southeast of the site.

Ecological Resources

- Saltbrush deserts, juniper woodlands, native grasslands, big and low sagebrush, and riparian communities are found on INEL. Big sagebrush is dominant, covering approximately 80% of INEL. Nonnative cheatgrass is a serious threat to the integrity of the sagebrush shrub-steppe community. Unusual lava-tube cave systems are found throughout INEL and in nearby areas.
- Potential wetlands total approximately 2,000 acres and include waste ponds, river diversion spreading areas and hundreds of small playas.
- The bald eagle (Federal threatened, State endangered) and American peregrine falcon (Federal and state endangered) are found on INEL, but they do not reside year-round on INEL. No known critical habitat is found at INEL, and no known listed Federal or State threatened or endangered plant species are found at the site. However, one plant is listed by the State as imperiled, and eight Federal candidate

species (two are State species of special concern) and five State species of special concern are found on INEL.

Socioeconomic Conditions

- The ROI for INEL comprises Bannock, Bingham, Bonneville, Butte, Clark, and Jefferson Counties. At least 95% of the site's employees reside in these counties.
- Total site employment in 1990 was 11,813. Total ROI employment by place of work in 1990 was 99,692.
- The ROI unemployment rate was 5.3% in 1991.
- The ROI per capita income in 1990 was $14,622.
- The total population in the ROI in 1990 was 196,039. Population demographics: Native Americans—2.5%; urban—56.3%.
- Housing: owner-occupied—72.1%; renter-occupied—27.9%.
- Sensitive populations: children (under 15 years old)—30%; women of child-bearing age (ages 15 to 44)—21.6%; adults over 65—9.7%.

Environmental Justice

- Minorities—Figure C.4-11a.
- Below poverty level—Figure C.4-28.
- Presence of Federally recognized Native American Tribes: Fort Hall Shoshone-Bannock Tribes. Tribal lands—Figure C.4-11b.

Land Use

- The site occupies approximately 890 square miles (569,600 acres) of desert, of which 11,391 acres (2%) are developed, and the remainder is undeveloped; of the 550,000 acres that are undeveloped, approximately 330,000 acres are currently used for controlled grazing by cattle and sheep. The available area for future site development is approximately 22,330 acres.
- Land use surrounding the site is predominantly vacant and undeveloped, primarily devoted to grazing by sheep and cattle.

Infrastructure

- Onsite wells and storage tanks provide an average of 5.242 million gallons of water per day.

- Onsite treatment facilities (such as septic tanks, drainfields, or wastewater treatment plants) treat an average of 0.254 million gallons of sewage per day.
- The Idaho Power Company supplies power; the current load is 41.8 megawatts.
- Transportation in the region consists of local access roads such as U.S. Routes 20 and 26. Interstate 15 passes to the east of the site and intersects Interstate 84 to the south. Rail lines, including an onsite spur connecting to the Union Pacific Railroad, also serve the region.

Cultural Resources

- With only 5% of the facility surveyed, INEL contains at least 1,700 archaeological properties. The extent of INEL's architectural resources and traditional cultural properties has not been identified.
- INEL contains one National Historic Landmark—the Experimental Breeder Reactor #1. One archaeological site has been listed, and the Experimental Breeder Reactor #1 has also been designated for listing on the National Register of Historic Places.

4.4.6 LAWRENCE LIVERMORE NATIONAL LABORATORY—LIVERMORE, CALIFORNIA

The Lawrence Livermore National Laboratory (LLNL) includes the Livermore Site, and LLNL Site 300. The WM PEIS also analyzed the Sandia National Laboratories (California) (SNL-CA) as part of LLNL. The LLNL Livermore Site occupies 1.3 square miles, is located 40 miles east of San Francisco and 3 miles east of Livermore in Alameda County, and employs 8,964 people. LLNL Site 300 covers 10.8 square miles, is located 15 miles southeast of Livermore, and employs 200 people. The SNL-CA is located on 413 acres next to and south of the LLNL Livermore Site. LLNL is shown in Figure 4.4–6.

In 1952, the Atomic Energy Commission (AEC) established the University of California Radiation Laboratory-Livermore Site (LLNL's predecessor) as a laboratory dedicated to nuclear weapons research. The University of California has managed and operated LLNL for DOE and its predecessor agencies. In 1953, to support the LLNL Livermore activities, the AEC purchased the first 4,000 acres of Site 300 for high-explosive testing. In 1956, SNL established the Livermore facility to provide a closer relationship with the LLNL design work. Today, the major programs at LLNL include defense and related programs, laser fusion, laser isotope separation, biomedical and environmental research, and environmental restoration and waste management.

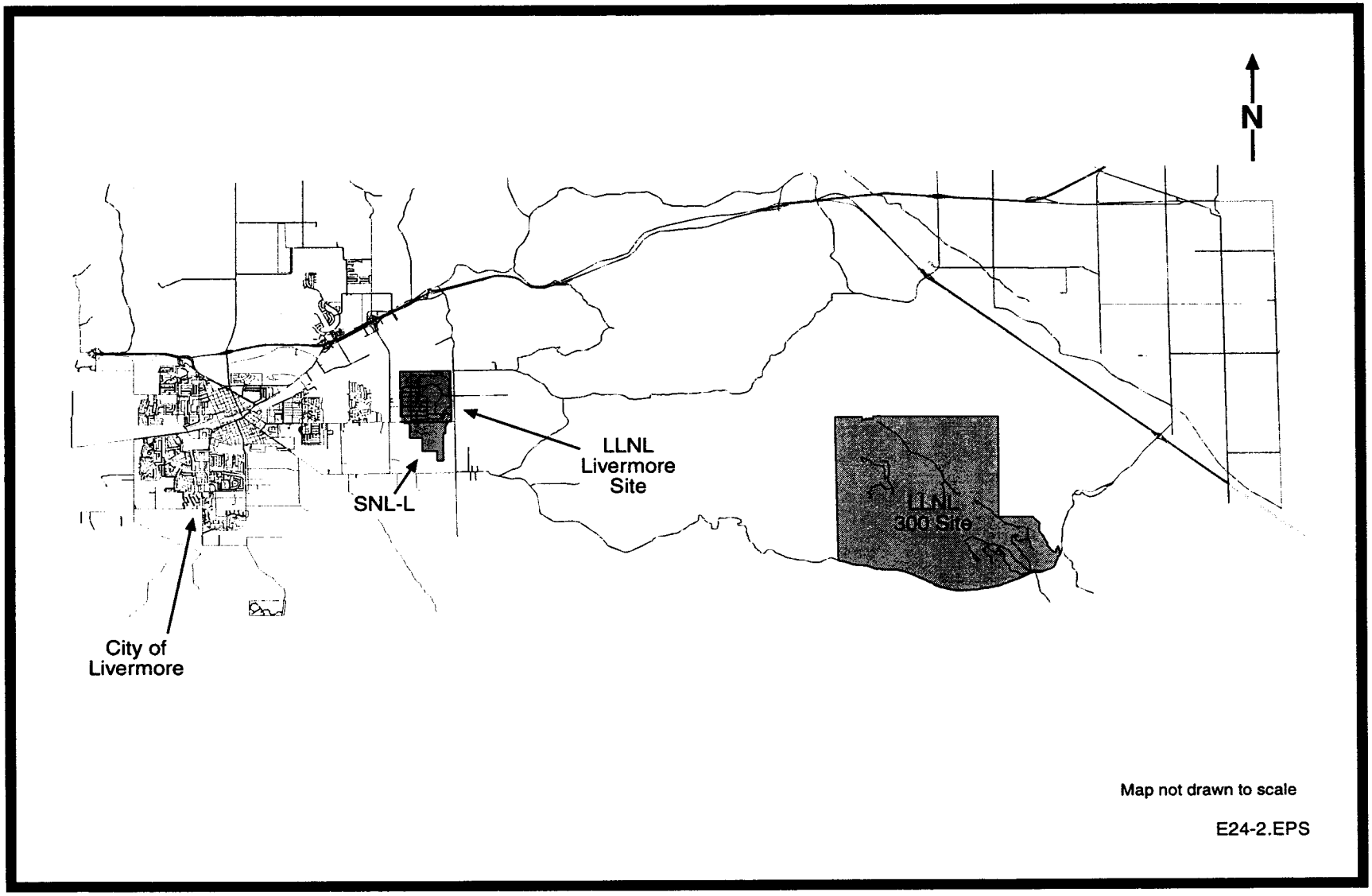

Figure 4.4–6. Lawrence Livermore National Laboratory

Owing to the proximity of SNL-CA to LLNL, the summary descriptions of environmental features presented below largely reflect the situations at SNL-CA.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 6,324,234 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) from point sources was 0.690 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a). The radiation dose from all sources for CY 1992 was 0.079 rem.
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 1.70 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Alameda County, which is located in the Bay Area Air Quality Management District, is currently classified as an attainment area for all six criteria air pollutants.
- Major sources of criteria pollutant emissions from the site are 96 boilers, 51 solvent cleaners, printing operations, paint booths, and oil shale experimental equipment. Tritium has been discharged from the tritium facility and miscellaneous diffuse sources.
- Prevailing winds at the San Francisco Airport in 1992 were from the west and northwest approximately 49% of the time, with the highest annual occurrence of windspeed of 4.6 to 11.5 mph 28% of the time. The average annual temperature is 59°F, ranging from a low monthly average of 46°F in January to a high monthly average of 71°F in July.

Water Resources

- Major surface water features at the Livermore Site include intermittent streams (such as Arroyo Mocho, Arroyo Seco, and Arroyo Las Positas), Patterson Reservoir (0.8 mile northeast of the Livermore Site), and Alameda Creek. Corral Hollow Creek is the only major surface water feature near Site 300 that receives drainage from local tributaries.
- No federally designated Wild and Scenic Rivers exist in the ROI.

- The Hetch Hetchy Aqueduct system supplies water for the Livermore Site. Groundwater is the main water supply for Site 300.
- No site facilities at either the Livermore Site or Site 300 lie within 100-year floodplains of Alameda Creek and Corral Hollow Creek, although portions of the Livermore Site adjacent to Greenville Road and portions of Site 300 near Corral Hollow Road are within the floodplains of the Arroyo Las Positas and Corral Hollow Creek, respectively.
- The majority of the wastewater generated from the Livermore Site discharges to the City of Livermore Water Reclamation Plant. Small amounts of low-threat wastewater are discharged into the stormwater drainage system under permits from the State and according to the CERCLA Record of Decision. Wastewater from Site 300 is released under permits, waivers, and agreements with the State of California.
- Major groundwater units at the Livermore Site include alluvial sediments and overlying lacustrine Livermore Formation sediments. Two water-bearing zones exist beneath Site 300 in the sandstones and conglomerates of the Neroly Formation. No aquifers are considered sole-source aquifers.
- Routine groundwater and surface water monitoring are conducted at both the Livermore Site and Site 300. Results of this monitoring are reported annually in the LLNL Environmental Report. Routine groundwater monitoring in 1992 showed that four parameters exceeded comparison criteria at the Livermore Site, and four parameters exceeded comparison criteria at Site 300.

Geology and Soils

- The LLNL Livermore Site is on relatively flat foothills with low relief and elevations ranging from 571 to 676 feet above National Geodetic Vertical Datum. Site 300 is in the Altamont Hills and includes steep ridges and canyons. Elevations range from 500 to 1,722 feet.
- The sediments beneath the Livermore Valley consist largely of the Livermore Formation. This includes gravel, sand, silt, and clay. Older formations are exposed at Site 300, which include the Panoche Formation, the Cierbo Formation sandstones, and the Neroly Formation.
- The soils at the Livermore Site are moderately developed soils and include loams, silty clay loams, gravelly loams, and clay loams. At Site 300, the soils are young with little or no development of the horizons that make up mature soils.
- Major faults in the area are the San Andreas, Hayward, Calaveras, and Greenville faults. Local faults have the greatest potential for damaging earthquakes.
- Local faults are the main seismic hazard with potential for damaging earthquakes.

- Potential for volcanic activity is small. Potential for slope instability at the Livermore site is also small. However, at Site 300, the potential for slope instability is considered moderate to high.

Ecological Resources

- At the Livermore Site, developed areas consist of ornamental vegetation and lawns; the undeveloped security zone is dominated by nonnative grasses. Wooded riparian habitat occurs along an arroyo.
- At Site 300, vegetation consists of the dominant introduced grassland (5,650 acres), native grassland, coastal sage scrub, oak woodland, and vegetation associated with seeps and springs. Site 300 includes a large stand of native perennial grassland now rare in California. Unique habitats include rocky outcrops and cliffs, two vernal pools, and forb communities along gullies.
- At the LLNL Livermore Site, wetlands occur along an arroyo and total 0.36 acres.
- At Site 300, wetlands total approximately 6.76 acres.
- At the LLNL Livermore Site, no threatened or endangered plant or animal species, or critical habitat has been found. Potential exists for the bald eagle (Federal threatened, State endangered), the San Joaquin kit fox (Federal endangered, State threatened), and the California red-legged frog (Federal proposed endangered) to be found, as well as one additional Federal proposed endangered species, three Federal candidate species, 32 State species of special concern, and two State threatened species. Several Federal and State endangered plants are also identified within the region.
- The large-flowered fiddleneck (Federal and State endangered), which is considered one of the most endangered plant species in California and possibly the nation, is found at Site 300. The peregrine falcon (Federal and State endangered), the San Joaquin kit fox (Federal endangered, State threatened), the longhorn fairy shrimp (Federal endangered), the conservancy fairy shrimp (Federal endangered), and the valley elderberry longhorn beetle (Federal threatened, State species of special concern) have been identified. Four State endangered, three State threatened, and 33 State species of special concern may occur at Site 300.

Socioeconomic Conditions

- The ROI for LLNL includes Alameda, Contra Costa, San Joaquin, and Stanislaus Counties. At least 97% of the Site's employees reside in these counties.
- Total site employment in 1994 was 8,713. Total ROI employment by place of work in 1990 was 1,512,433.
- The ROI unemployment rate was 9.3% in 1991.
- The ROI per capita income in 1990 was $21,099.

- The total population in the ROI in 1990 was 2,934,064. Population demographics: Native Americans—0.8%; urban—95.2%.
- Housing: owner-occupied—58.8%; renter-occupied—41.2%.
- Sensitive populations: children (under 15 years old)—22.2%; women of child-bearing age (ages 15 to 44)—24.2%; adults over 65—10.8%.

Environmental Justice

- Minorities—Figure C.4-12.
- Below poverty level—Figure C.4-29.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- LLNL includes the Livermore Site, which occupies 1.3 square miles (832 acres); LLNL Site 300, which is located 15 miles from the Livermore Sites and covers 10.8 square miles (6,927 acres); and SNL-CA, which is located on 413 acres next to the Livermore Site.
- LLNL, including the three sites, occupies a total area of 8,172 acres of which 323 acres are developed and 7,849 acres are undeveloped.
- Land use surrounding the Livermore Site and SNL-CA is predominantly agricultural, residential, and light industrial.
- Land use surrounding the LLNL Site 300 is predominantly agricultural, primarily for grazing cattle and sheep; however, the City of Tracy has plans for its development within approximately 1 to 1½ miles of Site 300's eastern boundary in its 1993 Urban Management Plan.

Infrastructure

- San Francisco's Hetch Hetchy water system provides an average of 0.717 million gallons of water per day.
- The city of Livermore's wastewater treatment system receives an average of 0.4 million gallons of sewage per day.
- The Pacific Gas and Electric Company and the Western Area Power Administration supply power; the current site load is 61 megawatts. The Pacific Gas and Electric Company also supplies natural gas.
- Transportation in the region consists of local access roads (such as South Vasco and Greenville Roads) and interstates (such as Interstates 580, 5, and 680). The Southern Pacific Railroad and the Western Pacific Railroad are the primary providers of rail service to the LLNL region.

Cultural Resources

- Native American occupation of the LLNL region began around 10,000 years ago, although no sites have been identified on the Livermore Site.
- LLNL Site 300 contains a variety of recorded archaeological properties, many of which have not been evaluated for the National Register of Historic Places. No traditional cultural properties or architectural resources have been recorded.

4.4.7 LOS ALAMOS NATIONAL LABORATORY—LOS ALAMOS, NEW MEXICO

Los Alamos National Laboratory (LANL) occupies 43 square miles (27,520 acres) in north central New Mexico and is approximately 25 miles north of Santa Fe on Pajarito Plateau, a series of mesas separated by deep canyons. Since its inception in 1943, LANL's primary mission has been nuclear weapons research and development and related projects. LANL is shown in Figure 4.4–7.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 159,152 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 7.90 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 1.40 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- The area encompassed by, and the counties surrounding, LANL are classified by EPA as attainment areas for all six of the National Ambient Air Quality Standards criteria air pollutants.
- Major sources of criteria air pollutants are steam plants and power plants, operations associated with beryllium, an asphalt plant, burning of wastes at the area TA-16 burnground, experimental detonation of conventional explosives, and the lead-pouring facility.

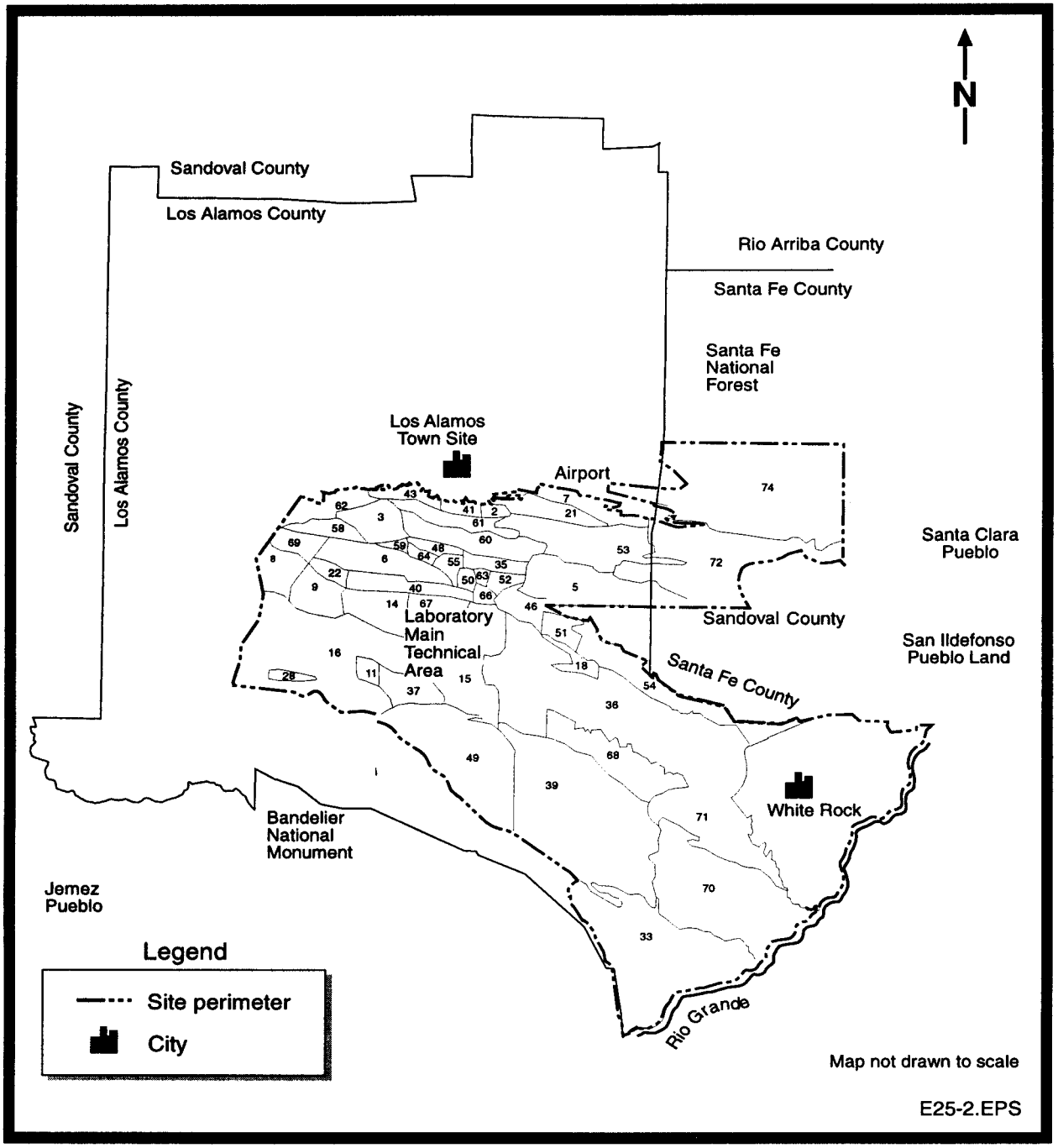

Figure 4.4–7. Los Alamos National Laboratory

- Prevailing winds at Albuquerque Airport for the 5-year period 1988-1992 were from the north approximately 10% of the time, with the highest annual occurrence of windspeed of 5 to 7 mph 38% of the time. The average annual temperature is 48°F, ranging from an average summertime daily maximum of 68°F to an average minimum in January of 29°F.

Water Resources

- Major surface water features include the Rio Grande (adjacent to the southeastern boundary of the site), 14 onsite intermittent tributaries, Rio de los Frijoles (parallels the southwestern boundary of the site), and the Los Alamos and Guaje Reservoirs.
- The East Fork of the Jemez River (located 5 miles west of LANL in a different drainage basin) is a federally designated Wild and Scenic River.
- Treated wastewater is discharged to onsite canyons. This water infiltrates into the ground and rarely reaches offsite areas.
- Surface water sampling in 1991 showed that 18 parameters exceeded their comparison criteria.
- Groundwater wells in the main aquifer supply water.
- Groundwater occurs within shallow alluvium, perched water, and in the main aquifer. The main aquifer is the only aquifer capable of supporting a municipal water supply and is hydrologically disconnected from the alluvial and perched waters. No aquifers are considered sole source aquifers.
- Groundwater monitoring in 1991 showed 13 parameters above comparison criteria.
- The technical areas located within the canyons would be within the 500-year floodplain of tributaries to the Rio Grande.

Geology and Soils

- The site is on the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep east-to-west oriented canyons cut by intermittent streams. Mesa tops range in elevation from about 7,800 to 6,200 feet.
- Major rock units include, from oldest to youngest, the Tesuque Formation sediments, the Chino Mesa Formation basalts, the Puye Formation conglomerates, the Tschicoma Formation volcanics, and the Bandelier Tuff (from a major volcanic eruption in the Jemez Mountains).
- Alluvium derived from erosion of the surrounding rocks fills many of the canyons, with thicknesses ranging from 3 to 100 feet.
- Soil types vary in texture from clay and clay loam to gravel. Rock is exposed on greater than 50% of the site area.

- Geologic concerns include potential downslope movements in association with regional seismic activity. The potential for subsidence is minimal, as is the potential for renewed volcanic activity.
- The strongest earthquake in the last 100 years within a 50-mile radius was estimated to have a magnitude of 5.5 to 6 on the Richter Scale. Studies have determined the presence of three active faults in the area.

Ecological Resources

- Major vegetative communities include juniper-grassland, piñon pine-juniper, ponderosa pine, mixed conifer, spruce-fir, and subalpine grassland. Old-growth forest may be present. LANL has minimized the clearing of vegetation, and canyons are relatively undisturbed. Specialized habitats include steep-walled cliffs and associated rockpiles and narrow mesas separated by deep canyons.
- Wetlands are restricted to several canyons and are primarily temporary or seasonal. Riparian habitat is receiving legal protection in some areas of the region.
- The bald eagle (Federal threatened, State endangered) and peregrine falcon (Federal and State endangered), one candidate species, one Federal notice of review species (State listed), and one State endangered species are found on LANL. Seventeen Federal- or State-listed species potentially are found nearby.

Socioeconomic Conditions

- The ROI for LANL comprises Los Alamos, Santa Fe, and Rio Arriba Counties. Ninety-four percent of the site's employees reside in these counties.
- Total site employment in 1994 was 6,199. Total ROI employment by place of work in 1994 was 83,496.
- The ROI unemployment rate in 1991 was 7.3%.
- The ROI per capita income in 1990 was $16,559.
- The total population in the ROI in 1990 was 151,408. Population demographics: Native Americans—5.4%; urban—64.2%.
- Housing: owner-occupied—71.1%; renter-occupied—28.9%.
- Sensitive populations: children (under 15 years old)—23.1%; women of child-bearing age (ages 15 to 44)—23.4%; adults over 65—9.9%.

Environmental Justice

- Minorities—Figure C.4-13a.

- Below poverty level—Figure C.4-30.
- Presence of Federally recognized Native American Tribes: Cochiti, Jemez, Nambe, Pojoaque, Santa Clara, San Ildefonso, San Juan, Picuris and Tesuque Pueblos.
  Tribal lands—Figure C.4-13b.

Land Use

- The site occupies approximately 43 square miles (27,520 acres), of which 11,333 acres are developed and 16,187 are undeveloped; of the land that is undeveloped, nearly all is available for future site development.
- LANL was designated a National Environmental Research Park in 1976.
- Land use surrounding the site is predominantly undeveloped with large tracts held by the Bureau of Land Management and the National Park Service.

Infrastructure

- Three DOE-operated well fields and surface water from the Jemez Mountains provide an average of 4.1 million gallons of water per day.
- An onsite wastewater treatment plant and collection system receives sewage.
- A Los Alamos County/DOE power pool and a 20-megawatt onsite gas fired generation plant supply power. In 1993, site usage was 68 megawatts.
- Transportation in the region consists of local access roads (such as U.S. Route 502) and other major roads (such as U.S. Routes 84 and 285 and Interstates 25 and 40). No major railroads provide rail service to the LANL region.

Cultural Resources

- Native American occupation of the LANL area began about 12,000 years ago.
- Over 975 prehistoric sites and 50 historic resources have been recorded. Approximately 75% of LANL has been inventoried for cultural resources.
- About 95% of the prehistoric and historic sites are considered eligible or potentially eligible for inclusion in the National Register of Historic Places.

4.4.8 NEVADA TEST SITE—LAS VEGAS, NEVADA

The Nevada Test Site (NTS) occupies 1,350 square miles (864,000 acres) of desert valley and Great Basin mountain terrain in southern Nevada, 65 miles northwest of Las Vegas. The NTS has been the primary location for testing the Nation's nuclear explosive devices since 1951. NTS is shown in Figure 4.4–8.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 14,266 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.012 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.0290 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Nye and Lincoln Counties are classified by EPA as attainment areas for all six National Ambient Air Quality Standards criteria air pollutants. Clark County is designated as a nonattainment area for the criteria air pollutants carbon monoxide and particulate matter of less than 10 micrometers in diameter (PM_{10}).

- Sources of radiological air emissions on the site are post-test drilling, mining, and sampling operations for underground nuclear tests and, possibly, evaporation of containment pond water. Other air pollutant emissions are from construction activities, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, fuels storage facilities, and asbestos removal activities.
- Prevailing winds at the McCarren International Airport in 1992 were from the southwest with a 12% occurrence. The highest annual occurrence of windspeed was between 4.6 and 11.5 mph, with an occurrence of 34%. Data from NTS towers indicate that prevailing winds are from the southwest during the summer and from the north to northwest during the winter. Temperatures range from an average daily minimum of 28°F in January to an average daily maximum of 96°F in July.

Water Resources

- The only permanent onsite water bodies are ponds associated with wastewater disposal and springs. No continuously flowing streams occur on the site.

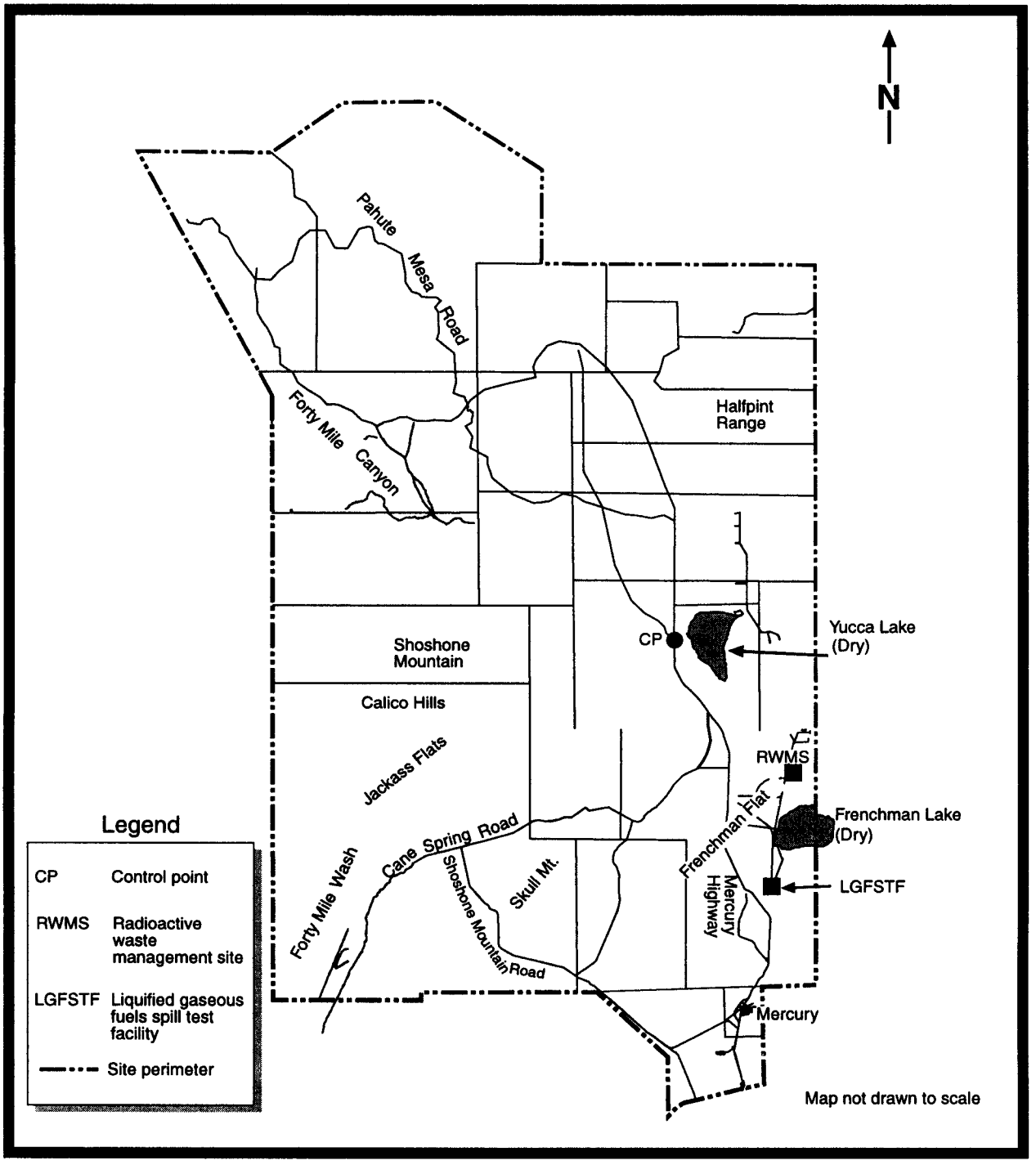

Figure 4.4–8. Nevada Test Site

- No federally designated Wild and Scenic Rivers exist on the site.
- During extreme precipitation, flash flooding may occur.
- Groundwater wells supply water.
- Onsite evaporation ponds receive waste discharge.
- Surface water sampling in 1991 showed nine parameters above comparison criteria.
- Major groundwater units include the lower carbonate aquifer, volcanic aquifer, and the valley fill aquifer. No aquifers are considered sole source aquifers.
- Groundwater monitoring in 1991 indicated that eight contaminant comparison criteria were exceeded at onsite wells.
- The site is not located within any floodplain as there are no continuously flowing surface water streams occurring on the site.

Geology and Soils

- The site is located in the Basin and Range physiographic province, with mountain ranges running from north to south separated by broad, flat-floored, and gently sloped valleys and elevations ranging from 3,000 to 6,900 feet.
- Major rock units include, from oldest to youngest, the Paleozoic carbonates and clastics, Tertiary tuffs and lavas, and Tertiary and Quaternary alluvium.
- Faults in the ROI include the Cane Springs and Yucca Faults.
- Severe earthquakes on faults in southern California (for example, the San Andreas Fault) should not result in damaging ground motion at the site. The Yucca Fault is the only capable fault on the NTS.
- Lava flows and associated cinder cones are within 30 miles of the site. The probability that a volcanic eruption would occur in the ROI in the near future is low.
- The potential for subsidence is low for a large portion of the site.

Ecological Resources

- Desert shrubs typical of the Mojave or Great Basin Deserts or transition desert between these two areas cover most of NTS. Shrubs and small trees are the dominant vegetation and vary, depending on elevation. Dominant associations include creosote bush, hopsage/desert thorn, sagebrush, and pinon pine and juniper with sagebrush. Crater environments and volcanic highlands are unique habitats.
- Springs and ponds have associated riparian areas, but no officially designated wetlands.
- The Federal and State endangered American peregrine falcon and Federal threatened and State protected desert tortoise are found on NTS. Nineteen candidate species are found on NTS (seven are State protected, one is State critically endangered, and one is protected as a game species); most

nonrodent species of mammals at NTS are on Nevada's protected species list. Twenty-one species of plants at NTS are State-listed. No plant species are federally endangered. Federal endangered aquatic species are located nearby at Ash Meadows (including the Devil's Hole pupfish, Warm Springs pupfish, Pahrump killifish, Ash Meadows speckled dace, and Ash Meadows Amargosa pupfish).

Socioeconomic Conditions

- The ROI for NTS comprises Nye and Clark Counties. One hundred percent of the site's employees reside in these counties.
- Total site employment in 1994 was 7,086. Total ROI employment in 1990 was 454,030.
- The ROI unemployment rate in 1991 was 5.4%.
- The ROI per capita income for 1991 was $18,543.
- The total population in the ROI in 1994 was 759,240. Population demographics: Native Americans—0.9%; urban—96%.
- Housing: owner-occupied—52.3%; renter-occupied—47.7%.
- Sensitive populations: children (under 15 years old)—21%; women of child-bearing age (ages 15 to 44)—23.2%; adults over 65—10.5%.

Environmental Justice

- Minorities—Figure C.4-14.
- Below poverty level—Figure C.4-31.
- Presence of Federally recognized Native American Tribes: Although none is located in the ROI, several have expressed an interest in DOE's waste management strategy. Interested tribal organizations include the Benton Paiute Reservation, Timbasha Shoshone Reservation, Bishop Paiute Reservation, Big Pine Point Shoshone Reservation, Fort Independence Reservation, Lone Pine Paiute Reservation, Yomba Reservation, Duckwater Reservation, Pahrump Paiute Tribe, Las Vegas Paiute Indian Colony, Chemehucvi Reservation, Colorado River Reservation, Paiute Indian Tribe of Utah, and Kaibab Paiute Reservation.

Land Use

- The site occupies approximately 1,350 square miles (864,000 acres) of desert valley and Great Basin mountain terrain, of which 25% is currently unused or provides buffer zones. Facility expansion is possible within all of the area in use.
- Land surrounding the site is predominantly federally owned.

Infrastructure

- Fourteen wells throughout the site supply an average of 1.36 million gallons of water per day.
- Onsite sewage treatment plants and septic tanks receive an average of 0.140 million gallons of sewage per day.
- The Nevada Power Company supplies power; the current site load is 30 megawatts.
- Transportation in the region consists of local access roads (such as Lathrop Wells Road, Jackass Flats Road, and Mercury Highway) and major routes (such as U.S. 95, U.S. 93, and Interstate 15). The Union Pacific Railroad is the primary provider of rail service to the NTS region.

Cultural Resources

- Human habitation of the NTS area dates from as early as 12,000 years ago. European contact began approximately 145 years ago.
- Numerous archaeological sites have been identified within the NTS facility. A long-range study will result in an 11% archaeological sample of NTS.

4.4.9 Oak Ridge Reservation—Oak Ridge, Tennessee

The Oak Ridge Reservation (ORR) occupies 35,000 acres in the valley and ridge province of eastern Tennessee. The ORR property was primarily used for agriculture before it was acquired by the Federal Government in 1942 for the wartime Manhattan Project. The ORR contains three major facilities: Oak Ridge National Laboratory (ORNL), the Y-12 Plant, and the K-25 Site. Also located on the ORR Site is the Oak Ridge Institute of Science and Education (ORISE), with an area of 340 acres. ORR is shown in Figure 4.4–9.

ORNL's mission is to conduct applied research and development in support of DOE programs in fusion, fission, conservation, and other energy technologies. The Y-12 Plant was established to separate uranium isotopes, and for many years served as a fabrication facility for nuclear weapons. The current Y-12 Plant mission is to perform defense-related assignments such as dismantling nuclear weapon components, providing special production support to various DOE programs, and serving as the nation's storehouse for special nuclear materials. The K-25 Site originally enriched uranium but was shut down permanently in 1987. Today, the K-25 Site's focus has shifted to supporting investigations related to waste management and environmental restoration issues and houses the Centers for Environmental Restoration and for Waste Management. The K-25 Site's evolving mission will include applied technology, data systems research and

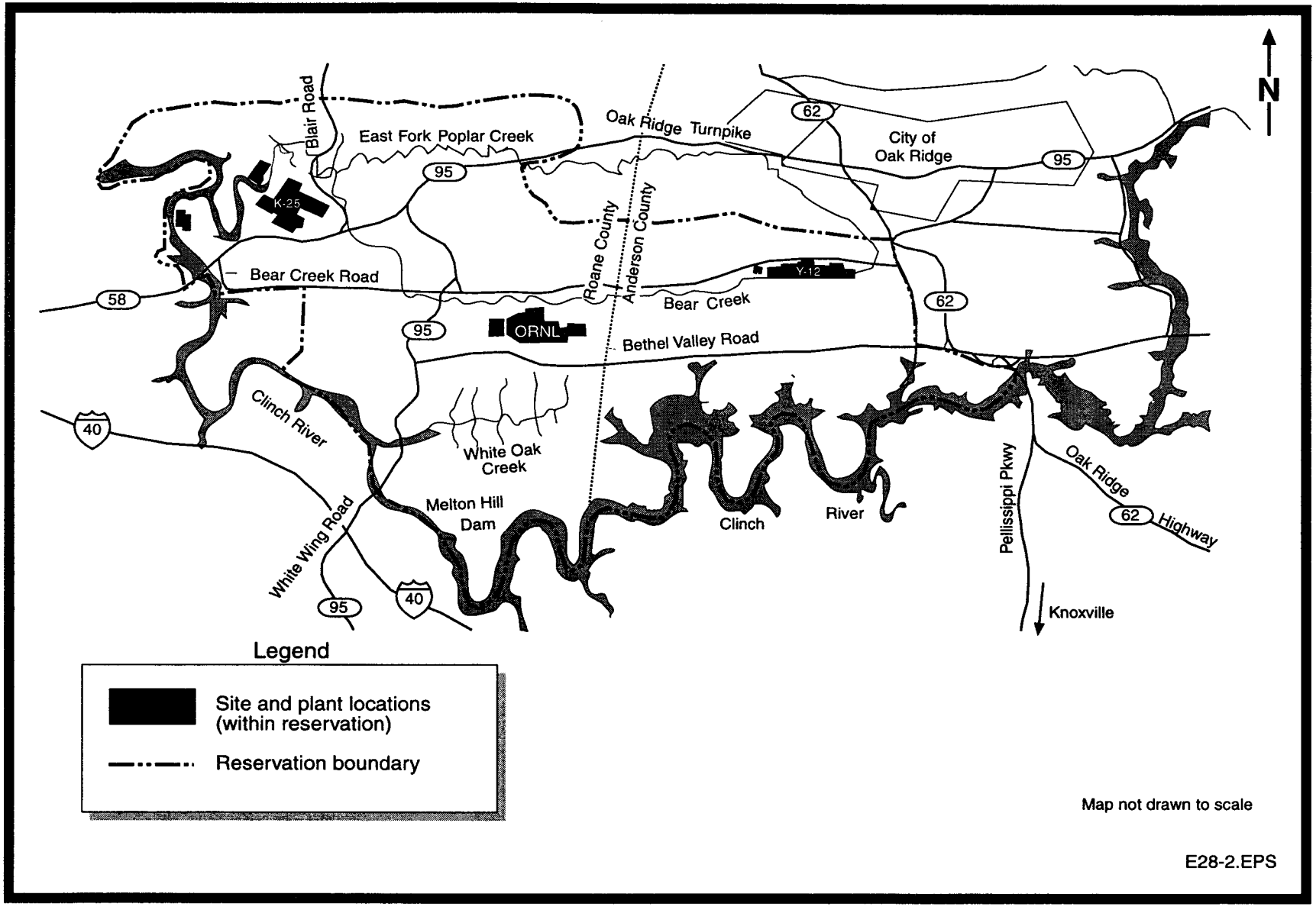

Figure 4.4–9. Oak Ridge Reservation

development, and engineering. ORISE works with DOE and others to provide capabilities in science and engineering education, particularly medical sciences, and environmental and energy systems.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 881,652 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 1.40 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 43 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- The Eastern Tennessee-Southwestern Virginia Interstate Air Quality Control Region is classified by EPA as an attainment area with respect to all six National Ambient Air Quality Standards criteria air pollutants.
- Major sources of criteria pollutant emissions from the site are steam plant emissions. The primary source of radionuclide emissions is the Toxic Substances Control Act Incinerator.
- Prevailing winds at ORR in 1992 were generally up-valley from the southwest and west-southwest or down-valley from the northeast and east-northeast; the highest occurrence of windspeed was between 1 and 4 mph with an annual occurrence of 58%. The average annual temperature is 57.3°F, ranging from an average daily minimum of 36.3°F in January to an average daily maximum of 87.2°F in July.

Water Resources

- Major surface water features include the Clinch River and its onsite tributaries—Bear Creek, East Fork Poplar Creek, White Oak Creek, Melton Branch, Poplar Creek, and Mitchell Branch.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- The Clinch River supplies water.
- Onsite streams and the Clinch River receive treated wastewater.
- Surface water sampling in 1992 showed concentrations of 26 parameters that exceeded comparison criteria.
- The major groundwater unit is the Knox Aquifer, composed of the Knox Group and the Maynardville Limestone. No aquifers are considered sole source aquifers.

- Groundwater monitoring for radioactive and nonradioactive parameters in 1992 indicated that 17 contaminants exceeded comparison criteria.
- Most of the ORR site is outside the 500-year floodplain of Clinch River except for areas adjacent to the confluences of White Oak Creek and Raccoon Creek with Clinch River.

Geology and Soils

- The topography consists of alternating valleys and ridges that strike northeast to southwest.
- Major rock units include, from oldest to youngest, the Rome Formation (sandstones and shales), the Conasauga Group (limestones and shales), the Knox Group (cherty limestones and dolomites), and the Chickamauga Group (limestones with interbedded shales).
- Unconsolidated residual material is 16 to 98 feet thick.
- The formation of karst solution pits and sinkholes has occurred in the carbonate bedrock. Changes to local groundwater levels or to surface water drainage patterns could create localized subsidence.
- The typical residual soil in the area is a reddish-brown clay. Alluvium also occurs in floodplains along streambeds. Valley soils are a mixture of clays, silts, and weathered shale fragments.
- The structure of the Valley and Ridge province is characterized by major subparallel thrust faults. None of these faults is considered capable.
- Seismic activity in the southern Appalachian Mountains that has affected the site area has been recorded 45 times since 1800. The probability of future seismic damage is moderate.

Ecological Resources

- Natural plant communities or pine plantations cover most of ORR. Vegetation consists of pine and pine-hardwood; hemlock, white pine and hardwood; cedar, cedar pine, and cedar-hardwood; bottomland hardwood; upland hardwood; northern hardwood; and nonforest. Upland hardwoods dominate. Upland hardwood, cedar barrens, and old fields are ecologically significant resources. Unique habitats include river bluffs and slopes and spring-fed limestone quarries.
- Approximately 20% of ORR consists of wetlands; half are bottomland forested and half are pothole wetlands.
- The Federal threatened and State endangered bald eagle has been located on ORR. Eight candidate species (two are State endangered, three are State threatened, and two are State in need of management), two State endangered species, and four State threatened species are found on ORR. Federal- and State-listed species are also present near ORR.

Socioeconomic Conditions

- The ROI for ORR comprises Anderson, Knox, Loudon, and Roane Counties. Ninety percent of the site's employees reside in these counties.
- Total site employment in 1990 was 21,544. Total ROI employment by place of work in 1990 was 287,974.
- The ROI unemployment rate in 1991 was 5.9%.
- The ROI per capita income in 1990 was $16,821.
- The total population in the ROI in 1990 was 482,481. Population demographics: Native Americans—0.25%; urban—67.9%.
- Housing: owner-occupied—68.3%; renter-occupied—31.7%.
- Sensitive populations: children (under 15 years old)—18.9%; women of child-bearing age (ages 15 to 44)—24.2%; adults over 65—13.3%.

Environmental Justice

- Minorities—Figure C.4–15.
- Below poverty level—Figure C.4–32.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site occupies approximately 35,000 acres of which 11,500 acres are developed and 23,500 acres are undeveloped; of the land that is undeveloped, approximately 5,629 acres are available for future site development.
- With the exception of the city of Oak Ridge to the north, land surrounding the site is predominantly rural, consisting of undeveloped forest land, agriculture, and low-density residential.

Infrastructure

- The Clinch River provides an average of 18.3 million gallons of water per day.
- The ORR wastewater facility serving K-25 and ORNL receives an average of 0.64 million gallons of sewage per day. Wastewater from the Y-12 facility is processed by the city of Oak Ridge.
- The Tennessee Valley Authority (TVA) supplies power; the current site load is 116 megawatts. Coal and natural gas are also used.
- Transportation in the region consists of local access roads (such as State Routes 1700 and 62) and major roads (such as Interstates 75, 40, and 81). The Southern Railway and the L&N Railway are the

primary providers of rail service to the ORR region, which includes a L&N rail line that runs adjacent to the site boundary.

Cultural Resources

- Native American occupation of the Oak Ridge area began about 12,000 years ago. European settlement began during the 18th century.
- More than 65 prehistoric sites and more than 240 historic resources (remains and standing structures) have been recorded at ORR. About 90% of the site has received at least reconnaissance-level studies; less than 5% has been intensely surveyed.
- About 10 prehistoric sites and 20 historic sites are potentially eligible for the National Register of Historic Places. The ORR Graphite Reactor has been designated as a National Historic Landmark.

4.4.10 PADUCAH GASEOUS DIFFUSION PLANT—PADUCAH, KENTUCKY

Paducah Gaseous Diffusion Plant (PGDP) occupies 3,425 acres in western Kentucky 10 miles west of Paducah, and employs 1,868 people. Paducah has been an active uranium enrichment facility since 1952. Enriched uranium is produced for the commercial sector as fuel for nuclear power reactors in the United States and overseas. Paducah is shown in Figure 4.4–10.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 500,502 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0045 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.017 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- McCracken County is currently classified by EPA as a marginal nonattainment area for ozone. The area is in attainment for the other five criteria pollutants.

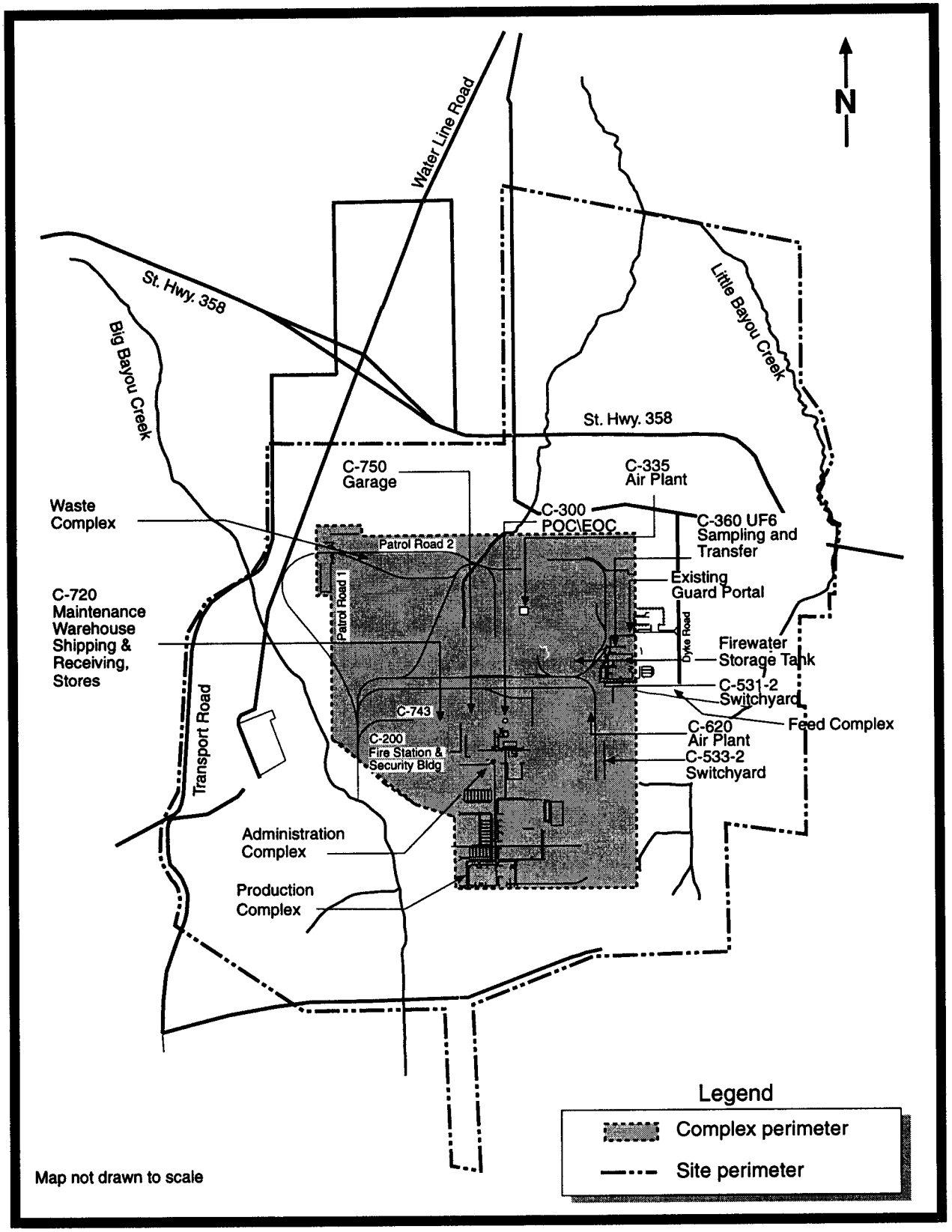

Figure 4.4–10. Paducah Gaseous Diffusion Plant

- The major sources of criteria air pollutant emissions are coal-, oil-, and gas-fired boilers. Sources of radionuclide emissions in 1992 were the cascade purge vent/stack at the C-310 purge and product building, decontamination activities at the C-400 cleaning building, and emissions from laboratory hoods in the C-710 building. Two vapor degreasers in the C-400 cleaning building are also sources of toxic air emissions.
- Prevailing winds at the Paducah Airport in 1992 were from the south 16% of the time on a yearly basis. The highest occurrence of windspeed was between 8 to 11 mph with an annual occurrence of 31%. January is the coldest month, with a daily average temperature of 35°F, while July is the warmest month with an average temperature of 79°F.

Water Resources

- Major surface water features include the Ohio River (less than 2 miles from Paducah), Metropolis Lake (1.5 miles northeast), and two small tributaries of the Ohio River (Big Bayou Creek and Little Bayou Creek) that provide surface drainage to the site.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- The site would not be affected by the probable 500-year maximum flood.
- The Ohio River supplies water to Paducah.
- Onsite streams and the Ohio River receive treated wastewater.
- Results from surface water monitoring in 1992 indicated concentrations elevated above comparison criteria for two contaminants.
- Major groundwater units include, from bottom to top, the McNairy Flow System (interbedded sand, silt, and clay), the terrace gravels, the Regional Gravel Aquifer (the primary aquifer in the area, composed of sand and gravel units), and the Upper Continental Recharge System (clayey silt with interbedded sand and gravel). No aquifers are considered sole source aquifers.
- Groundwater monitoring for radioactive and nonradioactive parameters in 1992 showed the presence of 15 contaminants exceeding comparison criteria. Two major plumes of groundwater contamination extend into offsite areas.
- The site is outside the 500-year floodplain of the Ohio River.

Geology and Soils

- The topography slopes slightly from more than 450 feet in the southern part of the site to 300 feet near the Ohio River.
- Surface sediments consist of valley fill deposits, which underlie most of the site, extending northward to the Ohio River.

- Major rock units include, from oldest to youngest, basement rocks; Tuscaloosa Formation basal gravels; the McNairy Formation consisting of interbedded sand, silt, and clay; the Porters Creek Clay; continental deposits of gravel and clay-sand units; and a 10-to-30-foot layer of loess (wind-blown sediment).
- Soils beneath the site are nearly level, somewhat poorly-drained, medium-textured soils that occur on uplands.
- Geologic hazards include potential for earthquakes. The site is near two active seismic zones: the New Madrid Fault Zone and the Wabash Valley Fault Zone. The potential for damage from volcanic activity is small.

Ecological Resources

- Nonforested areas consisting of mowed grass and developed areas cover most of Paducah; forested areas are small and dominated by mature hardwood upland and riparian forests.
- Onsite wetlands consist of forested wetlands (mature riparian hardwood forest). A wetland in the West Kentucky Wildlife Management area (the buffer area surrounding the production facilities) has been designated an area of ecological concern.
- Federally listed endangered and State-listed endangered species that have been identified or could be identified in the vicinity of Paducah include the interior least tern and four species of pearly mussel. The Indiana bat, a Federally and State-listed endangered species, also has been identified or could be identified in the vicinity of Paducah. An additional species of pearly mussel is Federally listed as endangered only. The bald eagle (Federally threatened, State endangered), evening bat (Federal threatened, State species of special concern), eight candidate species (one is a State-endangered fish, one is a State-threatened reptile, and one is a State species of special concern), one State-endangered bird species, two State-threatened plant species, and seven State species of special concern are found or could be found near Paducah. No Federally listed plant species potentially occur in the vicinity of Paducah.

Socioeconomic Conditions

- The ROI for Paducah comprises McCracken, Ballard, Carlisle, Graves, and Marshall Counties in Kentucky, and Massac County in Illinois. Ninety-three percent of the site's employees reside in these counties.
- Total site employment in 1990 was 1,740. Total ROI employment by place of work in 1990 was 79,756.

- The ROI unemployment rate in 1991 was 9.7%.
- The ROI per capita income in 1990 was $15,536.
- The total population in the ROI in 1990 was 151,526. Population demographics: Native Americans—0.2%; urban—44.1%.
- Housing: owner-occupied—55.6%; renter-occupied—44.4%.
- Sensitive populations: children (under 15 years old)—20.2%; women of child-bearing age (ages 15 to 44)—17.6%; adults over 65—16.8%.

Environmental Justice

- Minorities—Figure C.4-16.
- Below poverty level—Figure C.4-33.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site occupies approximately 3,425 acres, of which 750 acres are developed and 2,675 acres are undeveloped.
- Land use surrounding the site is predominantly undeveloped natural areas.

Infrastructure

- The Ohio River supplies an average of 15 million gallons of water per day; the water is treated onsite by chemical and physical processes.
- An onsite treatment plant receives an average of 0.2 to 0.4 million gallons of sewage per day. Treated sewage is discharged off site.
- Electric Energy Inc. supplies power; the current site load is 1,564 megawatts. The site also uses approximately 82 tons of coal per day.
- Transportation in the region consists of local access roads (such as State Routes 1154 and 358) and major roads (such as Interstate 24 and U.S. Highways 45, 60, and 63). The Burlington Northern Railroad, Paducah Railroad, Louisville Railroad, and the onsite U.S. Government Railroad are the primary providers of rail service to the Paducah region.

Cultural Resources

- The site has 3 recorded archaeological or historic sites, and others have been identified in areas near Paducah. This region has not been subject to any systematic cultural resources surveys.

4.4.11 PANTEX PLANT—AMARILLO, TEXAS

The Pantex Plant is approximately 17 miles northeast of downtown Amarillo, Texas, on the Llano Estacado (Staked Plains) and consists of 10,080 acres of DOE-owned land and 5,856 acres of land leased from Texas Tech University. The Pantex Plant was first used in 1942 by the Army Ordnance Corps for loading conventional ammunition shells and bombs. It was chosen in 1951 by the Atomic Energy Commission for expansion of its nuclear weapons assembly facilities. The mission of the Pantex Plant includes disassembly, assembly, quality evaluation, and maintenance of the Nation's nuclear weapons stockpile. The workforce at the Pantex Plant currently consists of 77 DOE employees and 2,930 prime contractor employees. The Pantex Plant is shown in Figure 4.4–11.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 265,185 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was less than 0.0001 mrem per year according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was negligible according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Potter and Armstrong Counties are classified by EPA as attainment areas for all six of the criteria air pollutants.
- The major source of emissions from the Pantex Plant is the boiler house for the steam plant. Sources of volatile organic compound emissions include building 16-4 (paint spray booth), building 12-19 (HE formulation), and building 11-36 (HE synthesis).
- Prevailing winds at the Amarillo International Airport in 1992 were from the south 13.5% of the time on a yearly basis; the highest occurrence of windspeed was between 12.5 to 18.4 miles per hour with an annual occurrence of 35%.

Water Resources

- No streams or rivers flow through or near the Pantex Plant; the only natural onsite surface water bodies are numerous ephemeral playa basins.
- No federally designated Wild and Scenic Rivers exist in the ROI.

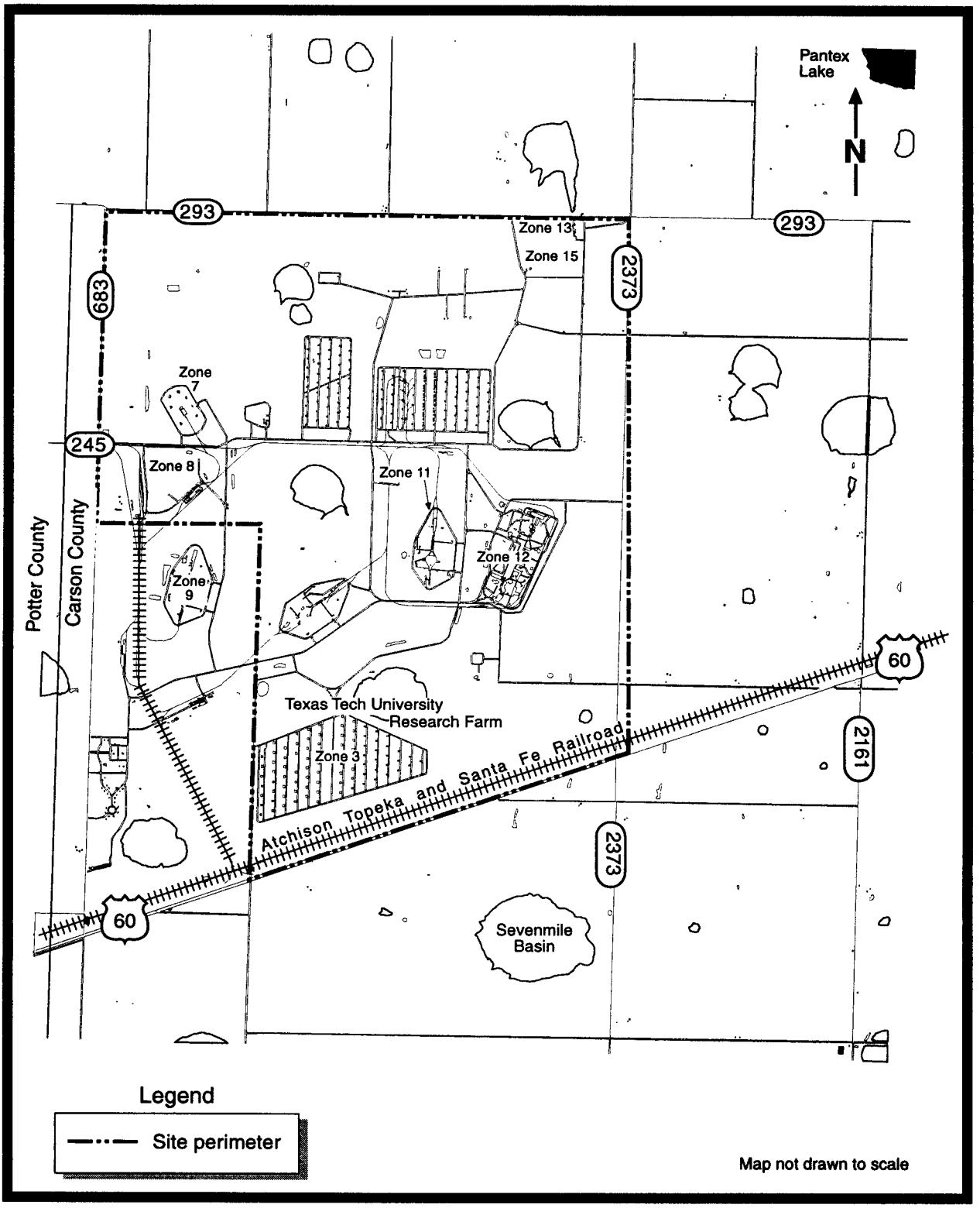

Figure 4.4–11. Pantex Plant

- Based on the results of a flood hazards analysis, the probability of flooding is low.
- Onsite playas receive treated wastewater.
- Onsite surface water sampling in 1992 showed concentrations of four parameters that exceeded comparison criteria. No offsite sampling was performed.
- Groundwater wells in the Ogallala Aquifer supply water.
- Major groundwater units include the Ogallala Aquifer, the primary source of water for the multi-billion-dollar agricultural industry in the Panhandle, and the underlying Dockum Group Aquifer. No aquifers are considered sole source aquifers.
- Groundwater monitoring in 1992 indicated that 10 parameters exceeded comparison criteria.
- The Pantex Plant is not located within a 500-year floodplain.

Geology and Soils

- The topography at the site is relatively flat and is characterized by rolling plains and numerous natural playa basins, or ephemeral lakes. Elevations range from approximately 3,500 to 3,600 feet above National Geodetic Vertical Datum.
- Major rock units include, from oldest to youngest, crystalline basement rocks, the Triassic Dockum Group (sedimentary rocks), the Ogallala Formation (sand, silt, clay, gravel, and some caliche), and the Blackwater Draw Formation (the surface deposit consisting of buried soils and silty clay and caliche).
- The primary soils at the site are deep clay loams and clays that occur on gentle slopes.
- No active surface faults occur in the ROI.
- Only 36 felt earthquakes have occurred in the Texas Panhandle between 1906 and 1986. Four earthquakes occurred near the site between 1982 and 1989. The potential for damage from earthquakes or volcanic activity is small.

Ecological Resources

- Very little relatively undisturbed habitat exists on the site. Vegetation consists of native and improved pasture, short-grass prairie, or planted vegetation.
- Wetlands are associated with five playas on the Pantex Plant; numerous smaller wetlands (10 acres or less) are on the western and southwestern parts of the site. The playas on the Pantex Plant constitute 376 acres.
- No critical habitat is known at the Pantex Plant. Federal and State endangered species found on or near the site include the American peregrine falcon, interior least tern, and whooping crane. The bald eagle

(Federal threatened and State endangered) is also found on or near the site. The Federal and State threatened Arctic peregrine falcon, the State-threatened white faced ibis and Texas horned lizard, and the State-endangered smooth green snake may also be found.

Socioeconomic Conditions

- The ROI for the Pantex Plant includes Carson, Potter, and Randall Counties. At least 96% of the site's employees reside in these counties.
- Total site employment in 1990 was 2,891. Total ROI employment by place of work in 1990 was 104,254.
- The ROI unemployment rate was 4.9% in 1991.
- The ROI per capita income in 1990 was $16,991.
- The total population in the ROI in 1990 was 194,123. Population demographics: Native Americans—0.7%; urban—87.2%.
- Housing: owner-occupied—64.7%; renter-occupied—35.3%.
- Sensitive populations: children (under 15 years old)— 24%; women of child-bearing age (ages 15 to 44)—23.2%; adults over 65—11.7%.

Environmental Justice

- Minorities—Figure C.4-17.
- Below poverty level—Figure C.4-34.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site consists of 10,080 acres of DOE-owned land and 5,856 acres of land leased from Texas Tech University for a total of 15,936 acres. Of the DOE-owned land, approximately 2,000 acres are developed and 8,080 acres are undeveloped; of the undeveloped land, approximately 7,713 acres are available for future site development.
- Land use surrounding the site is predominantly agricultural, involving both farming and ranching operations.

Infrastructure

- Five production wells in the Ogallala Aquifer provide an average of 0.5 million gallons of water per day.

- An onsite wastewater treatment plant and an open ditch that drains to an onsite playa receive an average of 0.275 million gallons of sewage per day.
- The Southwestern Public Service Company supplies power; the current site load is 12.6 megawatts.
- Transportation in the region consists of local access roads (such as State Routes 293, 245, and 683), and major roads (such as Interstates 40 and 27 and U.S. Highways 60 and 287). The Atchison, Topeka, and Santa Fe Railroads are the providers of rail service to the Pantex Plant region.

Cultural Resources

- The site has 42 prehistoric archaeological sites and 3 historic farmstead sites. The Texas State Historic Preservation Office has not evaluated whether the Pantex Plant may contain additional unrecorded archaeological sites.

4.4.12 PORTSMOUTH GASEOUS DIFFUSION PLANT—PORTSMOUTH, OHIO

The Portsmouth Gaseous Diffusion Plant (PORTS) is approximately 22 miles northeast of Portsmouth in Pike County, Ohio, occupying an area of 6.3 square miles (4,003 acres). Construction of the site began in late 1952 and ended in 1956, one year after the start of uranium enrichment processing at the site. Portsmouth was operated through November 1986 for DOE and its predecessor agencies by the Goodyear Atomic Corporation. Since then, Portsmouth has been managed by Martin Marietta Energy Systems, Inc. The mission of Portsmouth continues to be uranium enrichment. Portsmouth is shown in Figure 4.4–12.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 639,602 based on 1990 Census data (DOC, 1991, DOE 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.260 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 3.0 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Pike County is currently classified by EPA as an attainment area for all six National Ambient Air Quality Standards criteria air pollutants.

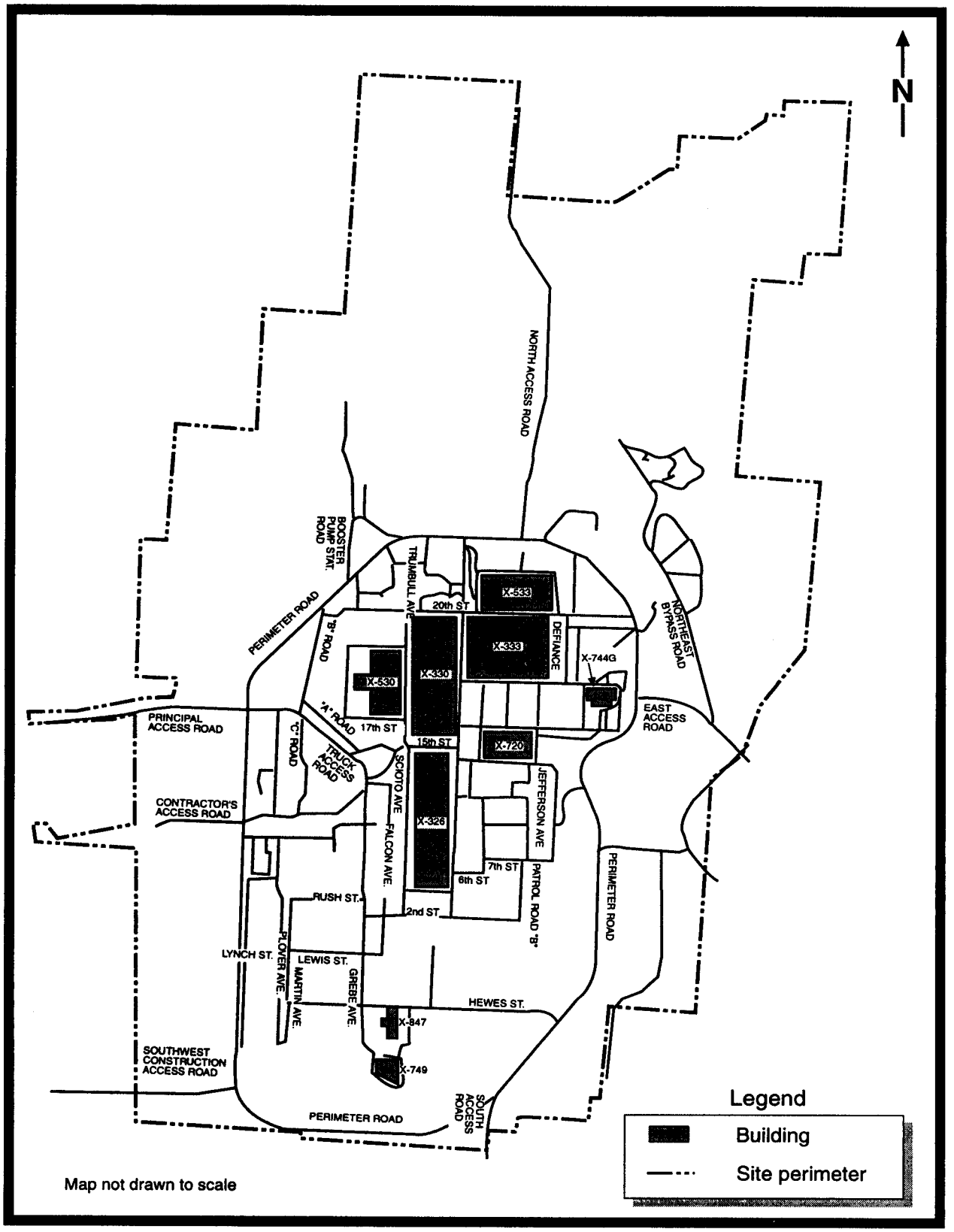

Figure 4.4–12. Portsmouth Gaseous Diffusion Plant

- The major sources of criteria pollutant emissions are three coal-fired boilers at the X-600 steam plant. Sources of radionuclide and fluoride emissions include purge cascade vents, cold recovery and wet evacuation vents, the X-345 high assay sampling area vent, the X-344 evacuation vent, and six seal exhaust vents.
- Prevailing winds at Portsmouth are from the south to southwest, with the south averaging the highest at just over 11%. Windspeeds average 5 mph, with winds up to 75 mph on record. The average annual temperature measured at Portsmouth during 1992 was 55°F, with seasonal average temperatures of 32°F or below in the winter, and 90°F or above in the summer.

Water Resources

- Major surface water features include the Scioto River and its onsite tributaries—Little Beaver Creek and Big Run Creek.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- An alluvial aquifer and the Scioto River supply water.
- Onsite streams and the Scioto River receive treated wastewater.
- Surface water sampling in 1992 showed four parameters above their comparison criteria.
- Major groundwater units include the Mississippian shale and sandstone bedrock aquifer and the unconsolidated sediment aquifer.
- Onsite groundwater monitoring in 1992 showed eight parameters above comparison criteria; no contaminants exceeded comparison criteria in measurements of offsite groundwater.
- The site is located outside a 500-year floodplain.

Geology and Soils

- The site is on gently rolling land about 130 feet above the Scioto River with an average elevation of 670 feet above National Geodetic Vertical Datum.
- The predominant landform in the area is a relatively level, filled valley of the preglacial Portsmouth River, which runs north to south.
- Major rock units include, from oldest to youngest, the Ohio Shale, the Bedford Shale, the Berea Sandstone, the Sunbury Shale, and the Cuyahoga Shale.
- The site is in an abandoned river valley filled with fluvial materials. These unconsolidated sediments are the Gallia Sand Member and the Minford Clay Member.
- The soils in the fenced area are mostly urban land and are covered by roads, parking lots, buildings, and railroads. Other soils are well-drained, upland soils.

- No significant geologic faults exist in the ROI.
- The potential for damage from volcanic activity is small.

Ecological Resources

- Vegetation consists of pastureland, old fields, oak-hickory, upland mixed hardwood, bottomland mixed hardwood, pine, second-growth hardwood, and scrub thicket. All forests and old fields are second growth.
- Wetlands at Portsmouth are minimal and total only one acre.
- The Federal and State endangered Indiana bat has been identified in the vicinity of Portsmouth. One candidate species (listed as State threatened), four State endangered species, five State threatened species, four State potentially threatened species, and seven State special interest species occur near Portsmouth. No threatened or endangered plants have been located on the site.

Socioeconomic Conditions

- The ROI for Portsmouth comprises Pike, Jackson, Ross, and Scioto Counties. Ninety-two percent of the site's employees reside in these counties.
- Total site employment in 1990 was 2,386. Total ROI employment by place of work in 1990 was 77,806.
- The ROI unemployment rate in 1991 was 9.3%.
- The ROI per capita income in 1990 was $19,918 (1990 dollars).
- The total population in the ROI in 1990 was 204,136. Population demographics: Native Americans—0.34%; urban—35.62%.
- Housing: owner-occupied—70%; renter-occupied—30%.
- Sensitive populations: children (under 15 years old)—21.9%; women of child-bearing age (ages 15 to 44)—21.3%; adults over 65—13.7%.

Environmental Justice

- Minorities—Figure C.4-18.
- Below poverty level—Figure C.4-35.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site occupies approximately 6.3 square miles (4,003 acres), of which 800 acres are developed and 3,203 acres are undeveloped; of the land that is undeveloped, nearly all is available for future site development.
- Land use surrounding the site is predominantly rural.

Infrastructure

- An onsite facility and 31 offsite supply wells provide an average of 14 million gallons of water per day.
- An onsite facility receives an average of 0.35 million gallons of sewage per day.
- The Ohio Valley Electric Corporation supplies power via an electrical and coal-fired system; the current site load is 1,537 megawatts of electricity and 4,500 tons of coal per month.
- Transportation in the region consists of local access roads (such as Piketon Hill Road and State Route 32) and major roads (such as Interstate 70 and U.S. Highways 23, 52, and 50). The Chesapeake and Ohio Railroad and Norfolk and Western Railroad are the primary providers of rail service to the Portsmouth region.

Cultural Resources

- The site has no recorded archaeological sites, standing structures, or traditional cultural properties, except for two cemeteries in the northeast corner of Portsmouth. This property has not been subject to a comprehensive cultural resources survey.

4.4.13 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE—GOLDEN, COLORADO

The Rocky Flats Environmental Technology Site (RFETS) occupies 6,500 acres approximately 16 miles northwest of Denver, in Jefferson County, Colorado, and employs 7,365 employees. From 1952 to 1992, the primary mission of RFETS was producing nuclear weapons components. The mission has now changed to special nuclear material stabilization and storage, as well as decontamination and decommissioning and cleanup. RFETS is shown in Figure 4.4-13.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 2,171,877 based on 1990 Census data (DOC, 1991, 1992b,c).

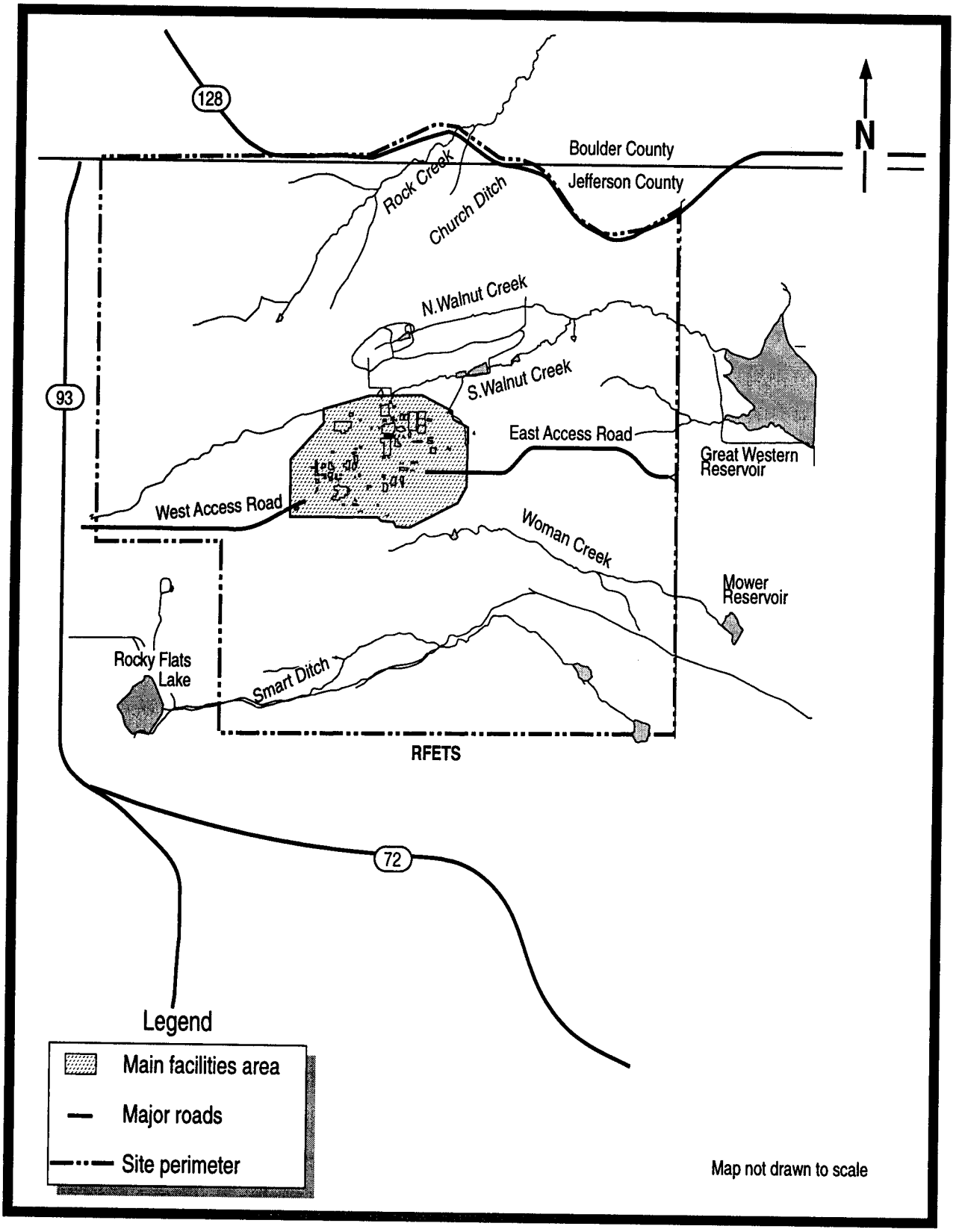

Figure 4.4–13. Rocky Flats Environmental Technology Site

- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0002 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.140 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Jefferson County is classified by EPA as a Federal nonattainment area for carbon monoxide, ozone, and particulate matter less than 10 micrometers in diameter (PM_{10}). The area is in attainment for the other three criteria air pollutants.
- The major sources of air pollution at the site are the emergency diesel generators and the natural-gas-powered boilers that produce steam for the site.
- Winds from the south were the most prevalent at Stapleton Airport in 1992 (14% of the time), and the most frequent windspeed was from 5 to 7 mph (45% annually). Mean windspeeds measured at RFETS in 1990 were 9.0 mph; highest was 88.6 mph. Mean temperature at RFETS in 1992 was 49.2°F, with temperatures ranging from a maximum monthly average in July of 77°F and a minimum monthly average in December of 17°F.

Water Resources

- Major surface water features include North Walnut Creek, South Walnut Creek, and Woman Creek, which are ephemeral streams draining the main site facilities in a west-to-east pattern.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- The Denver Water Board, via the Ralston Reservoir and the South Boulder Diversion Canal, supplies water for the site.
- Walnut Creek receives treated wastewaters.
- No contaminants in the surface water exceeded comparison criteria in 1992.
- Major groundwater units include, from deep to shallow, the Laramie-Fox Aquifer, a shale aquitard (upper unit of the Laramie Formation), the Arapahoe Formation Aquifer, and the surficial Rocky Flats Alluvium. No aquifers beneath the site are sole source aquifers.
- In 1992, 12 contaminants in the groundwater exceeded comparison criteria.
- Existing facilities at RFETS lie outside the 500-year floodplain.

Geology and Soils

- The site lies on the eastern edge of the Rocky Flats Plateau, which flanks the eastern edge of the Front Range of the Rocky Mountains. Elevation is approximately 6,000 feet.
- Major underlying rock units include the Pierre Shale and Fox Hills Sandstone. RFETS is situated on the Rocky Flats Alluvium, which varies in thickness up to 100 feet and provides a gravelly cover over bedrock.
- The surface soils at the site consist of clay, cobbly clay, and sandy loams. The soils are moderately deep, well drained, and have moderate to low permeability.
- The Golden Fault is west of the site.
- Geologic hazards include little or no risk from subsidence, landslides, or earthquakes.

Ecological Resources

- The Rocky Flats Buffer Zone is mostly virgin grassland with relict tallgrass species on the western side. The site is in the transitional area, or ecotone, between the Rocky Mountains and the High Plains. The vegetation and animal populations have high biodiversity.
- Jurisdictional wetlands were designated and mapped by the U.S. Army Corps of Engineers in 1995. Some 1,100 wetlands comprising about 195 acres were mapped. Other small wetlands exist at the site.
- The federally listed threatened bald eagle and endangered American peregrine falcon (both State-endangered) have been reported at the site. Nine federal C2 (potentially listable) species occur. A threatened plant, *Spiranthes diluvalis* (Ute ladies' tresses), has been searched for, but not found, for three growing seasons. Extensive observations have been made of the Preble's meadow jumping mouse, a species the U.S. Fish and Wildlife Service was petitioned to list in 1994. Potential habitats for other species of concern exist at the site. Consultation on water depletions of the South Platte River by site operations is in progress.

Socioeconomic Conditions

- The ROI for RFETS comprises Jefferson, Adams, Arapahoe, Boulder, and Denver Counties. These counties are the residence of 92.5% of the site's employees.
- Total site employment in 1991 was 7,365. Total ROI employment by place of work in 1991 was 1,198,525.
- The ROI unemployment rate in 1991 was 4.5%.
- The ROI per capita income in 1990 was $20,961.
- The total population in the ROI in 1991 was 1,790,600. Population demographics: Native Americans—0.8%; urban—95%.

- Housing: owner-occupied—60.8%; renter-occupied—39.2%.
- Sensitive populations: children (under 15 years old)—21.7%; women of child-bearing age (ages 15 to 44)—25.4%; adults over 65—9.3%.

Environmental Justice

- Minorities—Figure C.4-19.
- Below poverty level—Figure C.4-36.
- Presence of Federally recognized Native American Tribes: Although not located in the RFETS ROI, the Arapaho and Cheyenne have expressed an interest in DOE's waste management strategy.

Land Use

- The site occupies approximately 6,500 acres, of which 498 acres are occupied by operational facilities and 6,002 acres are undeveloped; of the undeveloped land, approximately 5,753 acres are available for future site development.
- Land use immediately surrounding the site on three sides is mostly rural open space. Land uses immediately beyond these open spaces are grazing agricultural, industrial, mining, and low-density residential. Residential areas within 5 to 10 miles are growing rapidly.

Infrastructure

- The Denver Municipal Water District provides an average of 0.272 million gallons of water per day from the Ralston and Gross Reservoirs.
- An onsite wastewater treatment system consisting of primary, secondary, and tertiary treatment and using an activated sludge process receives an average of 0.15 million gallons of sewage per day.
- The Public Service of Colorado's Valmont and Cherokee Generating Station, via electricity and gas, provides power; the average loads are 18.3 megawatts of electricity and 1,750 million cubic feet of gas per day.
- Transportation in the region consists of roads and interstates (such as nearby State Route 93) and rail lines intersecting in Denver, a major railway hub.

Cultural Resources

- Native American groups have lived in the RFETS area since about 10,000 years ago. European occupation of the region began in the late 19th century.

- Portions of the site have been subject to a comprehensive cultural resource survey. Several historic and prehistoric archaeological sites have been identified. The site contains no recorded standing structures but has the potential to contain traditional cultural properties.

4.4.14 SANDIA NATIONAL LABORATORIES—ALBUQUERQUE, NEW MEXICO

Sandia National Laboratories, New Mexico (SNL-NM), is immediately southeast of Albuquerque, New Mexico, on Kirtland Air Force Base (KAFB). SNL-NM occupies two parcels of land on KAFB, which have been allocated to DOE. These parcels total 2,820 acres. SNL-NM is a research and development laboratory with a primary mission of developing, engineering, and testing nonnuclear components of nuclear weapons. SNL-NM is operated for DOE by Sandia Corporation, a subsidiary of Lockheed/Martin Corporation. The current workforce at the site consists of 40 DOE employees and 8,556 prime contractor employees. SNL-NM is shown in Figure 4.4–14.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 610,714 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0034 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.020 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Bernalillo County, in which SNL-NM is located, is classified by EPA as a nonattainment area for the criteria pollutant carbon monoxide. The county is in attainment for the other five criteria air pollutants.
- Major sources of air pollution at the site include vapor degreasers, solvents for cleaning benches, gasoline dispensing facilities, paint spray booths, and solvents vented from the Hazardous Waste Management facility fume hoods and bulking operations.
- Prevailing winds are from the north with a frequency of 10%. The dominant windspeed range is 5 to 7 mph, with an occurrence of almost 38%. The frequency of calm winds is 8%. Average monthly temperatures range from 35 to 78.8°F. Average annual precipitation is 8 inches.

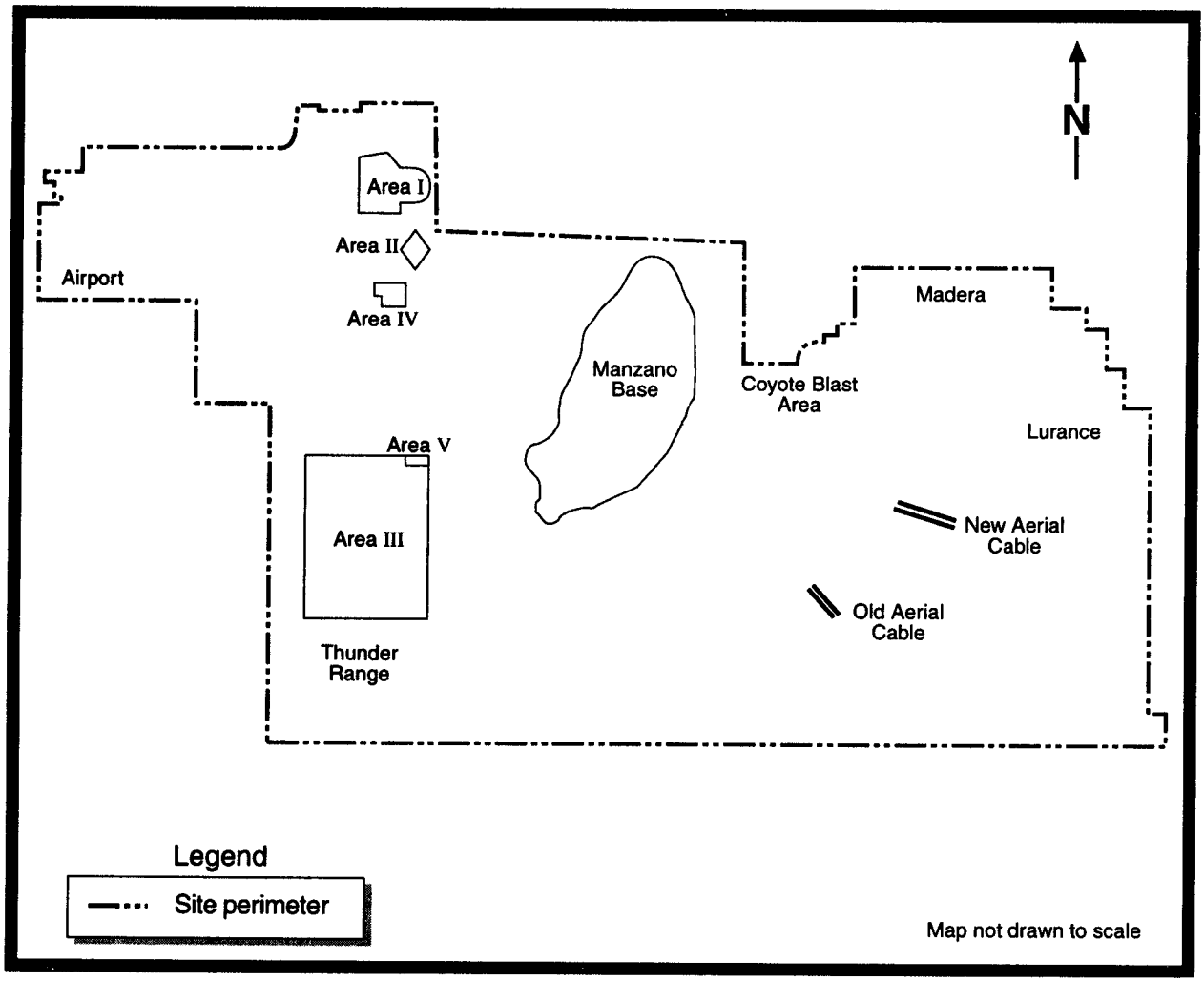

Figure 4.4–14. Sandia National Laboratories-New Mexico

Water Resources

- Major surface water features include the Rio Grande (6 miles from the western edge of KAFB) and onsite intermittent drainages such as Tijeras Arroyo and Arroyo del Coyote.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- The city of Albuquerque and KAFB wells supply water for the site.
- The city of Albuquerque wastewater treatment plant and surface water impoundments receive wastewater.
- In 1992, surface water monitoring showed two parameters above their comparison criteria.
- The major groundwater unit is the Valley Fill Aquifer, consisting of unconsolidated and semiconsolidated sands, gravels, silts, and clays. No sole source aquifers exist in the ROI.

- Groundwater monitoring in 1992 showed that comparison criteria were exceeded for five parameters.
- All active facilities are located well outside the Rio Grande's 500-year floodplain.

Geology and Soils

- The topography at the site is generally flat, except for the steep-sided arroyos that cut through the mesa area.
- Major rock units below the eastern section of the site include basement rocks. Most of the rest of the site is underlain by the Santa Fe Group, which includes gravels, sands, silts, and clays deposited in a basin formed by the uplift of the mountains to the east. Ortiz gravel and Rio Grande fluvial deposits are surficial deposits in some places.
- The soils present include sandy, gravelly, loamy, stony, and very cobbly soils. Basalt, sandstone, and limestone outcrops are also present.
- Four faults, including two capable ones, cut across the site.
- The site is in an area characterized by high seismic activity but of low magnitude and intensity. Studies indicate that a nondamaging earthquake may be expected every 2 years, with a damaging event every 100 years.
- The potential for damage from volcanic activity is small.

Ecological Resources

- Vegetation includes grassland, arroyo banks/dissected terrace, and grassland on dune sand. Grassland vegetation dominates. Dominant shrub species are sand sagebrush and four-wing saltbush, which are widespread in the western United States. Unique habitat includes arroyos.
- Wetland habitat is extremely limited on KAFB.
- No known Federally listed threatened or endangered species have been found at SNL. The Federal and State endangered peregrine falcon could exist in woodland or canyons. Two candidate species exist and one candidate species potentially exists on KAFB; three State-listed endangered cacti are located within KAFB; five State-listed endangered fauna exist or potentially exist on KAFB; and four plants classified as State Priority 1 are located in the vicinity of KAFB.

Socioeconomic Conditions

- The ROI for SNL-NM includes Bernalillo, Cibola, Sandoval, Santa Fe, Torrance, and Valencia Counties. At least 90% of the site's employees reside in these counties.

- Total site employment in 1992 was 8,596. Total ROI employment by place of work in 1990 was 393,398.
- The ROI unemployment rate was 7.0% in 1991.
- The ROI per capita income in 1990 was $16,281.
- The total population in the ROI in 1990 was 722,138. Population demographics: Native Americans—5.85%; urban—85.3%.
- Housing: owner-occupied—67.88%; renter-occupied—32.12%.
- Sensitive populations: children (under 15 years old)—23%; women of child-bearing age (ages 15 to 44)—23.1%; adults over 65—10.3%.

Environmental Justice

- Minorities—Figure C.4-20a.
- Below poverty level—Figure C.4-37.
- Presence of Federally recognized Native American Tribes: Isleta, Laguna, Sandia, Santa Ana, Santo Domingo, and Zia Pueblos.
  Tribal lands—Figure C.4-20b.

Land Use

- The site occupies approximately 2,820 acres, of which 175 acres are currently developed and 206 acres are available for future site development.
- Land use surrounding the site includes the Kirtland Air Force Base.

Infrastructure

- Onsite wells provide an average of 1.0 million gallons of water per day.
- The City of Albuquerque sewer system receives sewage; a site load of 0.548 million gallons per day was recorded in 1991.
- KAFB, which purchases electricity from the Public Service Company of New Mexico and the Western Area Power Administration, supplies power. The current site load is 34.5 megawatts. The Gulf Gas Utilities Company supplies natural gas.
- The ROI contains local road and rail networks. The site is 6 miles southeast of downtown Albuquerque. I-40 and I-26 intersect within the city limits. There is no direct rail access to the site.

Cultural Resources

- The State Historic Preservation Office has not evaluated the site for unrecorded archaeological sites, architectural resources, or traditional cultural properties.

4.4.15 SAVANNAH RIVER SITE—AIKEN, SOUTH CAROLINA

The Savannah River Site (SRS) is approximately 25 miles southeast of Augusta, Georgia, and 20 miles south of Aiken, South Carolina, in Aiken, Barnwell, and Allendale Counties in southwest-central South Carolina. It is on approximately 198,000 acres of land in a principally rural area, with most of the land serving as a forestry research center. SRS was established in 1950 by the Atomic Energy Commission. The site is currently operated by Westinghouse Savannah River Company. SRS is shown in Figure 4.4–15.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 620,618 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.140 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 6.40 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- The areas encompassed by, and the counties surrounding, SRS are classified by EPA as attainment areas for all six of the National Ambient Air Quality Standards criteria air pollutants.
- The major source of criteria air pollutants are nine coal-burning and four fuel-oil-burning boilers, and the processing facilities for fuel and target fabrication. Non-SRS sources of toxic air pollutants consist primarily of industrial installations, small manufacturing shops, and residential wood combustion.
- Prevailing winds at the Bush Field Airport in 1992 are uniformly distributed with winds from the west-southwest 7% of the time and from the west-northwest 6% of the time on a yearly basis. The highest occurrence of windspeed is from 5 to 7 mph, with an annual occurrence of 35%. The annual average temperature is 66°F), with seasonal temperatures ranging from an average summertime daily maximum of 90.8°F to an average daily minimum in January of 37.9°F.

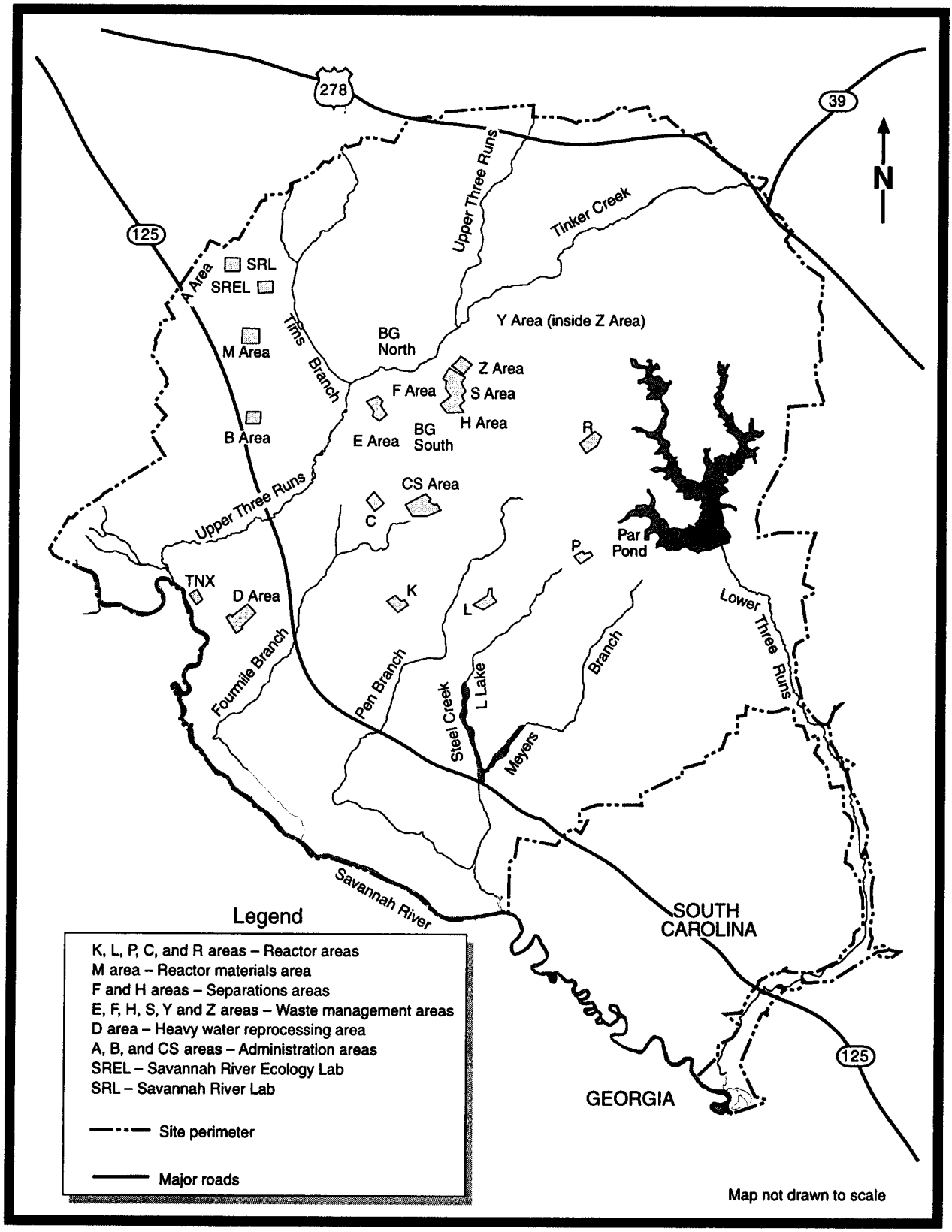

Figure 4.4–15. Savannah River Site

Water Resources

- Major surface water features include the Savannah River (which runs along the southwestern SRS border for 20 miles); onsite drainages such as Upper Three Runs, Fourmile Branch, Beaver Dam Creek, Pen Branch, Steel Creek, and Lower Three Runs; and numerous Carolina bays.
- No Federally designated Wild and Scenic Rivers exist in ROI.
- Groundwater wells and the Savannah River supply water for the site.
- Onsite streams and the Savannah River receive treated wastewater.
- Major groundwater units are the interbedded sandy clays and clayey sands of the coastal plain sediments. The sandy beds generally form aquifers, and the clay-rich beds act as aquitards. No sole source aquifers occur in the ROI.
- Onsite groundwater monitoring in 1992 showed that 42 parameters exceeded comparison criteria. Groundwater monitoring data indicate that contaminant plumes have not migrated into offsite water.
- The 100-year floodplain does not encroach on existing facilities.

Geology and Soils

- The topography of the area is generally flat, with some rolling hills and knolls. Elevations range from 85 to 427 feet above mean sea level.
- Major rock units include, from oldest to youngest, the crystalline basement rocks, the Dunbarton Triassic Basin, and the Atlantic Coastal Plain sediments.
- The soils in the area are primarily sandy loams that occur on alluvial terraces of the Savannah River and on the Aiken Plateau.
- Several interbasinal faults are located in the down-faulted Dunbarton Triassic Basin. However, no conclusive evidence exists of recent displacement along any fault within 186 miles of SRS.
- Two major earthquakes have occurred within 186 miles of the site. The probability of future seismic damage is moderate.

Ecological Resources

- Major plant communities include cypress-gum and lowland hardwood swamps, sandhills, and old agricultural fields. Ninety percent of SRS land cover is comprised of upland pine forests and bottomland hardwood forests. Important terrestrial habitats include old fields, sandhills, upland pine forests, bottomland and upland hardwood forests, and swamp forests. Longleaf pine/wiregrass communities support sensitive species, such as the red-cockaded woodpecker. SRS was designated a National Environmental Research Park in 1972.

- SRS contains approximately 43,000 acres of wetlands (20% of SRS), consisting of emergent marsh, cypress/tupelo, bottomland hardwood, and open water. These wetlands include the Savannah River swamp (about 10,000 acres) and over 200 Carolina bays scattered throughout the SRS.
- Federal and State endangered Kirtland's warbler, peregrine falcon, wood stork, red-cockaded woodpecker, and shortnose sturgeon are present on SRS. The Federally endangered smooth coneflower is also present. Two Federal threatened species and 11 candidate species are found on the site. The State-endangered Rafinesque's big-eared bat is present as well as the State-threatened Bewick's wren. Over 50 plants and animals on the State list are found on SRS. Additional listed species are located near SRS.

Socioeconomic Conditions

- The ROI for SRS includes Aiken, Barnwell, Allendale, and Bamberg Counties in South Carolina and Burke, Columbia, Richmond, and Screven Counties in Georgia. At least 90% of the site's employees reside in these counties.
- Total site employment in 1990 was 19,201. Total ROI employment by place of work in 1990 was 254,777.
- The ROI unemployment rate was 8.4% in 1991.
- The ROI per capita income in 1990 was $15,837.
- The total population in the ROI in 1990 was 460,028. Population demographics: Native Americans—0.2%; urban—69.6%.
- Housing: owner-occupied—67.1%; renter-occupied—32.9%.
- Sensitive populations: children (under 15 years old)—23.7%; women of child-bearing age (ages 15 to 44)—24.3%; adults over 65—10.3%.

Environmental Justice

- Minorities—Figure C.4-21.
- Below poverty level—Figure C.4-38.
- Presence of Federally recognized Native American Tribes: Three Native American groups, the Yuchi Tribal Organization, the Nubiunal Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy, have expressed general concerns about SRS and the Central Savannah River Area regarding several plant species traditionally used in tribal ceremonies.

Land Use

- The site occupies approximately 198,000 acres of land, most of which serves as a forestry research center. SRS was designated a National Environmental Research Park in 1972. Of the total area, approximately 15,840 acres are developed and 182,160 are undeveloped; of the undeveloped land, approximately 145,400 acres are available for future site development.
- Land use surrounding the site is predominantly rural.

Infrastructure

- Onsite wells provide an average of 1.6 million gallons of water per day.
- Onsite treatment plants receive an average of 0.5 million gallons of sewage per day.
- South Carolina Gas and Electric Company and onsite generation provide power; the current site load is 130 megawatts.
- Transportation in the region consists of local access roads (such as U.S. 278 and State Route 125) and major roads (such as Interstates 20 and 95). The Seaboard Coast and Southern Railroads are the primary providers of rail service to the SRS region, including onsite rail spurs.

Cultural Resources

- Native American occupation of the area began about 11,000 years ago.
- Over 800 prehistoric sites and about 400 historic sites have been identified at SRS.
- Fifty-five sites have been determined eligible for the National Register of Historic Places.

4.4.16 WASTE ISOLATION PILOT PLANT—NEW MEXICO

The Waste Isolation Pilot Plant (WIPP) is in Eddy County in southeastern New Mexico, approximately 25 miles east-southeast of Carlsbad in an area known as Los Medanos (The Dunes). The area, which totals 10,245 acres, is a sparsely inhabited plateau with little water and limited land uses. WIPP is a DOE facility authorized in 1980 to demonstrate the technical and operational principles involved in the permanent disposal of defense-generated transuranic waste. WIPP is shown in Figure 4.4–16.

Human Health

- Because WIPP is not open for TRUW disposal, only preoperational radiation surveillance has been conducted to establish background information at the site. Radiological measurements will also be performed to monitor any radionuclide release from the site after its opening for TRUW disposal.

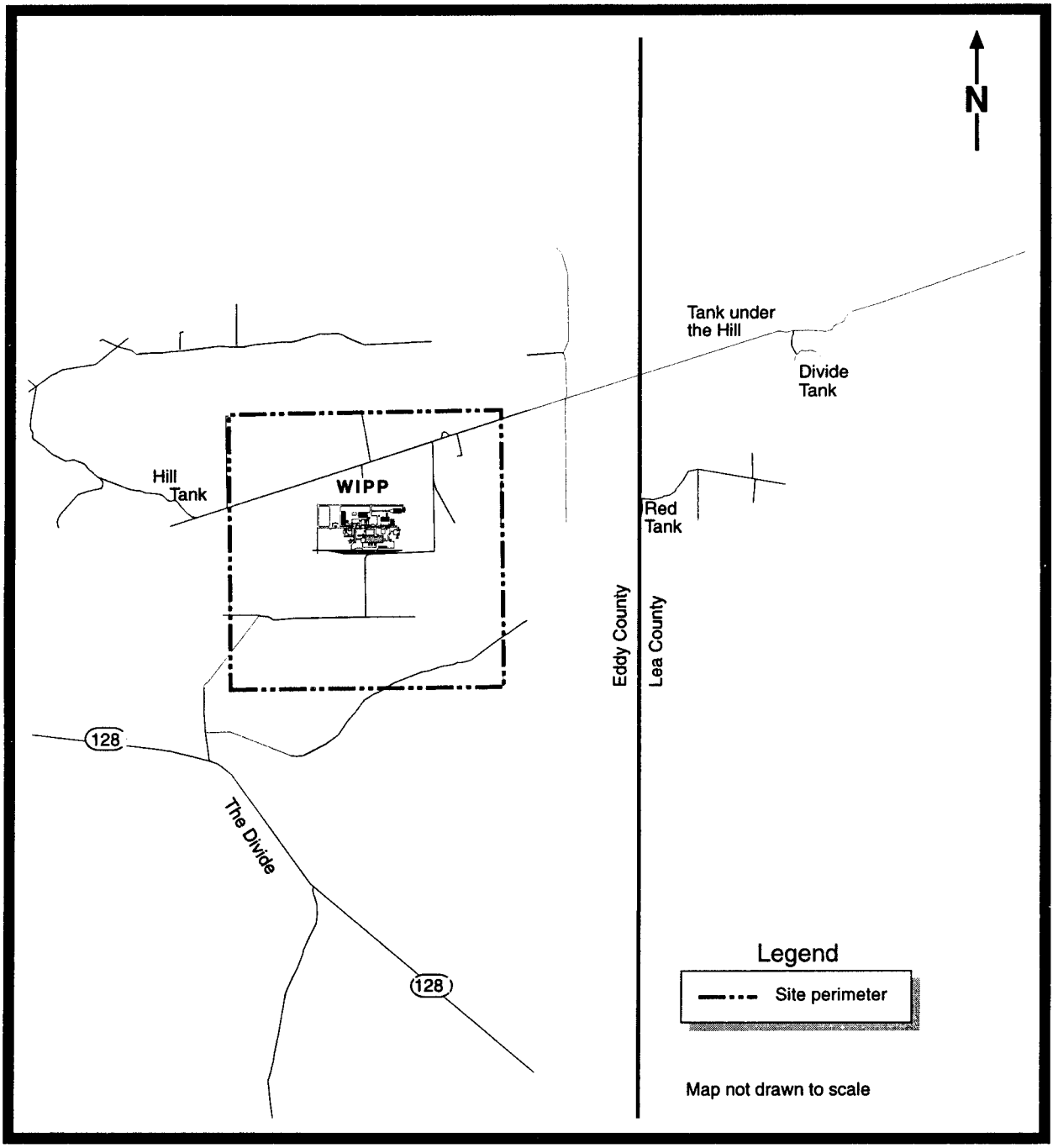

Figure 4.4–16. Waste Isolation Pilot Plant

- The ROI population used for PEIS health risk analyses is 99,889.

Air Quality

- Eddy County is currently classified by EPA as an attainment area for all six of the criteria air pollutants.
- Operations involving radioactive waste are expected to begin upon receipt of wastes shipped to WIPP for disposal. These operations would be the major source of air pollution at the site.
- Prevailing winds are from the southeast approximately 13% of the time, and the dominant windspeed ranges from 5 to 7 mph with an occurrence of almost 38%. The frequency of calm winds less than 2 mph is 4%. The average annual temperature for the WIPP area in 1992 was 63°F. The annual precipitation in 1992 was 16.58 inches, which is 4.33 inches above the long-term average for the area.

Water Resources

- Major surface water features include the Pecos River (14 miles west of the site); surface water runoff impoundments called "tanks" scattered throughout the nearby area; Laguna Grande de la Sal (10 miles south of the site), which is a large catchment basin for limited surface drainage; and artesian saline springs.
- No Federally designated Wild and Scenic Rivers exist in the ROI.
- The city of Carlsbad supplies water for the site.
- The WIPP sewage lagoon, a zero-discharge treatment facility, receives wastewaters.
- Surface water analysis in 1987 for various metals and organics showed elevated levels of six contaminants resulting from the natural saline springs in the area. Radionuclide concentrations fall within expected levels.
- Groundwater units include, from deepest to shallowest, the Bell Canyon Formation (water-bearing), the Castile Formation, the Rustler Formation (containing five water-bearing zones including the Culebra Dolomite), and the Dewey Lake Red Beds (sand beds). No sole source aquifers occur at the site. In the vicinity of WIPP, water is of low quality (ranging from brackish to brine). There are no aquifers on the WIPP site.
- Groundwater monitoring in 1992 showed naturally high concentrations of constituents in the Culebra Dolomite and seven constituents in the Dewey Lake Red Beds. Maximum concentrations of constituents in groundwater are provided in Table 2.21-3 of the affected environment technical report (DOE, 1996).
- WIPP is more than 400 feet above the floodplain of the Pecos River, well outside areas that may be flooded.

Geology and Soils

- The site is on a slight hummocky plain covered with caliche and sand within the Delaware Basin of the Pecos Valley. Elevations range from 3,250 to 3,570 feet.
- Major rock units include, from oldest to youngest, the Bell Canyon Formation (sandstones, shales, siltstones, and limestones), the Castile Formation (anhydrite and halite), the Salado Formation (anhydrite and halite), the Rustler Formation (anhydrite, siltstone/claystone, halite, and carbonate), the Dewey Lake Red Beds (siltstones and claystones, with subordinate sandstones), the Santa Rosa Sandstone, the Gatuna Formation sandstones, the Mescalero caliche, and Recent-age sands.
- Soils are made up of noncalcareous loose sands. Permeability and the potential for wind erosion are very high.
- Because of karst features in the area, dissolution and subsidence has occurred, and may continue to occur. These events are limited in extent and do not affect the integrity of the Salado Formation near repository depth.
- The Delaware Basin is considered to be tectonically stable. No surface faulting is known at the site.

Ecological Resources

- WIPP is characterized by stabilized sand dunes. Dominant vegetation includes Harvard Shin oak, mesquite, sand sage and plains yucca, and numerous species of forbs and perennial grasses. Dominant shrubs are deep-rooted species with extensive root systems.
- Wetlands are not present at WIPP.
- The Federal and State endangered American peregrine falcon and the Federal threatened and State endangered bald eagle may be located at WIPP, as well as four Federal Notice of Review species (one is State threatened). No critical habitat for terrestrial endangered species has been identified at WIPP.

Socioeconomic Conditions

- The ROI for WIPP comprises Eddy, Otero, Chaves, and Lea Counties in New Mexico and Culberson and Loving Counties in Texas. Ninety percent of the site's employees reside in these counties.
- Total site employment for 1990 was 932. Total ROI employment by place of work in 1990 was 99,707.
- The ROI unemployment rate in 1991 was 6.1%.
- The ROI per capita income in 1990 was $13,557 (1990 dollars).
- The total population in the ROI in 1990 was 217,661. Population demographics: Native Americans—1.83%; urban—73.64%.
- Housing: owner-occupied—69.2%; renter-occupied—30.8%.

- Sensitive populations: children (under 15 years old)—26.4%; women of child-bearing age (ages 15 to 44)—21.4%; adults over 65—12.3%.

Environmental Justice

- Minorities—Figure C.4-22.
- Below poverty level—Figure C.4-39.
- Presence of Federally recognized Native American Tribes: Although not located in the WIPP ROI, the Mescalero Apache Tribe has expressed an interest in DOE's waste management strategy.

Land Use

- The site occupies approximately 10,245 acres of land, of which approximately 10,210 acres are available for future site development, although a 1-mile buffer zone is planned to be provided around the area above the maximum extent of underground development.
- Land surrounding the site is sparsely inhabited, with limited land uses.

Infrastructure

- An offsite well system from the city of Carlsbad provides an average of 0.075 million gallons of water per day.
- An onsite sewage lagoon receives an average of 0.012 million gallons of sewage per day.
- The Southwestern Public Service Company supplies power; the current site load is 4,579 kilovolt-amperes.
- Direct access to the site is available from Routes 128 and 31. A rail spur to the site connects to the Atchison, Topeka, and Santa Fe Railroad.

Cultural Resources

- Since 1976, a total of 98 archaeological sites and numerous isolated artifact finds have been recorded within the 16-square-mile WIPP site.

4.4.17 WEST VALLEY DEMONSTRATION PROJECT—WEST VALLEY, NEW YORK

The West Valley Demonstration Project (WVDP) occupies 220 acres of the Western New York Nuclear Services Center (WNYNSC) in West Valley, New York, a rural setting approximately 31 miles south of Buffalo, in Cattaraugus County, a largely rural area. The WNYNSC was established in 1961. The New

York State Energy Research and Development Authority formed a private company—Nuclear Fuel Services, Inc. (NFS)—to construct and operate a nuclear fuel reprocessing plant. NFS leased WNYNSC, constructed the site, and began operations in 1966 to recycle fuel from commercial and Federally owned reactors. In the late 1970s, the site was shut down. WVDP is shown in Figure 4.4–17.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 1,698,391 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0003 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.011 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Cattaraugus County, in which WVDP is located, is classified by EPA as an attainment area for all six criteria air pollutants.
- Major sources of air pollution at the site are radiological and include the main ventilation stack, cement solidification system ventilation stack, contact size-reduction facility ventiliation stack, and supernatant treatment system ventilation stack.
- Prevailing winds were from the south-southeast with a frequency of 17% in 1992. The frequency of calm winds was 1%. Precipitation for the year was almost 7 inches above the annual average of 41 inches.

Water Resources

- Major surface water features include Cattaraugus Creek (2.4 miles from the site), Buttermilk Creek (0.5 mile from the site), and onsite tributaries (Quarry Creek, Erdman Brook, and Frank's Creek). The WVDP site and these streams are within the Cattaraugus Creek drainage basin, which ultimately flows into Lake Erie.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- Two reservoirs, formed by damming tributaries to Buttermilk Creek, supply water for the site.
- Erdman Brook receives treated wastewater.
- One constituent was above comparison criteria in surface waters in 1991.

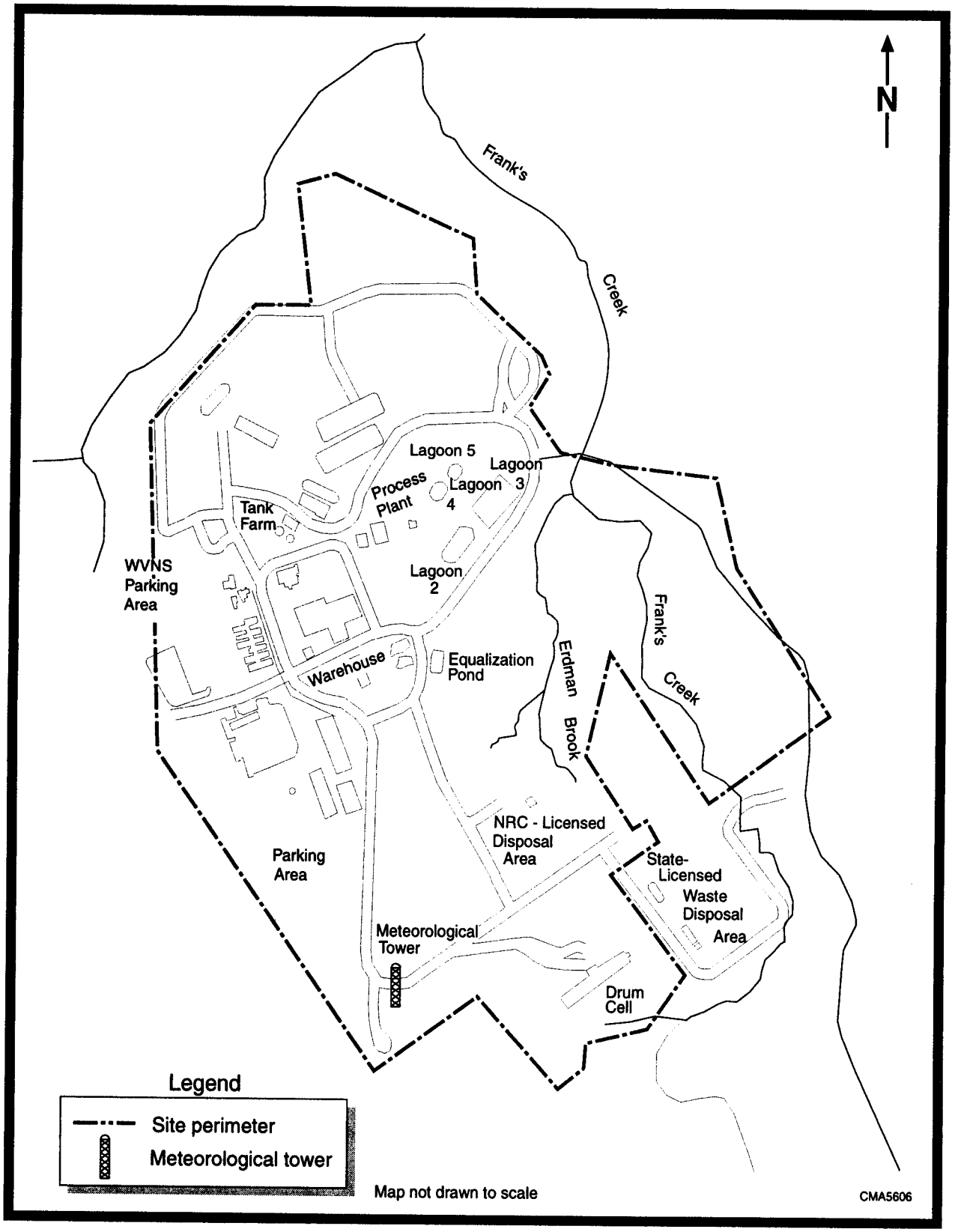

Figure 4.4–17. West Valley Demonstration Project

- Major groundwater units include a shallow aquifer composed of weathered Lavery till and alluvial gravels and a bedrock aquifer consisting of decomposed shale and rubble. The Cattaraugus Creek Basin Aquifer System is considered a sole source aquifer.
- Groundwater monitoring in 1991 showed that all parameters except gross beta and tritium were within comparison criteria. Monitoring at 10 offsite residential wells indicated no evidence of contamination by activities at WVDP.
- No safety-related WVDP facilities are in a 100-year floodplain.

Geology and Soils

- The topography at the site is generally gently rolling, with slopes between 5 and 15% and an average elevation of 1,300 feet above National Geodetic Vertical Datum.
- Major rock units include, from oldest to youngest, crystalline basement rocks; the Canadaway and Conneaut Groups (shales and siltstones); the Kent and Olean clayey silt tills; a lacustrine unit of silt, clay, sand, and gravel; and the Lavery silty clay till. Alluvial sands and gravels cover glacial till in some places.
- The major soils present include a well-drained gravelly loam and a poorly drained silt loam.
- No faulting of any consequence is recognized within the site.
- The site is in a region that has experienced a moderate amount of minor seismic activity.
- The potential for damage from volcanic activity or subsidence is small.
- The site is currently experiencing some erosion.

Ecological Resources

- Vegetation communities at WVDP include mixed hardwood forest (40% of the site), evergreen forest, bottomland forest, old-field successional areas, and forest-stage successional areas. WVDP is equally divided between forest and abandoned farm fields, which are becoming re-established with native vegetation. The State has designated the site as critical habitat because white-tail deer use it extensively as a wintering area. Unique habitats include rock faces.
- Delineated wetlands total approximately 35 acres and include wet meadows, emergent marshes and pond fringes, shrub swamps, forested swamps, and bogs and fens. A riparian area on Cattaraugus Creek is recognized by the State as Habitat Significant for Wildlife.
- No Federal-listed threatened or endangered species or critical habitats are found on WVDP. No State-listed endangered species have been recorded on the site, but 1 State threatened bird species, 38 plant species listed as protected, and 31 species considered exploitable vulnerable have been recorded on the

site. The Federal and State endangered Indiana bat, 3 State endangered, 4 State threatened, and 16 State species of special concern may potentially exist on the site.

Socioeconomic Conditions

- The ROI for WVDP comprises Cattaraugus and Erie Counties. Ninety-six percent of the site's employees reside in these counties.
- Total site employment in 1990 was 1,100. Total ROI employment in 1990 was 569,246.
- The ROI unemployment rate in 1991 was 8%.
- The ROI per capita income in 1990 was $17,937.
- The total population in the ROI in 1990 was 1,052,766. Population demographics: Native Americans—0.7%; urban—84%.
- Housing: owner-occupied—64.4%; renter-occupied—35.6%.
- Sensitive populations: children (under 15 years old)—19.9%; women of child-bearing age (ages 15 to 44)—23%; adults over 65—15.1%.

Environmental Justice

- Minorities—Figure C.4-23a.
- Below poverty level—Figure C.4-40.
- Presence of Federally recognized Native American Tribes: Seneca Nation.
  Tribal lands — Figure C.4-23b.

Land Use

- The site occupies approximately 220 acres of land; approximately 165 acres are available for future site development.
- Land use surrounding the site is predominantly rural. The site occupies a portion of the WNYNSC.

Infrastructure

- An onsite facility supplied from a reservoir provides an average of 0.07 million gallons of water per day.
- An onsite wastewater treatment plant receives an average of 0.07 million gallons of sewage per day.
- The Niagara Mohawk Power Company supplies electrical service; the WVDP electric load in December 1993 was 2.9 megawatts. Natural gas service is provided by National Fuel Gas Distribution Corporation; the natural gas usage in December 1993 was 15,880 British Thermal Units.

- Access to I-90 from WVDP is by Route 219, 5 miles west of the site. Route 17 is located 20 miles south of the site. An inactive rail spur is available on the site.

Cultural Resources

- The undeveloped portions of WVDP have not been evaluated by the New York State Historic Preservation Office.

4.5 Brief Descriptions of Other Sites

In this section, information is presented to characterize the activities that have produced waste at other sites. This includes all sites except the 17 major sites and those sites located within the same geographical location as one of the 17 major sites.

Ames Laboratory—Ames, Iowa. Ames Laboratory grew out of Iowa State University's involvement in the Manhattan Project starting in 1942. Ames furnished most of the uranium used in the first successful nuclear chain reaction in 1942. Uranium production continued throughout World War II. Current research includes innovative materials, superconductors, and environmental restoration technologies. Responsibilities at this Site include remediation of a chemical disposal site (1 acre) and a diesel fuel oil underground storage tank (1 acre). The laboratory occupies approximately 15 acres at the University.

Battelle Columbus Laboratories—Columbus, Ohio. Battelle Columbus Laboratories is made up of two major research complexes covering 10 acres, one in the city of Columbus and one in rural Madison County, Ohio. The Columbus Site houses corporate offices and general research laboratories. The other site is made up of a number of facilities formerly dedicated to nuclear research. Since mid-1943, the Battelle Memorial Institute has continuously performed contract research and development work for DOE and its predecessor agencies. The Battelle Columbus Laboratories are privately owned. DOE no longer needs the facilities and is obligated contractually to remove the contamination so that the laboratories can be used by Battelle without radiological restriction. Fifteen buildings, or portions thereof, and associated soil areas are radioactively contaminated as a result of work done under government contract.

Bettis Atomic Power Laboratory—West Mifflin, Pennsylvania. Bettis Atomic Power Laboratory is located on a 202-acre tract in West Mifflin, Pennsylvania, about 8 miles southeast of Pittsburgh. Bettis is

one of four DOE Laboratories participating in the joint DOE and Department of the Navy Naval Nuclear Propulsion Program. The Laboratory is operated for DOE by the Westinghouse Electric Corporation and is engaged solely in designing and developing naval nuclear propulsion plants. Laboratory operations include developing and testing nuclear fuel materials and reactor materials including radiochemical analyses.

Charleston Naval Shipyard—Charleston, South Carolina. The Charleston Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program of DOE and the Department of the Navy. The activity at the Charleston Naval Shipyard is being phased out as the operation is shut down.

Colonie Interim Storage Site—Colonie, New York. The 10-acre Colonie Site was used to manufacture a variety of products from depleted uranium. Since termination of AEC contracts, work has been limited to fabrication of shielding components, ballast weights, and projectiles from depleted uranium. In 1983, Congress assigned DOE the responsibility for site cleanup. Radiological surveys conducted from 1983 through 1987 identified 56 vicinity properties requiring corrective actions. Remedial action is expected to be completed by 1998.

Energy Technology Engineering Center (ETEC)—Los Angeles, California. ETEC is operated by the Rocketdyne Division of Rockwell International Corporation for DOE at 50 DOE-owned facilities located on a 90-acre area within Area IV of the Santa Susana Field Laboratory (SSFL) site. In 1946, the ETEC facilities began work in nuclear energy research and development. Small test and demonstration reactors and critical assemblies were built and operated, reactor fuel elements were fabricated, and used reaction fuel elements were disassembled and the cladding was removed from around the fuel. Since 1956, ETEC facilities were used to conduct manufacturing, engineering, and R&D activities for the AEC, the Energy Research and Development Administration (ERDA), and DOE. In 1966, ETEC was associated with the Liquid Metal Fast Breeder Program. Since 1987, no work with nuclear materials has been done at ETEC, and the only work related to its earlier operations has been cleanup and decontamination of the remaining inactive nuclear facilities. Currently all ETEC projects involve decontamination and decommissioning.

Fermi National Accelerator Laboratory—Chicago, Illinois. Fermi National Accelerator Laboratory (Fermi) is operated by a consortium of U.S. and Canadian universities for DOE. It explores the fundamental structure of matter using high-energy accelerators. Fermilab's accelerator, the Tevatron, is the

world's highest energy accelerator. Environmental restoration includes cleanup of polychlorinated biphenyls (PCBs).

General Atomics—San Diego, California. General Atomics (GA) Technologies was founded in 1955 and was one of the first private organizations to engage in fusion power research. DOE awarded a contract in January 1991 to GA to provide inertial confinement fusion (ICF) target component fabrication and technology development support to DOE for laboratories engaged in ICF experimental activities. DOE is responsible for the management, cleanup, and disposal of radioactive waste generated from DOE programs at this site, which is on less than 1 acre of land. Decontamination and decommissioning planning activities for the GA Hot Cell Facility were initiated in Fiscal Year (FY) 1992 and are expected to be completed by FY 1997.

General Electric Vallecitos Nuclear Center—Vallecitos, California. The Vallecitos Nuclear Center was used for mixed oxide fuel fabrication and development from 1962 to 1979. DOE is responsible for the management, cleanup, and disposal of the radioactive waste generated from DOE programs at this facility. Decontamination and decommissioning (D&D) planning activities for an alpha cell located within General Electric's Hot Cell Facility were initiated in FY 1992. D&D of the Hot Cell Facility has been delayed by waste disposition issues and is expected to be reinitiated in FY 1997.

Grand Junction Projects Office—Grand Junction, Colorado. The Grand Junction Projects Office (GJPO) supported the development of uranium ore processing and milling technology between 1942 and 1974. GJPO was accepted into the decontamination and decommissioning program in 1988. Remediation of the GJPO Site began in 1990 and, with the anticipated addition of 12 contaminated buildings in the program, is expected to be completed in FY 1998.

Inhalation Toxicology Research Institute—Albuquerque, New Mexico. The Inhalation Toxicology Research Institute (ITRI) covers about 135 acres on the Kirtland Air Force Base. The principal mission is to investigate human health effects from inhalation of airborne particulates, including fission products, fuel cycle actinides, insulating materials, and diesel exhaust. Radioactive waste is disposed at DOE-owned sites. Underground storage tank leaks have produced diesel oil contamination of the groundwater below lagoons used for the disposal of sanitary waste. Complete groundwater cleanup is expected by 1996.

Kansas City Plant—Kansas City, Missouri. Established in 1949, the Kansas City Plant (KCP), which covers 141 acres, manufactures rubber, plastic, electronic, and other nonnuclear parts for nuclear weapons. The plant also provides development hardware for research programs conducted at DOE laboratories. KCP has recently been assigned several additional missions as part of the nonnuclear consolidation of the DOE weapons complex. The facility was formerly used as an airplane engine production plant for the U.S. Department of Defense. Onsite groundwater, soil, and air release contamination has resulted from the use of solvents and spillage of transformer oils contaminated with polychlorinated biphenyls (PCBs). Complete cleanup of contaminated sites is expected by 2000 (except long-term and ongoing groundwater treatment).

Knolls Atomic Power Laboratory—Kesselring Site, West Milton, New York. The Knolls Atomic Power Laboratory, Kesselring (KAPL–K), is in Saratoga County near West Milton, New York, approximately 17 miles north of the city of Schenectady, 9 miles southwest of Saratoga Springs, and 13 miles northeast of Amsterdam. KAPL–K consists of 3,900 acres of Government-owned land. Facilities construction began in 1951, and the site was originally developed as a test site for liquid metal fast breeder reactors. In the early 1950s, the site was then developed for the Navy Nuclear Propulsion Program. KAPL–K's mission is to test prototype nuclear propulsion plants for submarines and surface ships and to train U.S. Navy Nuclear propulsion plant operators.

Knolls Atomic Power Laboratory—Niskayuna, New York. The Knolls Atomic Power Laboratory, Niskayuna (KAPL-N), is located on a 170-acre tract in Niskayuna, New York, about 2 miles east of Schenectady, on the south bank of the Mohawk river. KAPL-N is operated by KAPL, Inc., a wholly owned subsidiary of the Lockheed Martin Corporation under contract with DOE. KAPL consists of three sites: the Niskayuna and Kesselring sites in New York and the Windsor Site in Connecticut. These sites are engaged solely in research and development for the design and operation of naval nuclear propulsion plants in conjunction with the joint DOE and Department of the Navy Naval Nuclear Propulsion Program. The KAPL-N is the primary KAPL site, and its mission is to design and develop improved naval propulsion plants and reactor cores.

Knolls Atomic Power Laboratory—Windsor, Connecticut. The Knolls Atomic Power Laboratory, Windsor (KAPL-W), is located on a 10.8-acre tract about 5 miles north of Hartford, Connecticut, in the town of Windsor. The KAPL-W conducts full-scale testing of a pressurized-water naval nuclear propulsion plant and associated propulsion plant hardware, and trains personnel to operate these plants. This testing

propulsion plant was shut down in March 1993 and has been defueled. The draft EIS for the disposal of this plant was published in June 1996.

Laboratory for Energy-Related Health Research—Davis, California. A less-than-1-acre DOE-owned facility located 1 mile from the main campus of the University of California, Davis, the Laboratory for Energy-Related Health Research investigates health effects of exposure to low levels of radiation. The removal, treatment, packing, and disposal of 35,000 gallons of sludge waste was completed in 1991-1992. Complete decontamination and decommissioning of the facilities is expected by FY 1995. Complete Comprehensive Environmental Response, Compensation, and Liability Act remedial actions are expected by 1997 at which time the Site will be released to the University.

Lawrence Berkeley Laboratory—Berkeley, California. The Lawrence Berkeley Laboratory (LBL) occupies a 133-acre site within the University of California, Berkeley, campus. The LBL site is leased by DOE through a series of 50-year lease agreements. The lab originated on the Berkeley campus of the University of California in 1931. From 1948 to 1972, the Laboratory was operated by the University of California for the U.S. Atomic Energy Commission (AEC). During this period, pioneering discoveries were made in nuclear and elementary particle physics, nuclear chemistry, biology, and nuclear medicine. Three of the basic modern types of accelerator—the cyclotron, the Alvarez Linear accelerator, and the synchrotron—were invented and developed at LBL. In 1972 the Lawrence Radiation Laboratory became the Lawrence Berkeley Laboratory with major funding from ERDA, which replaced the AEC. Today, LBL is operated as one of nine multi-program National Laboratories of the DOE. LBL's major role is to conduct basic and applied science research that is appropriate for an energy research Laboratory.

Mare Island Naval Shipyard—Vallejo, California. The Mare Island Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program of DOE and the Department of the Navy. These activities are being phased out as the Mare Island Naval Shipyard is shutting down.

Middlesex Sampling Plant—Middlesex, New Jersey. The Middlesex Sampling Plant (MSP) is on a 9.6-acre site in north central New Jersey currently used for storage of radioactively contaminated soil. The MSP is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP). The MSP was established in 1943 by the Manhattan Engineer District (MED) to sample, store, and ship uranium, thorium, and

beryllium ores. In 1955, the AEC, successor to MED, terminated operations and later used the site for storage and limited sampling of thorium residues. In 1967, AEC activities ceased, onsite structures were decontaminated, and the site was certified for unrestricted use under criteria applicable at that time. Between 1968 and 1980 the site was used by the General Services Administration and then by the Navy as a U.S. Marine Corps training center. In 1980, custody of MSP was returned to DOE, which then began remedial action to clean up vicinity properties.

Mound Plant—Miamisburg, Ohio. Established in 1948, the 306-acre Mound Plant made nonnuclear and tritium components for nuclear weapons, which are assembled at another site. Its other activities include: the separation, purification, and sale of stable isotopes of the noble gases; solar energy research; fossil fuels research; nuclear safeguards; waste management; heat-source testing (plutonium); and fusion fuel systems. Decontamination and decommissioning operations began in 1978 and will continue until FY 2003. Cleanup of all operable units is expected by FY 2015.

Norfolk Naval Shipyard—Portsmouth, Virginia. The Norfolk Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program of DOE and the Department of the Navy.

Palos Forest—Chicago, Illinois. Site A/Plot M at Palos Forest was a reactor site for the Manhattan Project. Two reactors were decommissioned by 1956. Some of the resulting waste was buried at this 20-acre site. Characterization and assessment efforts are currently being performed.

Pearl Harbor Naval Shipyard—Pearl Harbor, Oahu, Hawaii. The Pearl Harbor Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program of DOE and the Department of the Navy.

Pinellas Plant—St. Petersburg/Largo, Florida. The Pinellas Plant, which covers about 99 acres, was established in 1956 to manufacture neutron generators and other electronic and mechanical components of nuclear weapons. In 1993, DOE decided to transfer the missions of the Pinellas Plant to other DOE facilities, and the Pinellas Plant is now shifting to solely a cleanup mission. Interim groundwater cleanup

actions are underway. Remediation of a 4.5-acre parcel adjacent to the Pinellas Plant began in FY 1990 and is expected to be completed by FY 1999. The Pinellas Plant sent 3,605 gallons of waste oil in 1978 and 1979 to Peak Oil. Peak Oil used a refining process to purify used oils and lubrication fluids. Mismanagement of waste oil and hazardous waste resulted in extensive soil and groundwater contamination. Pinellas Plant was consequently identified as a Potentially Responsible Party and is partially responsible for cleanup.

Portsmouth Naval Shipyard—Kittery, Maine. The Portsmouth Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program between DOE and the Department of the Navy.

Princeton Plasma Physics Laboratory—Princeton, New Jersey. Located on the Princeton University campus, the Princeton Plasma Physics Laboratory (PPPL) researches magnetic confinement fusion and the practical application of plasma physics. PPPL operates two major magnetic fusion devices, the Tokamak Fusion Test Reactor and the Princeton Beta Experiment-Modification, and a smaller device, the Current Drive Experiment-Upgrade. Remedial actions include characterization of soil and groundwater contamination on the 72-acre site.

Puget Sound Naval Shipyard—Bremerton, Washington. The Puget Sound Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program between DOE and the Department of the Navy. Puget Sound is the only naval shipyard that removes for safe disposal defueled reactor compartments from decommissioned nuclear submarines.

Reactive Metals, Inc.—Ashtabula, Ohio. Established in 1952, Reactive Metals, Inc. extruded slightly enriched uranium metal for use as a production reactor fuel element. The 60-acre site ceased production in October 1990. Cleanup is being carried out and remediation of buildings and onsite soils is in progress.

Sandia National Laboratories (California)—Livermore, California. The Sandia National Laboratories (California) (SNL-CA) is located on 413 acres next to and south of the LLNL Livermore Site, which is 15 miles due east of Livermore, California. In 1956, SNL established the Livermore facility to provide a

closer relationship with LLNL's nuclear weapons research design work. Today LLNL's mission includes laser fusion, laser isotope separation, and biomedical and environmental research, as well as environmental restoration and waste management. Owing to the proximity of SNL-CA to LLNL, the summary descriptions of environmental features presented for LLNL (Section 4.4.6) largely reflect the situation at SNL-CA.

Stanford Linear Accelerator Center (SLAC)—Palo Alto, California. Established in 1962, the Stanford Linear Accelerator Center (SLAC) conducts theoretical and experimental research in high-energy particle physics. It also develops new techniques in high-energy accelerators. SLAC, which is on 426 acres of land, is assessing onsite soil and groundwater contamination from volatile organic compounds and onsite and offsite contamination from polychlorinated biphenyls (PCBs).

University of Missouri—Columbia, Missouri. The University of Missouri is located in Columbia, Missouri. The University is contracted by Rockwell International to conduct experiments to separate radioactive actinide elements from spent fuel using the PUREX process. No experiments have been performed using reactor spent fuel; only pure actinides are present in waste material generated in the experiments. The DOE plans to decontaminate the hot cells to their original condition upon completion of testing. The university also operates the Columbia Research Reactor, a 10-megawatt light-water moderated reactor that uses plate-type fuel containing 93% enriched uranium-235. The university currently stores spent fuel from the reactor in a wet storage facility.

Weldon Spring Remedial Action Project—St. Louis, Missouri. In the 1940s, the Army used the Weldon Spring Site as an ordnance works. In the 1950s and 1960s, the AEC used it for processing uranium and thorium. The site occupies approximately 100 acres, including a 9-acre quarry. Cleanup includes the quarry, a chemical plant, and contaminated groundwater onsite and offsite.

Chapter 4
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CHAPTER 5
Impact Analysis Methodologies

This chapter summarizes the methodologies used to evaluate the potential direct, indirect, and cumulative effects of the 36 Alternatives within the four broad categories of alternatives described in Chapter 3. Following an overview of the waste management impact analysis framework and analytical process, this chapter describes the generic methodologies and assumptions used for waste loads, waste management technologies, and waste management facilities. The chapter then describes how DOE, using generic designs of proposed waste management facilities, derived estimates of facility pollutant discharges to the environment, of resources required or consumed in the process of constructing and operating the facilities, and of costs. The methodologies and assumptions used to evaluate the environmental impacts for each resource area are also explained.

Related discussions of methodologies can be found in other chapters:

Chapter 4 describes the methodology used to characterize the affected environment.

Chapters 6 through 10 describe specific methodologies for the analysis conducted for each of the five waste types.

Chapter 11 describes in more detail the methodologies to estimate cumulative impacts.

Appendix B provides the specific methodology used for the analysis of the sensitivity of waste management (WM) alternative decision making to waste from environmental restoration.

Appendix C provides detailed descriptions of methodologies used to estimate environmental and socioeconomic impacts and cost.

Appendices D, E, and F provide detailed descriptions of methodologies used to estimate human health risks from normal operations, transportation, and facility accidents, respectively.

The technical reports listed in the chapter references provide detailed descriptions of data gathering and estimating methodologies used for each waste type to assess risk, cost, transportation, and accident impacts.

5.1 Overview of the WM PEIS Analysis Approach

5.1.1 IMPACT ANALYSIS FRAMEWORK

In order to evaluate the potential environmental impacts of the alternatives, DOE first identified the type, characteristics, quantity, and special requirements (e.g., handling requirements) of each waste type. The Department then determined the health risks, environmental impacts, and costs of waste management

treatment, transport, storage, and disposal as applicable for each waste type. Figure 5.1–1 depicts this framework. To frame the analysis within reasonable bounds and to make the analytical process more manageable, DOE developed and applied particular assumptions. This chapter describes those assumptions and explains the process DOE used to conduct the health risk, environmental impacts, and cost analyses contained in the WM PEIS.

5.1.2 WM PEIS Analytical Process

The treatment, storage, or disposal impacts of alternatives for managing the five waste types were evaluated using an analytical process consisting of three phases, as shown in Figure 5.1–2, for each of the alternatives under the four broad categories of alternatives (No Action, Decentralized, Regionalized, and Centralized).

In the **first phase**, DOE made assumptions regarding waste loads for the five waste types. These assumptions related to the volume of waste currently in inventory and anticipated from future operations of DOE facilities and to its physical (gaseous, liquid, solid), chemical, and radiological characteristics. The assumptions used for each waste type are based on DOE records (see Section 5.2.1) and are described in the waste-type chapters.

DOE also developed a generic design of the waste management processes and facilities that could produce environmental impacts. In developing the generic design, DOE considered all the types of facilities needed to process each waste type (including treatment, transportation, storage, and disposal facilities). The Department also examined the various technologies available for managing the specific waste type and selected one technology option for analysis purposes.[1] The technologies used in the WM PEIS were chosen for analytical purposes only; the Records of Decision based on the WM PEIS will not select technologies.

The generic design of the waste management facility was placed at a specific location on each DOE site—either co-located with existing waste management facilities or at the geographic center of the site—so that actual environmental data from those locations could be used in the analysis of impacts (e.g., data regarding distance to receptors and prevailing winds). It is important to note that the use of a specific location was only to facilitate the computerized analysis of impacts. Decisions regarding the actual location

[1] The facilities considered and the technology chosen for each waste type, and the rationale for that selection, are described more fully in the waste-type chapters.

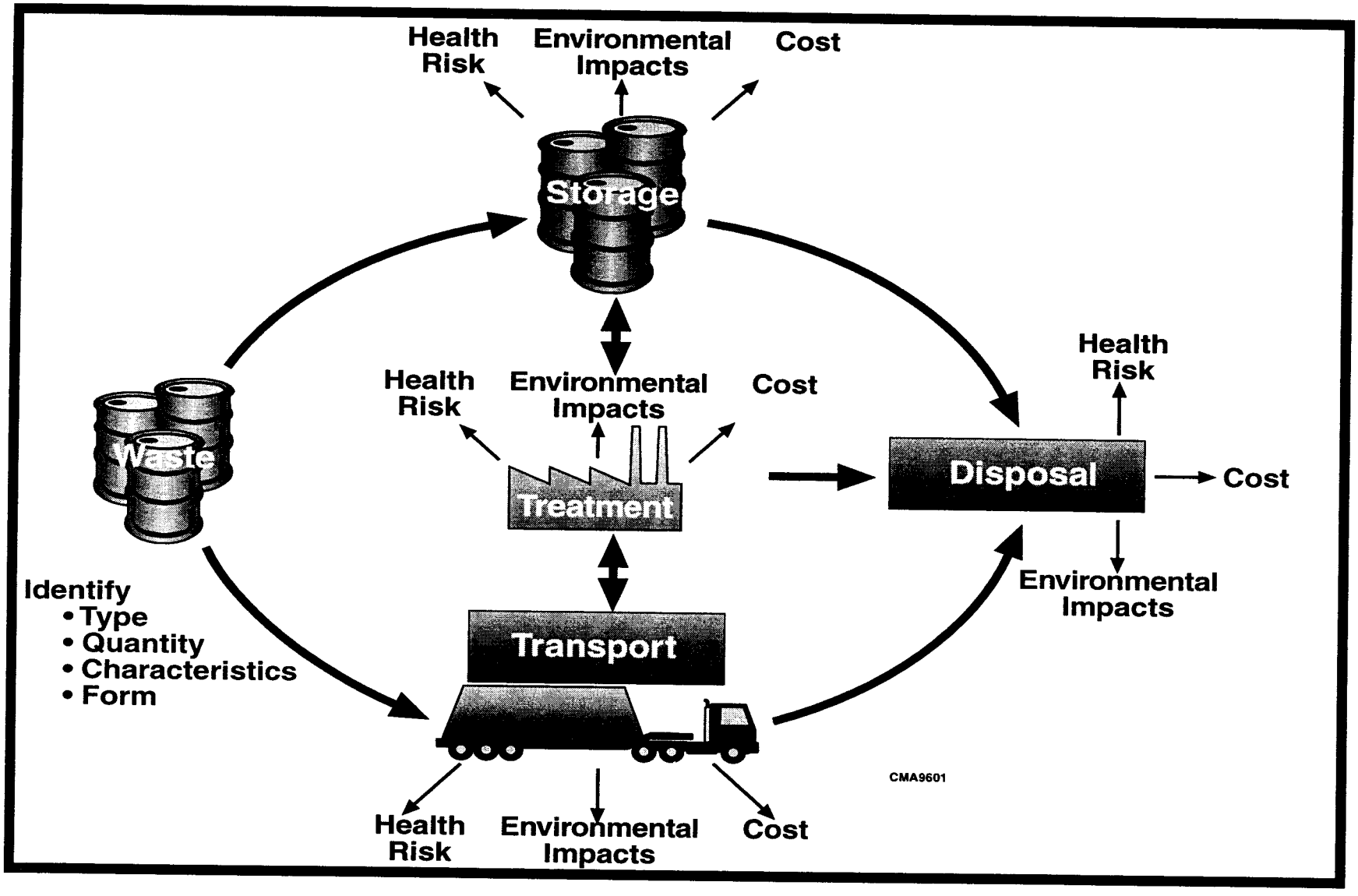

Figure 5.1–1. Waste Management Analysis Overview

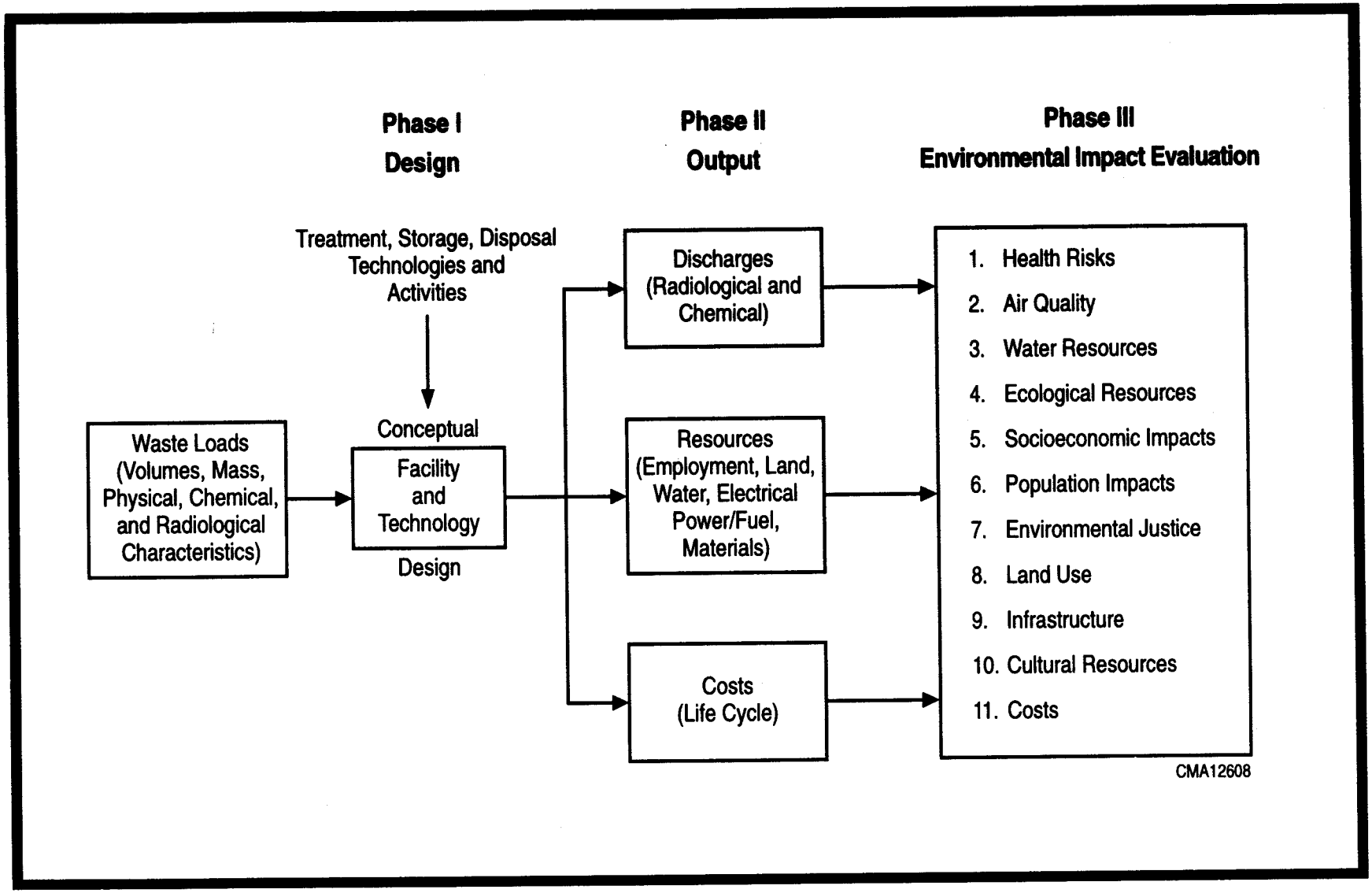

Figure 5.1–2. WM PEIS Analytical Relationships

of waste management facilities at particular DOE sites will not be made on the basis of this PEIS, but rather will be the subject of sitewide or project-specific NEPA reviews. Because locating future WM facilities at the centers of the sites could lead DOE to underestimate impacts at the large sites, where the distance from the center of the site to the site boundary is large, co-locating future WM facilities with existing WM facilities was done at the six largest DOE sites (Hanford, INEL, LANL, NTS, ORR, and SRS). Sections 6.1.3 and 7.1.3 list existing LLMW and LLW disposal facility capacities at these six sites. For the remaining 11 sites, DOE assumed that facilities would be located at the center of each site. Since these are the smaller sites, locating WM facilities at the center of a site would have less mitigative effect on offsite impacts than at the larger sites. Therefore, assuming that facilities would be located at the center of the smaller DOE sites is a reasonable assumption because it is unlikely to drastically affect impact estimates, particularly offsite human health risk.

In the **second phase** of the analytical process, waste materials (using the waste load assumptions developed in the first phase) were conceptually "processed" through the assumed facilities, and estimates of outputs were obtained for radiological and chemical discharges to the environment, the resources required or consumed, and costs. In the **third phase**, the discharges, resources, and costs became the input for evaluating environmental impacts, socioeconomic impacts, and human health risks.

For many aspects of the human health risk and environmental impacts analysis DOE relied on computer models for estimates of discharges and exposures. Table 5.1-1 lists the models used, gives the resource for which they were used, and describes how they were used.

The remainder of this chapter describes the methodologies developed for and used in the three-phase analytical process described above. Information about the generic design phase (waste loads, waste management technology, and waste management facilities) is provided in Section 5.2. Section 5.3 describes the methodology and assumptions used to determine discharges, resources required or consumed, and costs. The methodologies and assumptions used for evaluating the environmental impacts on the various resource areas are described in Section 5.4.

Table 5.1-1. Major Computer Models Used in the WM PEIS

Name	Resource	Developer	Description
MEPAS (Multimedia Environmental Pollutant Assessment System)	Unit dose, risk, and toxicity factors for contaminants related to groundwater	Battelle Pacific Northwest Laboratory	This model simulates the transport of contaminants through the vadose zone and into groundwater to give environmental concentrations of contaminants at various receptor locations.
DUST (Disposal Unit Source Term Model)	Contaminant-specific flux rates out of the disposal facility	Oak Ridge National Laboratory	This model selects unit risks and unit toxicities stored in a data base for specific contaminants in site-facility-, and waste form-specific records.
DITTY (Dose-In-Ten-Thousand-Years, Sub-model of GENII)	Exposure to radionuclides and hazardous chemicals	Battelle Pacific Northwest Laboratory	This model takes the 70-year average concentration, adjusted for humans, and multiplies it by the drinking water populations to give a total contaminant dose, which is multiplied by a slope factor or reference dose to give a unit risk or unit toxicity.
GENII (formerly Generation Model)	Radionuclide unit doses for atmospheric releases	Battelle Pacific Northwest Laboratory	This model simulates the environmental transport of radionuclides released to the environment and predicts the exposure and dose to specified receptors. The model uses an emission rate of 1 Ci/yr (curie per year) for each radionuclide, utilizing a series of Gaussian-plume models to estimate air concentrations.
RADTRAN 4	Population risk along transportation routes	Sandia National Laboratories	This model calculates population risk by scheduling packages through a route, with several input parameters quantifying the loaded vehicle, route, population centers, speed, and stop time.
RISKIND	Consequences of most severe (Category VIII) transportation-related accidents: committed dose, latent cancer fatalities	Argonne National Laboratory	This model calculates consequences for highest potential radiological risk; as identified by screening site-specific characteristics, considering physical forms of waste, and relative hazards of individual radionuclides.
ISC2 (Industrial Source Complex Model, Revision 2)	Hazardous chemical risk and toxicity factors of atmospheric releases	EPA	This model predicts the average concentration in air of chemicals released to the environment which is multiplied by appropriate slope factors and reference doses to give unit risks and unit toxicities.
HIGHWAY 3.1	Truck transportation mileage and routing	ORNL	This model simulates the U.S. highway system, using a least distance and driving time algorithm, including 1990 U.S. Census population densities of centers along routes.
INTERLINE 5.0	Rail transportation mileage and routing	ORNL	This model simulates the U.S. rail system, using a shortest route algorithm, including 1990 U.S. Census population densities of centers along routes.
ALOHA (Areal Locations of Hazardous Atmospheres)	Accidental source term releases (gases)	National Oceanic and Atmospheric Administration	This model uses a dispersion algorithm to simulate continuous and intermittent releases of passive nonbuoyant vapors and heavy gases in rural and urban atmospheres, calculating time-dependent concentrations and hazard distances for various levels of concern.
MicroShield	Unit external dose exposure rate	Grove Engineering (1992)	This model computes the exposure rate for workers within each facility module assuming that a unit concentration of each radionuclide is present.
WASTE_MGMT	Waste loads, radiological and chemical profiles, and emissions	Argonne National Laboratory (1996c)	Using reference files for waste inventory and characterization, TSD facility characterization, and alternative definition, the model quantifies and characterizes waste loads at and emissions from the facilities, and the quantities and characteristics of waste transported among the sites.

Table 5.1-1. Major Computer Models Used in the WM PEIS—Continued

Name	Resource	Developer	Description
MOBILE 5A	Vehicle emissions for criteria air pollutants CO, NO_2 and VOC.	EPA	This model calculates emissions in grams of pollutants per vehicle mile traveled.
PART 5	Vehicle emissions for criteria pollutant PM_{10}	EPA	This model calculates emissions in grams of pollutants per vehicle mile traveled.
RIMS II	Multipliers for disposable income, output and job years for economic impact analysis	U.S. Department of Commerce Bureau of Economic Analysis	This model estimates the response of regional economies to changes in expenditures.
WASTE_ACC	Accident frequencies and radiological profiles of the resulting atmosphere releases	Argonne National Laboratory (1996b)	Using reference filter for accident initiation frequencies, event conditional probabilities, and source term development parameters, the model quantifies the amount of each radioisotope in the atmospheric release and the probability of the release. Interfaced with WASTE_MGMT.

5.1.3 DOE SITES EVALUATED

DOE has some waste management responsibility for 54 sites that are within the scope of this PEIS. Of the 54 sites, 17 have been designated major sites in the PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite, (2) they are candidates to host disposal facilities, (3) they manage HLW, or (4) they were included to be consistent with the Federal Facilities Compliance Act process. The major sites contain the bulk of the five waste types, have the capacity for the future disposal of LLMW or LLW, or have existing or planned major waste management facilities. The WM PEIS analyzes the impacts of waste management activities at these major sites. The designation of these sites as major has no relevance outside of the context of the WM PEIS analysis. Major sites have not been "preselected" for waste management activities; rather, analysis of potential waste management activities at these sites provides a range of environmental impacts that could arise from treating, storing, and disposing of DOE's waste. As a result, broad comparisons of potential impacts across sites can be made.

5.2 Phase I: Reference Design

5.2.1 Waste Loads

Waste Volumes. Waste loads reported in Tables 1.6–2 and 1.6–3 in Chapter 1, as well as in Chapters 6 through 10, represent a "snapshot in time"—accurate to the extent existing inventories and future operations were understood when the databases were developed. Accordingly, inventories and projections reported in Table 1.6–3 and Chapters 6 through 10 may not exactly match projections at the time of publication of the Final WM PEIS.

Factors affecting the degree of uncertainty in waste loads can be found in Appendix I, which provides a more recent snapshot of DOE's waste inventory and projections. At selected sites, substantial differences are apparent and represent uncertainties. It was deemed necessary to make only selected updates in the waste load information and associated analyses presented in the WM PEIS. Additionally, as Appendix I shows, consolidation of waste loads and operations across sites in Regionalized and Centralized Alternatives serves to somewhat dampen uncertainty associated with site-specific waste inventories and projections.

Considering these uncertainties, dampening effects, and the selected updates, the waste loads used for the WM PEIS analysis are sufficiently accurate for programmatic decision making. Sources of data for each of the waste types are listed below:

- **Low-level mixed waste (LLMW)**—The *Mixed Waste Inventory Report* (DOE, 1994) was used for all LLMW inventories and generation rates, except for Colonie, ETEC, and RFETS, whose generation rates and inventories come from late 1994 site estimates, and ANL-E and NTS, whose generation rates and inventories come from the updated *Mixed Waste Inventory Report* (DOE, 1995a).
- **Low-level waste (LLW)**—The *Integrated Data Base for 1992* (DOE, 1992) was used for generation rates and inventories of stored waste, except for BNL, NTS, ORR, Pantex, and WVDP, whose generation rates and inventories come from the updated *Integrated Data Base Report–1994* (DOE, 1995b). The Waste Management Information System (ORNL, 1992) was consulted for data not available in the Integrated Data Base.
- **Transuranic Waste (TRUW)**—The *Integrated Data Base for 1992* (DOE, 1992) and the *Interim Mixed Waste Inventory Report* (DOE, 1993a) were used for TRUW inventories and generation rates, except for Hanford and SRS. SRS generation rates and inventories come from the updated *Mixed Waste*

Inventory Summary Report (DOE, 1995a), while Hanford's come from the ***WIPP TRUW Baseline Inventory Report (BIR-2) for 1995*** (DOE, 1995c).

- **High-level Waste (HLW)**—Site-specific plans and NEPA documents for Hanford, INEL, SRS, and WVDP were used for HLW volume and canister production rates.
- **Hazardous waste (HW)**—The EPA Information System biennial and annual reports (EPA, 1991) were used for generation rates. Offsite shipments to commercial treatment were derived from DOE fiscal year 1992 HW shipping manifests.

With some exceptions, the more recent data in Appendix I include waste projections that are lower than the projections used for analysis by the WM PEIS. This is a reflection of current pollution prevention policies and the reduction in the nuclear weapons mission. The net effect is that the WM PEIS impacts are likely to be conservative, portraying greater impacts than will actually occur. DOE believes that these conservative estimates are adequate for the programmatic purposes of the WM PEIS and that the trends in the WM PEIS are not sensitive to these fluctuations in waste projections. Project-level analyses which would be used to determine actual technology designs and capacities for the waste management activities would rely on the most current data.

It is DOE policy that sites employ pollution prevention practices to reduce the amount of waste generated. The databases from which estimates of annual generation were obtained did not fully consider pollution prevention efforts. Possible impacts of pollution prevention are discussed in Appendix G.

Environmental Restoration Waste. In addition to existing wastes and wastes expected to be generated from the routine operation of DOE facilities (generally referred to as waste management wastes), environmental restoration and decontamination activities at DOE sites will also generate wastes (generally referred to as environmental restoration wastes) that must be further treated or disposed of at waste management facilities.[2] The location and timing of these future environmental restoration activities and the size and characteristics of resulting waste loads are difficult to predict. Thus, the waste loads analyzed in detail in this PEIS do not include wastes that may be generated as a result of environmental restoration activities.

[2] An unknown percentage of environmental restoration wastes will be managed at environmental restoration—not waste management—facilities (see Appendix B). The environmental impacts of managing environmental restoration waste at environmental restoration facilities will be addressed in the Remedial Investigation/Feasibility Studies that DOE conducts under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) for each environmental restoration site.

However, in each of the waste type chapters except HLW and HW, the anticipated environmental restoration waste loads are described for the DOE complex, and compared to the existing and anticipated waste management waste loads. These chapters also contain a discussion of the extent to which the environmental restoration waste loads could affect the comparison of waste management alternatives. There are no HLW loads anticipated from environmental restoration activities. Even though treatment of HLW is not analyzed in this PEIS, the removal of HLW from the tanks at the Hanford Site is considered to be a waste management activity and not a result of environmental restoration activities. DOE anticipates that volumes of HW generated during environmental restoration activities would be treated offsite at commercial facilities. Environmental-restoration HW will not be transferred to waste management facilities.

Physical Structure. While this PEIS covers five waste types, those wastes are not homogenous and are derived from thousands of different waste streams. Thus, the waste streams were combined into treatability groups for purposes of developing treatment system designs. Each treatability group is identified with one of the five waste types considered in the WM PEIS and a treatment method, where appropriate, that EPA recognizes as meeting the requirements of RCRA. For the WM PEIS analyses, the physical structure of the waste was used for the initial sort for treatability. At the most basic level of analysis, all waste can be grouped into six physical categories using common engineering criteria design parameters, which also served as the initial set of treatability categories:

- **Aqueous liquids**—Primarily water with organic content less than 1% (such as process wastewater)
- **Organic liquids**—Liquids and slurries with organic content greater than 1% (such as solvents)
- **Organic and inorganic sludge and particulates**—Solid and semisolid material other than debris (such as sludge from treatment plants, resins, and solids less than 2.5-inch diameter particle size)
- **Soils**—Contaminated soils
- **Debris**—Solid material exceeding 2.5-inch diameter particle size that is either (1) manufactured, or (2) plant or animal matter, or (3) discarded natural or geological material (such as cobblestones)
- **Other**—Special waste streams (such as batteries, laboratory packs, reactive metals, and toxic metals, which include mercury, lead, and beryllium)

Four waste types use this basic framework analysis: LLMW, LLW, TRUW, and HW. For purposes of the WM PEIS analysis, HLW, also in the above treatability categories, is assumed to have been treated (vitrified). The HLW analysis only addresses the environmental consequences of storing and transporting vitrified HLW canisters. The environmental impacts of HLW treatment are addressed in other DOE NEPA

documents identified in Section 9.1 and are included in the cumulative impacts addressed in this PEIS in Chapter 11.

Radiological and Chemical Composition. The DOE used standard radiological profiles for each site and made assumptions about the concentration of each waste type in each treatability group based on available data on the origins of the waste. Hazardous constituents were apportioned to the treatability groups on the basis of the most prevalent hazardous chemicals using average compositions for all DOE sites. The assumptions for both radioactive and hazardous elements are waste-type specific and are summarized in more detail in the waste-type chapters. Details of the radiological and chemical compositions assumed for each waste-type are found in the respective technical report published for that waste type. See the reference lists for titles.

The standard profiles supported the evaluation of risks from waste disposal to the hypothetical farm family and impacts to groundwater quality for the most prevalent radionuclides and hazardous constituents in DOE wastes. Impacts were not evaluated for many radionuclides and hazardous constituents not present in significant quantities, because the databases on which the WM PEIS is based, in most cases, do not contain sufficient information on the presence of these constituents. Adverse impacts could occur from some of these small quantity constituents. In addition, one radionuclide that is contained in the standard profile used when the actual characterization of the waste is not known, carbon-14, was not included in the evaluation of impacts from disposal of LLW or LLMW. Carbon-14 would be expected to move relatively quickly through the groundwater, and has a moderately long half-life (approximately 5,730 years). Therefore, health risk and groundwater quality could be adversely affected if significant quantities of this radionuclide were present in the waste. However, including this radionuclide without specific knowledge of its existence or concentration at a site would have biased the analysis results without scientific foundation for the assumption of its presence. Adverse impacts from the presence of specific radionuclides or hazardous constituents could be mitigated by additional treatment and/or instituting waste acceptance criteria at the disposal facility. The impacts of these trace quantity constituents could be considered in more detail in sitewide or project-specific NEPA documents, if necessary.

5.2.2 WASTE MANAGEMENT TECHNOLOGIES

Various waste management technologies are used to sort and handle waste, reduce waste volume, destroy organic chemicals in waste, remove toxic metals from waste, treat hazardous characteristics to render them nonhazardous, recover and recycle materials, and stabilize and package waste for disposal. The facilities that use these technologies must be designed to accommodate the various physical and chemical forms and the radioactive and chemical characteristics discussed in previous sections. Existing, generic technologies necessary to meet the treatment, storage, and disposal requirements for each waste type were identified and sized to meet anticipated waste volume needs. Existing, rather than advanced, technologies were used because the applicability of advanced technologies is more problematic, because estimates of environmental impacts would more likely be conservative (tending to be the highest likely to occur) with the use of existing technologies, and because the type of technology would be unlikely to determine the preferred alternative. However, advanced technologies could be considered in project-specific NEPA reviews expected to tier from this programmatic review.

For analytical purposes, and to facilitate utilization in any system at any site, the waste management technologies were grouped into **common functions** (front-end support such as administrative and laboratory services; receiving, inspecting, dumping, and sorting the waste; maintenance of facilities; certification and shipping of the waste), **pretreatment** (shredding and compaction), **primary treatment** (thermal destruction, special processing, neutralization, deactivation, aqueous waste treatment, lead recovery, mercury separation and recovery), **secondary treatment and stabilization** (polymer stabilization, grout stabilization, packaging, and vitrification of secondary processing residues), **storage** (administration, receiving and inspection, contact-handled storage, and remote-handled silo storage), and **disposal** (administration, receiving and inspection, shallow land disposal, engineered vault disposal, silo disposal, and borehole disposal).

5.2.3 WASTE MANAGEMENT FACILITIES

Treatment, transportation, storage, and disposal "modules" were developed to represent every component required for waste management. Each module was assumed to contain several types of equipment, each able to perform a step needed in the waste management process.

Individual modules were linked together for each treatability group and were adjusted for the chemical and physical type of waste. This method was used so that impacts could be compared among sites, with each site assumed to be using the identical array of linked modules. Any variation in impacts would then result from site-specific environmental differences. This approach also allowed an examination of the changes in impacts resulting from changes in the linked modules.

Typically the type of facility considered was a building structure, i.e., a "fixed" facility at a given site. The analysis also considered the possible use of mobile treatment facilities that could be moved from site to site for treatment of the very small amounts of waste that exist at a number of the sites considered.

The generic design of the waste management facility, consisting of these treatment, storage, transportation, and disposal modules, enabled the calculation of land utilization, worker-years, resource consumption (i.e., water and electricity), pollutant discharges, and costs for the treatment, storage, transportation, and disposal of each waste type. The engineering features of the generic facility and the waste loads "processed" through the generic facility formed the basis for the risk and environmental impacts analysis.

For purposes of analysis, the following assumptions were made regarding the construction and operation of the waste management facilities:

- The facilities were assumed to be built over a 10-year period and operated over a 10-year period to process wastes generated over the 20-year construction and operation period. It was assumed that existing waste management facilities did not operate (i.e., did not process waste) during the 10-year construction period for new facilities. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for HLW storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. The WM PEIS analysis is highly conceptual, and DOE recognizes that construction of actual facilities could occur within a much shorter time period and that waste will begin to be processed at some facilities before construction at all facilities is completed. Nevertheless, DOE believes that the WM PEIS provides a reasonable and conservative estimate of environmental impacts sufficient to support programmatic decision making.
- For new facilities, the costs of decontamination and demolition were included; for disposal facilities, the costs of custodial care after closure through a 300-year period of institutional control were included, but were not substantial.
- The facilities were assumed to operate 240 days per year with three 8-hour shifts.

Although the WM PEIS analyzes the environmental impacts from the operation of the WM facilities for only 10 years, it is possible that the facilities could operate for up to 30 years. During this additional 20-year operating period, additional WM wastes or ER wastes could be processed. DOE believes that most of the impacts of operating the WM facilities for an additional 20 years would be similar, on an annual basis, to the impacts of operating these facilities for the 10 years analyzed in the WM PEIS. DOE believes this for the following reasons:

- The 10-year period of operations analyzed in the WM PEIS includes processing any wastes in storage, wastes accumulated during 10 years of construction, and wastes generated during the 10 years of operations. Therefore, the annual feed rate into the WM facilities would be expected to be higher or comparable to the feed rate during the latter 20 years of operations.
- Many of the impacts analyzed in the WM PEIS were analyzed on a daily or annual basis. For example, infrastructure impacts were analyzed for resource use in gallons of water per day, gallons of wastewater per day, and megawatts of power per year. Resource use during operation of the facilities for an additional 20 years is unlikely to exceed these annual rates of resources use and therefore is unlikely to exceed the environmental impacts predicted in the WM PEIS.
- Some impacts in the WM PEIS, such as human health risk to the offsite population, were analyzed for the entire 10-year operations period. DOE expects that the impacts during the additional 20 years of operations would be no more that twice the impacts predicted in the WM PEIS. For example, if the WM PEIS predicted a population health risk of 1 in 1 million (see Chapters 6 through 11 for actual health risk estimates), the additional health risk of operating the facilities for 20 more years would be no more than 2 in 1 million, with total health risk for 30 years of operations of 3 in 1 million.

This analysis assumes that the characteristics of the waste processed during the additional 20-year operating period are similar to the characteristics of the wastes analyzed in the WM PEIS. If the characteristics of the wastes processed during the latter 20 years of operations are found in the future to be appreciably different from the characteristics of the waste analyzed in the WM PEIS, additional environmental documentation could be prepared to support continued operations.

5.3 Phase II: Output

5.3.1 DISCHARGES

As noted above, using a generic design of a waste management facility (including treatment, storage, transportation, and disposal modules) and hypothetically processing wastes through that generic design, DOE derived estimates of pollutant discharges. DOE assumed the existence of discharges as a result not only of the radiological and chemical components of the waste, but also from the burning of fuel to operate the waste management facility.

5.3.2 RESOURCES REQUIRED OR CONSUMED

The resources required to process wastes (e.g., workers, land, water, electrical power, and raw materials) were based on estimates for the materials, labor, and other resources needed to build, operate, and maintain the waste management facilities. The resources were identified and added in the estimating process, and became input to the impacts analyses. Resource estimates were developed for the construction and operations and maintenance phases. The industrial engineering analysis established the number of workers for each type and size of facility module.

5.3.3 COSTS

The costs evaluated were life-cycle costs of facilities plus transportation costs between sites. Facility costs include the costs of: planning, design, construction, operations and maintenance (O&M), and decontamination. The total costs of each alternative include the sum of the treatment, storage, disposal, and transportation costs, and, in some instances, any special costs where specialized treatment (other than treatment specified in generic design modules) is now being performed and will continue to be performed in the same manner in the future. Each alternative includes a definition of the assumed technologies for the complete treatment process. For each site and each alternative, wastes were hypothetically routed through the waste management process, and the modules were individually sized to handle the processing requirements. Since many sites have some existing treatment, storage, and disposal capabilities, the analysis

accounts for existing facilities to minimize additional construction requirements. Only the O&M and decontamination costs were estimated for those existing facilities (INEL, 1996).

The transportation methodology tables (for LLMW, LLW, TRUW, and HW) include summaries of fixed and variable costs for each intersite transportation route segment and were computed for road and rail options. Each fixed cost component equals the number of trips multiplied by a fixed cost waste-type trip price. Each variable cost component equals total mileage transported by route segment, multiplied by a waste-type cost-per-mile price. The number of trips reflects the amount of waste divided by the capacity of individual trucks or railcars. Weight and volume restrictions were considered, and the mileage for each trip was derived from current DOE guidelines. Trip prices and cost-per-mile prices were established by reviewing transportation industry tariffs and practices (INEL, 1995b). Transportation costs for HLW were computed using regression formulas developed by ANL from industry practices (ANL, 1996a).

Costs are presented in constant dollars, reflecting the total life-cycle costs by waste-type alternative. Costs were estimated using an approach that tied the cost of facilities and transportation to waste quantities. In addition, DOE used costs associated with existing technologies and historical industrial cost experience for estimating purposes.

The program life-cycle cost estimates for the various WM PEIS alternatives include the following major cost elements:

- **Preoperations costs**—technology site adaptation, including bench tests and demonstrations; statutory and regulatory permitting; plant startup costs; and related generic design, project management, and contingencies
- **Facility construction costs**—building, equipment, and related design; construction management, project management, and contingencies
- **Operations and maintenance costs**—annual operations, maintenance, utilities, contractor supervision and overhead, and related project management and contingencies
- **Decontamination and decommissioning costs**—demolition of facilities, environmental closure, postclosure, and monitoring activities
- **Transportation costs**—intersite road and rail transportation carrier costs for the transportation network established by Department of Transportation computer models (INEL, 1995b)

The cost elements also include the following subelements: direct labor, equipment, and materials; indirect technical labor and facilities; overhead and profit; government administration and management; and reserve/contingencies. The cost elements do not include site infrastructure costs, operations office oversight costs, or DOE program and policy-related costs.

The waste management process modules costs were developed for a range of facility waste processing capacity. The cost estimates for each module size (small, medium, large) were then used as data points linking waste load throughput to cost. For very small waste loads, mobile units or skid-mounted units were used. These units use existing structures and utility connections (INEL, 1995a, c-e).

Preoperations costs were estimated by including factored costs for generic design, safety assurance studies, project management and contingencies; extracting costs for bench tests, demonstrations, and permitting requirements from management analysis studies; and including the operations and maintenance costs for 1 year to allow for test production runs and operational certification; the preoperational monitoring requirements (DOE Order 5400.1, Chapter IV, Section 3) were also included.

Construction costs were estimated for each module, sized for large, medium, and small operations. This procedure involved laying out the waste management process line and contacting industrial suppliers about prices for the equipment used; determining the size and nature of the building required to house the process line; computing building costs using standard construction estimating procedures; and factoring in all other elements that constitute the remainder of the construction cost element (INEL, 1995a,c-e).

Operations and maintenance costs were estimated by extracting annual costs for operations labor, material, and utilities from management analysis studies; by considering maintenance labor and material costs from equipment purchase and site costs; and by including costs for contractor supervision and overhead, project management, and contingencies.

Decontamination costs were estimated by multiplying the area of the facility by a unit cost based on square footage established through cost studies, addressing different waste-type facilities separately (INEL, 1995a,c-e).

The cost analysis provides data that should fall within $\pm 30\%$ of actual costs using the waste loads quantified in the alternatives. This range reflects the experience of the cost estimators using similar procedures (based

on standard design costing procedures) for other generic design industrial processes and DOE projects. Changes in the characterization and quantity of the waste loads would significantly affect costs. Indirect costs and overhead burden rates used in the cost estimating methodology were based on those historically encountered at DOE's Idaho National Engineering Laboratory (INEL). They fall approximately in the middle of the range of cost factors found at several other DOE sites and were therefore considered to be representative for complexwide estimating purposes.

Facility costs were established on the basis of the costs of DOE facilities (primarily at INEL) and commercial facilities. To the extent possible, equipment costs for each facility module were compared with data from existing facilities to establish a cost confidence level with the boundaries established for programmatic life-cycle cost estimates. Both DOE and the commercial nuclear industry are now planning or operating similar facilities. These facilities were surveyed to obtain capacity and cost data, and other information needed to support the cost methodology data. Before using these costs, the data were adjusted to account for capacity differences and escalation.

Additional assessment activities included a review of existing DOE facility capital and operating costs for comparison with the cost methodology data. Existing DOE facilities that have been evaluated include the Waste Experimental Reduction Facility (incineration, shredding, and compaction) at INEL; the Controlled Air Incinerator at Los Alamos National Laboratory; the Toxic Substances Control Act (TSCA) Incinerator at the Oak Ridge Reservation; the Supercompactor and Repackaging Facility at Rocky Flats; the Radioactive Waste Management Complex (LLW disposal) at INEL; and the Transportable Waste Water Treatment Unit from the Uranium Mill Tailings Remedial Action Project. Planned DOE facility costs at INEL were also evaluated for the Radioactive Waste Storage Facility, the Waste Characterization Facility, the Idaho Waste Processing Facility, and the Mixed Low-Level Waste Treatment Facility.

Other facilities evaluated include the Illinois Compact Low-Level Engineered Disposal Facility and the Commonwealth of Massachusetts Low-Level Radioactive Waste Disposal Facility.

Cost estimates for facility components were adapted from commercial sources (INEL, 1995b-d, 1996). Commercial facilities evaluated include conceptual designs and cost estimates for the following: air- and area-monitoring units from Eberline Corporation of Santa Fe, NM; amalgam mixers from Miracle Paint Rejuvenator of St. Paul, MN; blending equipment from Velmac Associates, Inc., of Novato, CA; calciner/kiln units from ABB Raymond, Inc., of Lisle, IL; chemical oxidation units from Peroxidation

System, Inc., of Tucson, AZ; compactor units from Stock Equipment Company of Chagrin Falls, OH; concentrator units from LCI Corporation of Charlotte, NC; drum capping and washing units from Stock Equipment Company of Chagrin Falls, OH; dry offgas filters from Pall Advances Separation Systems of Cortland, NY; dry and wet offgas treatment trains from NGK-Locke, Inc., and Callidus Technologies; drying equipment from Wyssmont, Co., Inc., of Fort Lee, NJ; extruder equipment from Sterling Extruders, Davis-Standard Division of Edison, NJ; gross-organic removal units from McTighe Industries, Inc., of Mitchell, SD; incineration packages from Joy Energy Systems of Charlotte, NC, and ABB Raymond, Inc., of Lisle, IL; quencher and scrubber (wet scrubbing) units from Croll-Reynold Company of Westfield, NJ; melter units from Ajax Corporation and Retec Corporation; preparation and feed units from various vendor quotes; processing equipment from the U.S. Navy LLW processing facility of Lynchburg, VA; open dump, and sort devices, and robotic arms in consultation with personnel from DOE contractors involved with the Office of Technology Development, Robotic Technology Development Program; organic stripper units from APV Crepaco, Inc., of Tonwanda, NY; radiological and hazardous material measurement systems from conceptual designs and cost estimates provided by Lockheed Martin; segmented gamma scanning (SGS) assay systems data from Atlan-Tech Corporation, Inc., of Roswell, GA; shredder units from Komor Industries, Inc., of Groveport, OH; feeder/shredder units from System Service Solutions of Wilsonville, OH; retort units from Denver Mineral Engineers, Inc., of Littleton, CO; size reduction and baler systems from Stock Equipment Company of Chagrin Falls, OH; selected solidification units from Stock Equipment Company; solidification module assemblies from Stock Equipment Company; stack monitoring units from Eberline Corporation of Santa Fe, NM; suspended-solids filtration systems (Membralox) from U.S. Filter Corporation of Warrendale, PA; thin film evaporator units from LCI Corporation of Charlotte, NC; washing equipment from CF Systems (a subsidiary of Morrisen-Knudson); wet oxidation units from Zimpro of Rothchild, WI; and the commercial treatment and disposal processes for hazardous wastes from various vendors (INEL, 1995a-d).

5.4 Phase III: Environmental Impact Evaluation

The environmental impact assessment methodologies and assumptions described in this section address the range of natural and human resource issues pertinent to the range of alternatives under consideration in this PEIS. The following sections provide the scientific approach and analytical methods used to evaluate potential environmental consequences (including health risks), as presented in the subsequent waste-type Chapters 6 through 10.

The generic design and estimated waste loads provided the output data for the impact assessments. The estimated discharges of pollutants to air and water as a result of the treatment, transportation, storage, and disposal of the five waste types were used to calculate human health risks. Combustion by-products discharged to the air from waste treatment facilities were not considered in the health risk assessments conducted for most waste types because the potential impacts from exposure to these contaminants are expected to be minor compared with impacts from releases of radionuclides and hazardous chemicals occurring in the wastes. However, emissions of dioxin and furan from hazardous waste treatment facilities were considered in the health risk analysis conducted for LLMW and HW. The results of the health risk analysis are presented in Sections 6.4 and 10.4 of this volume. The health risk analysis also included evaluation of the potential impacts of waste transportation. Impacts from transportation included estimation of excess latent cancer fatalities resulting from exposure to diesel exhaust (see Appendix E for additional details).

The air quality analysis for O&M considered emissions of criteria pollutants from incineration and from combustion to provide heat for buildings. Emissions of these pollutants were compared with applicable air quality standards to determine compliance. The standards are set, in part, through consideration of adverse health effects. Therefore, health effects of combustion by-products were also indirectly considered in the air quality analysis in the WM PEIS.

Risks to the public and workers from facility treatment, storage, and disposal operations, for both routine and accident conditions, used information on waste characteristics and worker-years. Wastes transported to other sites for treatment or disposal were evaluated for the radiological, chemical, and physical risks they pose to the public and to workers for both routine and accident conditions (for rail and truck transport).

For comparison purposes, environmental concentrations of pollutants are presented in this PEIS with the appropriate regulatory standards or guidelines. For all resource areas, an effort was made in this PEIS to use data that were as current as possible.

All exposures to chemical and radiological discharges were estimated using computer models that simulate the fate and transport of contaminants in the environment.

Use of Percentages in Analysis and Presentation of Environmental Impacts. In summary, DOE used a three-step process to evaluate environmental impacts: (1) preparing comprehensive estimates of all

impacts, (2) screening these impacts and focusing the analysis on those with a greater potential to be significant, and (3) preparing a summary listing and description of potentially significant impacts.

First, DOE estimated environmental impacts at major DOE sites for each alternative and each waste type. The site data tables in Volume II of the WM PEIS list the results of this comprehensive analysis without any screening for significance. Because of the volume of data and because NEPA requires agencies to focus on significant impacts, DOE made the tables a separate part of the document and did not insert them in Volume I. DOE screened the table values and further evaluated those with a potential for significance in the PEIS text (Chapters 6 through 10).

Use of Percentages where Regulatory Standards Exist. In assessing impacts on resources for which regulatory standards or guidelines exist, DOE evaluated the significance of waste management facility pollutant emissions and effluents by comparing facility emission and effluent estimates or resultant concentrations to relevant Federal and state regulatory limits. DOE based its evaluation of the significance of impacts on the environmental and socioeconomic resources that have no such comparable regulatory standards, on significance criteria defined in CEQ regulations of 40 CFR 1508.26 and on the experience and judgment of the WM PEIS interdisciplinary team members in their fields of expertise.

Air Quality Impacts. The air quality impacts presentation focused on sites and alternatives where air quality standards could be exceeded (that is, where air quality impacts could be significant). Thus, all cases where emissions are 100% of a standard or greater are presented in the waste type chapters. In addition, DOE chose a 10%-of-standard threshold to highlight the sites where air pollutant emissions from proposed waste management activities do not exceed standards, but where they could substantially contribute to overall pollutant emissions from all sources in the area, which could result in cumulative air quality impacts.

Water Quality Impacts. For the groundwater quality impacts analyses for low-level mixed waste and low-level waste, estimates of pollutant concentrations in downgradient well water caused by disposal facility leachate were compared to relevant water quality comparison criteria. As was the case for air quality, all sites/alternatives where the comparison criteria are met or exceeded are presented in the waste type chapters because they represent a potential for significant impacts to persons consuming the groundwater. In addition, to account for some level of uncertainty in the modeling results for the disposal analysis, water pollutant concentrations that met or exceeded 25% of the comparison criteria are also presented in the waste

type chapters for discussion, even though they would be less likely to indicate instances where impacts would be significant.

Economic and Population Impacts. For economic and population impacts, DOE used a 1% significance screening level because regional economic or population changes of 1% or more in the communities around DOE sites are likely to be considered by those communities as substantial; that is, economic benefits are likely to be important and population growth could substantially affect social and medical services, housing, and educational systems. This is particularly true if the economic or population changes occur in localities within an affected region rather than uniformly across the region.

Ecological Resources and Land Use Impacts. For ecological resources and land use impacts, DOE used a screening level of 1%, principally to screen out sites under an alternative where DOE can reasonably conclude it is unlikely there would be significant impacts. DOE based this percentage on the fact that it has not yet proposed facility locations and detailed impact evaluation would require location-specific information and that, at sites where less than 1% of the available land would be required for waste management facility construction, DOE would have sufficient flexibility to locate the facility in a manner that would avoid significant impacts to critical habitats and site land use.

Infrastructure Impacts. The analysis of infrastructure impacts was somewhat more complex. For the impacts analysis of the onsite water, power, and wastewater treatment infrastructure, DOE discusses requirements that exceed 5% of current capacities in Chapters 6 through 10. DOE believes that, in general, infrastructure requirements below 5% could be accommodated by existing infrastructure because estimates of capacity would have some built-in margin for substantial peak loads. Corresponding capacities of onsite transportation infrastructure were not known, so DOE estimated increases in site employment as an index of the potential increased traffic load on existing site transportation infrastructure. DOE discussed site employment increases of 5% or more as instances in which transportation infrastructure impacts from those increased traffic loads could be significant. Similarly, offsite infrastructure impacts were keyed to regional population growth, with growth greater than 5% considered to have the potential to cause substantial stress to the regional transportation infrastructure.

For both the standards-based and nonstandards-based analyses, it must be emphasized that:

- All impacts were analyzed consistently; that is, the impact values were estimated for each major site using the same input data and computations for all alternatives.

- All impacts estimates are provided in the WM PEIS in the site data tables.
- Screening values were used to focus the waste-type chapter presentations on impacts with a greater potential to be significant, thereby minimizing discussion of those likely not to be significant.
- Screening values were not used and should not be interpreted as "absolute" benchmarks of the significance or nonsignificance of an impact, but only as indicators of the importance or extent of impacts resulting from particular alternatives.

Use of Percentages in Defining the Affected Environment. Other screening criteria were used to focus the impacts analysis on those components of the environment likely to experience significant impacts. For example, the region-of-influence (ROI) for socioeconomic impacts was defined as encompassing the DOE site host county and nearby counties which, in combination, were the residence counties of at least 90% of the site's current employees (DOE, 1993c). The rationale for use of this percentage is that it would identify those counties where most of the project expenditures would be made, particularly for locally available materials, such as concrete, where the major portion of the workers' salaries would most likely be spent, and where workers would be most likely to move, which in turn would affect housing, community service, and financial infrastructure.

5.4.1 Human Health Impacts

The human health risk analysis provides estimates of the adverse effects, or impacts, on human health that might occur as a result of implementation of the proposed waste management actions. Risks resulting from facility routine operations and accidents and waste transportation were estimated in the WM PEIS.

Risks to the public and workers from facility treatment, storage, and disposal operations, for both routine operation and accident conditions, were derived using information on waste loads (volumes and characteristics) and required worker-years. Wastes transported to other sites for treatment or disposal were evaluated for the radiological, chemical, and physical risks they pose to the public and crews for both incident-free and accident conditions (for both rail and truck transport).

The approach taken in the WM PEIS risk analysis was first to identify the groups potentially at risk and then to compare the risk that these groups (and individuals within them) may sustain if the different alternatives were implemented. Each phase of waste management activities—treatment, storage, and

disposal—included in an alternative was considered when identifying the persons at risk, the exposures that produce that risk, and the types of health impacts that the exposed groups might experience. As discussed in Appendix F (Section F.2.3.4), incineration was selected as the treatment technology most likely to dominate risk to site workers and to the surrounding populations, and accordingly was used as the reference technology for accident calculations.

The risk assessments conducted for the WM PEIS used assumptions and best-estimates when data were only generally known or where processes have not been demonstrated fully; therefore, uncertainties are present. Additional details about the methodologies and assumptions used to assess human health impacts can be found in Appendices D, E, and F.

5.4.1.1 Uncertainty in Risk Estimates

Human health risk assessment results are conditional estimates that are influenced to a large extent by the many assumptions that must be made in order to account for an insufficient understanding of biological processes or a lack of information on contaminant or receptor behavior. Therefore, in evaluating risk estimate results, it is important to recognize that uncertainties are involved in the analysis in order to place the risk estimates in proper perspective.

Risk estimates are composed of a number of parameters. To estimate risk, information must be available on dose/response relationships which define the biological response per unit of exposure to a contaminant. Although human epidemiological data are used for developing radiation dose-response models, dose-response data are also developed in laboratory tests using animals exposed to relatively high doses. Therefore, uncertainty in dose/response relationships includes extrapolating from effects in animals seen at high doses in order to estimate potential effects in humans that most often are exposed at lower doses.

Another important component of risk assessment is estimation of exposure concentrations. Uncertainties associated with this component of the analysis include estimating (generally through the use of mathematical models) releases of contaminants from emission sources to different environmental media, the transport and transformation of contaminants in these media, and the pathways, frequency and duration by which humans contact the contaminants. Modeling involves trying to simulate a process that is inherently complex using a fixed and relatively small number of variables. Model uncertainty may result from the general limitations of mathematical models as well as from the lack of information on model parameters. For example, the fate

and transport models used to estimate risks for the WM PEIS require large amounts of data, including meteorological measurements, hydrogeologic settings, and release parameters. Where possible, actual data are used, but generic data are often substituted where site-specific data are unavailable.

The assumptions made in performing this program-level evaluation were intended to yield reasonably conservative risk estimates (e.g., estimates that tend to overestimate rather than underestimate risk) using the best available data and state-of-the-art models. Many of the uncertainties associated with the WM PEIS risk estimates are "systemic," given the programmatic nature of the WM PEIS and the use of the unit approach to risk assessment. This means that many of the modeling and scenario assumptions (e.g., facility emission rates for particular types of waste treatment or storage, inhalation rates, etc.) were applied consistently or systematically throughout the analysis. Therefore, the *relative* differences in risk estimates among waste management alternatives should not be affected by errors associated with these systematic uncertainties.

The uncertainties associated with the WM PEIS risk estimates cannot easily be quantitatively evaluated because of the many different parameters involved in the models used in the analysis. However, risk estimate uncertainty can be qualitatively differentiated as follows. Certain risks, such as worker physical hazard injuries during construction, or transportation accident physical trauma injuries, are based on historical statistics or actuarial data (e.g., number of hours worked, or number of miles traveled). Therefore, these risks can be estimated with a relatively high degree of confidence.

On the other hand, risks associated with the release of radionuclides or chemicals to ambient environmental media during the routine operation of treatment or storage facilities are estimated using probabilistic models. The risk estimates produced by these models have a larger uncertainty than those based on actuarial data. However, it is reasonable to assume that such releases will occur on a routine basis over the operational lifetime of the facility; that is, the estimated annual frequency (or probability) of occurrence of these events is one.

A third group of risk estimates generally involve even more uncertainty than facility routine operation exposure risks. This group includes facility accident risks and the hypothetical farm family and intruder scenarios. These risk estimates also involve the use of probabilistic models. However, unlike releases from facilities during routine operations, facility accidents generally have estimated probabilities of occurrence that are much less than one. Therefore, in interpreting the potential risks from facility accidents, both the

estimated probability of occurrence as well as the estimated consequences should be considered. Certain low probability accidents (e.g., aircraft crashes) may have potentially large consequences (e.g., a large number of latent cancer fatalities), but they are not expected to occur very often (e.g., probability of less than one-in-one million on an annual basis). Other types of accidents (e.g., fires) may have a higher probability of occurrence (e.g., one-in-one hundred) but generally have smaller consequences.

The hypothetical farm family risk estimates include an additional degree of uncertainty, since they attempt to estimate risks far into the future (up to 10,000 years). Both the hypothetical farm family and intruder scenarios take place in the future and assume the loss of institutional control of disposal facilities allowing the establishment of a farming operation that uses groundwater near the disposal site and excavation directly into the disposal unit.

Finally, the maximally exposed individual (MEI) risk estimates generally involve a greater level of uncertainty than population risk estimates, given the required assumptions about continuous exposure at a specific location for a single individual.

Appendix D, Section D.4, presents an evaluation of some parameter uncertainties associated with the WM PEIS health risk estimates.

Similar to the facility risk discussed above, the determination of transportation risk is subject to numerous uncertainties. Whereas risks such as physical injuries and fatalities from transportation accidents are based on historical statistical data, radiological risks are predicted using complex mathematical models. These models attempt to describe transportation operations that take place over time and through a constantly changing landscape. Moreover, different models and assumptions are typically used to describe different shipment modes, such as truck and rail, and may result in different levels of uncertainty between modes. Additional details related to the uncertainties in transportation risk estimates, including considerations in comparing truck and rail shipment results, are provided in Appendix E.

5.4.1.2 Populations and Individuals at Risk

Several groups may be exposed to a variety of hazards during the treatment, storage, and disposal phases of waste management. In general, the WM PEIS considers:

- The offsite population—those living within a 50-mile radius of the site, as well as within 0.5 miles on each side of the transportation routes
- The onsite population—the workers on DOE sites who are not involved in actual environmental management activities (the "noninvolved" or "collocated" workers)
- The facility workers (or "waste management workers," including those operating the trucks and trains that transport the waste)

The WM PEIS health risk analysis evaluates impacts to members of the public living within a 50-mile radius of DOE sites, to waste management workers, and to onsite workers not directly involved in the proposed waste management actions. For each of these groups of receptors, the standard risk assessment assumption of 70 years is used for the length of an average lifetime.

For offsite population receptors, health risks are primarily from exposure to airborne contaminants released from waste treatment facilities. Both radionuclide and hazardous chemical contaminants are potentially released. Exposure to radionuclides and hazardous chemicals is assumed to occur over the 10-year period of facility operation. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for HLW storage facilities, which are discussed in Chapter 9. Exposure to radionuclides that are inhaled or ingested is expected to continue for up to 50 years, since these contaminants, once incorporated into the body, will irradiate tissues even after the 10-year operation period has ended. This 50-year exposure period (also known as a commitment period) is assumed for radionuclide releases from both treatment facilities and from trucks or railcars following transportation accidents.

Waste management workers are also subject to physical hazard injuries and fatalities resulting from industrial accidents occurring during the assumed 10-year facility construction period and 10-year facility operation period.

Population risks are expressed as numbers of cancer incidences, cancer fatalities, or genetic effects. Individual risk was assessed by considering the hypothetical MEI within each onsite and offsite population. These persons would receive the highest total dose—estimated by summing the highest doses delivered

along all pathways over the person's lifetime. Risks for individuals are expressed in probabilities that a particular adverse effect will occur (ORNL, 1995a,b). DOE has not specifically evaluated the human health risk to subpopulations that may derive a substantial portion of their food supply from native plants and animals that live near DOE sites. This is a complex analysis that cannot be performed with confidence until locations of the facilities on the sites are known, the routes of exposure explicitly defined, and the dietary habits of the populations quantified.

5.4.1.2.1 *Intruder Scenario*

To consider the maximum potential human exposure from the disposal of waste, the WM PEIS examines scenarios of a hypothetical intruder and a hypothetical farm family.

An intruder scenario was evaluated in order to estimate the potential health risks to an individual from the disposal of LLW and LLMW in a future era when disposal facilities are no longer under institutional control. A hypothetical intrusion scenario with two different time frames (100 and 300 years after closure of the disposal facility) was developed. The scenario assumes that a single adult drills a well directly through the disposal facility to the water table. As a result of the drilling, contaminated soil from within the facility is brought to the surface, where it mixes with the top layers of the surface soil. The individual raises crops on this plot of land and consumes the resulting produce.

Exposure of the intruder to radionuclide and chemical contaminants was assumed to result from the ingestion of plants, inhalation of resuspended soil particulates, and inadvertent ingestion of soil. In addition, the intruder was assumed to be exposed to direct radiation from the soil. Health effect endpoints evaluated as a result of radionuclide and direct radiation exposure included probability of cancer fatality, cancer incidence, and genetic effects. For chemical exposure, the endpoints used were probability of cancer incidence and noncancer risks.

5.4.1.2.2 *Hypothetical Farm Family*

The hypothetical farm family is assumed to establish a water supply well 300 meters downgradient from the center of an underground disposal facility. This distance is roughly equivalent to the 100-meter distance

from the edge of the disposal unit used in the performance assessment analyses required under DOE Order 5820.2A. Concentrations of groundwater contaminants at this location are assumed to be higher than those that could be expected at greater distances from the unit due to dispersion of contaminants. Construction of multiple units is expected to be required at certain sites, particularly under the Regionalized and Centralized Alternatives in order to process the projected waste volumes. Since the analysis looks only at a single receptor located 300 meters from the center of each unit, DOE assumes that each of these close-in receptors will be affected primarily by the contaminant plume from the disposal unit closest to them. DOE recognizes that commingling of contaminant plumes from multiple disposal units may occur as distance from the units increases, but anticipates that, at 300 meters, the highest concentration of contaminants is likely to result from the single closest plume. At greater distances from the disposal units, where overlap of the plumes is more likely, the concentrations in any given plume should be lower than those estimated at the 300 meters well as a result of dispersion and dilution. The WM PEIS did not address groundwater contaminant concentrations at distances greater than 300 meters from disposal units. More detailed analyses, such as the performance assessments required under DOE Order 5820.2A, will address the issues of existing groundwater contamination and multiple disposal units. For example, in April 1996 DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help ensure that continuing disposal of low-level waste will not compromise the future radiological protection of the public. The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned LLW disposal facility and other sources of radioactive material in the ground that might interact with the LLW disposal facility.

The hypothetical farm family scenario assumes that a series of families lives downgradient of the disposal unit for a period of 10,000 years. Each family's lifetime is assumed to be of 70 years' duration; therefore, 143 lifetimes were evaluated. The exposure to this hypothetical farm family was assumed to occur at a time when there has been a breach of the disposal facility and when institutional controls (fences, warning signs, land records, etc.) no longer exist. The family engages in farming activities, such as growing and consuming their own crops and livestock, and uses nearby water for drinking, bathing, and recreation as well as for watering their crops and livestock. This hypothetical farm family is assumed to be located so that they received the highest possible exposure to contaminants in groundwater by all possible routes. The 10,000-year period was selected for the analysis to maintain consistency with the "Guidelines for Radiological Performance Assessment of DOE Low-Level Radioactive Waste Disposal Sites" that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been

changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A.

The hypothetical farm family scenario attempts to estimate potential risk resulting from the future contamination of groundwater following disposal of LLW and LLMW. Humans are assumed to be exposed through use of the groundwater as a source of drinking water and irrigation water. Several aspects of the scenario should be noted. The analysis addresses only new disposal units and does not account for existing disposal inventory or existing groundwater contamination at a site. Also, this analysis does not attempt to suggest that farming is a reasonable or preferred future use of the land at DOE sites upon the loss of institutional control. Farming was selected only in order to maximize the potential exposure and risk from contaminated groundwater through its use both as drinking water and in crop irrigation at arid sites.

5.4.1.2.3 *Collective Offsite Population*

The population risk vulnerability analysis was developed to compare LLMW and LLW disposal alternatives using measures that characterize their relative potential to cause disposal risks to offsite populations.

Rationale for Not Quantifying Offsite Population Risks From Disposal. The hypothetical farm family scenario does not attempt to quantitatively estimate the potential risks to current offsite populations living near DOE sites (collective risks) from the disposal of LLMW and LLW. Certain considerations led DOE to conclude that an alternative to collective risk estimation was needed for the WM PEIS comparison of disposal alternatives. First, other DOE efforts to address disposal risk do not generally estimate population risk. DOE has been addressing the issue of protecting the public from the effects of exposures to radioactive and mixed waste constituents released from disposal facilities. Ongoing Department efforts include performance assessments conducted for LLW disposal facilities in compliance with the requirements of DOE Order 5820.2A and performance evaluations conducted for candidate LLMW disposal sites by the FFCAct Disposal Workgroup. Although these efforts currently address risks to single individuals at specified compliance points, none attempts to predict collective risks to current or future populations.

Second, DOE determined that estimation of offsite population risk from exposure to disposal facility contaminants in the WM PEIS would require too many speculative assumptions and would not provide a credible basis for comparison of LLMW or LLW disposal alternatives. The concentrations of contaminants

in the groundwater and the number of people potentially exposed will be determined in large part by the locations of the disposal units and the receptor wells. Estimation of the number of adverse health effects in current offsite populations would require information about the exact locations of the disposal facilities on sites. Since the WM PEIS does not attempt to make such siting decisions, offsite population doses (i.e., person-rem) and risks (e.g., number of latent cancer fatalities) from disposal were not estimated. Analysis of future offsite population risks requires similar siting information and involves additional uncertainty with respect to the sizes of future populations. Therefore, the WM PEIS could not credibly estimate adverse health impacts from disposal for future offsite populations.

Given this uncertainty about quantifying potential collective risks to offsite populations from waste disposal, DOE determined that some relative indicator of the potential for offsite risks would be an appropriate approach. Therefore, DOE has supplemented the quantitative estimates of farm family MEI risk presented in Sections 6.4 and 7.4 of Chapters 6 and 7 with statistical analyses of site environmental data. These analyses evaluate site parameters that influence groundwater contamination or that are expected to be associated with the sizes of the populations potentially at risk. The results of the analyses are indicative of the relative potential for offsite population risk from disposal. This procedure is a screening- level analysis that does not take into account any measures that would limit migration of disposed wastes into the groundwater, such as engineered disposal units or changes in waste acceptance criteria. The objective of the analysis is not to rule out any sites for disposal—a number of sites are currently disposing LLW—but to indicate where disposal mitigation measures are more likely to be necessary and where the costs of disposal would likely increase as a result of such measures.

Population Risk Vulnerability Analysis Approach. In the population risk vulnerability analysis, DOE selected environmental variables expected to determine or be associated with the level of offsite population risk, performed statistical factor and cluster analyses to determine how to group the sites in terms of vulnerability, then tabulated the individual site and overall alternative vulnerability classification of the LLMW and LLW disposal alternatives.

Selection of Important Explanatory Variables. The variables chosen to be used in the factor and cluster analyses of the 16 candidate disposal sites were six site characteristics that would likely cause or be associated with future levels of offsite population risk from radioactive or mixed waste disposal—annual rainfall, annual groundwater recharge, aquifer depth, travel time of water from the time it infiltrates the ground surface to the time it reaches the aquifer and appears in a downgradient well, current human

populations within 50 miles of the site, and site acreage (see Table 5.4–1). The first three variables, which characterize the surface and groundwater hydrology of the sites, are measures known to influence the speed, duration, and extent of dispersal of contaminants from disposal facilities, and the level of resulting downgradient concentrations in groundwater. The travel time estimates are based on the physical properties of the soils, the aquifer depth, and the groundwater velocity at each site. Current population levels are considered the most appropriate measure of the potential size of the population at risk, at least on a relative basis from site to site. It should be noted that the parameter "current population level within 50 miles" serves only as a general index of potential populations at risk from contaminated groundwater, not as a specific estimate of future populations at risk. The 50-mile radius populations may include large, relatively distant population centers (such as Buffalo in the case of WVDP) that would not likely draw groundwater from downgradient wells or, on the other hand, may exclude large population centers just outside the 50-mile radius (such as Las Vegas in the case of NTS) that may use downgradient wells in the future. Site acreage provides an indirect measure of two associated characteristics—the size of the potential populations at risk and the likelihood that contaminants in downgradient groundwater would appear in a publicly accessible wellwater source, the former because the larger sites exclude population growth on extensive areas, the latter because of the relationship between the proximity of offsite population centers to locations on the sites where disposal facilities likely would be constructed.

These site characteristics are generally strongly correlated with each other—for example, the smaller sites tend to be situated in regions of denser population with higher rainfall. Therefore, DOE transformed the 96 data points comprising the six variable measures on the 16 sites mathematically, using a statistical technique called factor analysis, into principal factor variables that are composite measures of the important variations in these site characteristics. Factor analysis reconstitutes the data into a smaller derivative set of "explanatory variables" as linear combinations of the original variable set (Norusis/SPSS Inc., 1993). Appendix C, Section C.4.1 provides the details of the factor analysis methodology. In this analysis, 80% of information in the data set is represented after the factor transformations by two principal factors. The first factor, which accounts for approximately 64% of the variability in the site environmental data, is primarily a positive measure of the site rainfall and recharge characteristics and a negative measure of groundwater travel time. The second factor, accounting for an additional 15% of the data variability, is primarily a measure of the sites' size and population characteristics. The sites are arrayed according to their scores on the first two principal factors of the site environmental data in Figure 5.4–1. Sites to the right in the diagram have higher scores on the first factor, indicating they have groundwater hydrologic conditions

Table 5.4–1 Environmental and Population Data Used to Categorize Disposal Sites in Terms of Population Risk Vulnerability

Site	Population Within 50 Miles	Acreage	Annual Rainfall (cm)	Aquifer Depth (ft)	Annual Aquifer Recharge (ft/yr)	Time of Travel (yr)
ANL-E	7,939,785	1,025	80	90	0.33	246
BNL	5,738,554	5,263	107	200	0.50	59
FEMP	2,764,589	1,050	104	59	0.50	18
Hanford	377,645	370,656	16	236	0.16	191
INEL	153,061	572,160	23	600	0.23	298
LLNL	6,324,234	6,900	36	98	0.08	70
LANL	159,152	28,000	47	749	0.05	411
NTS	14,266	864,000	19	787	<0.001	1,352
ORR	895,379	34,560	139	26	0.60	11
PGDP	500,502	3,425	120	49	0.43	17
Pantex	265,185	16,000	51	320	0.02	175
PORTS	639,062	4,032	101	24	0.39	24
RFETS	2,171,877	6,550	38	18	0.16	25
SNL	610,714	2,791	20	94	0.06	132
SRS	620,618	192,700	122	110	1.30	23
WVDP	1,698,391	220	104	10	0.23	226

that would tend to move contaminants more quickly downgradient from disposal units and possibly to drinking-water wells that might be used by the public. Sites to the left in the diagram are those where site characteristics would tend to limit migration of contaminants and increase the time over which any movement might result in wellwater contamination. In terms of scores on the second factor, sites plotted in the upper portion of the diagram are those that are smaller in size with higher surrounding populations. Those plotted lower are the larger sites with lower surrounding populations. Land uses on and near the sites, the site size itself, and the size of the surrounding populations are more likely to change substantially during the time contaminants may be leaching from disposal units than the physical characteristics of the site. Therefore, DOE considers the first factor scores more important than the second factor scores in characterizing the sites' relative potentials for offsite population risk.

Derivation of Population Risk Potential Groups. The factor analysis gives a general indication of the relative population risk vulnerability of the 16 proposed disposal sites. The factor scores of the 16 sites show relationships among the sites in hydrologic and population characteristics that would be reasonable

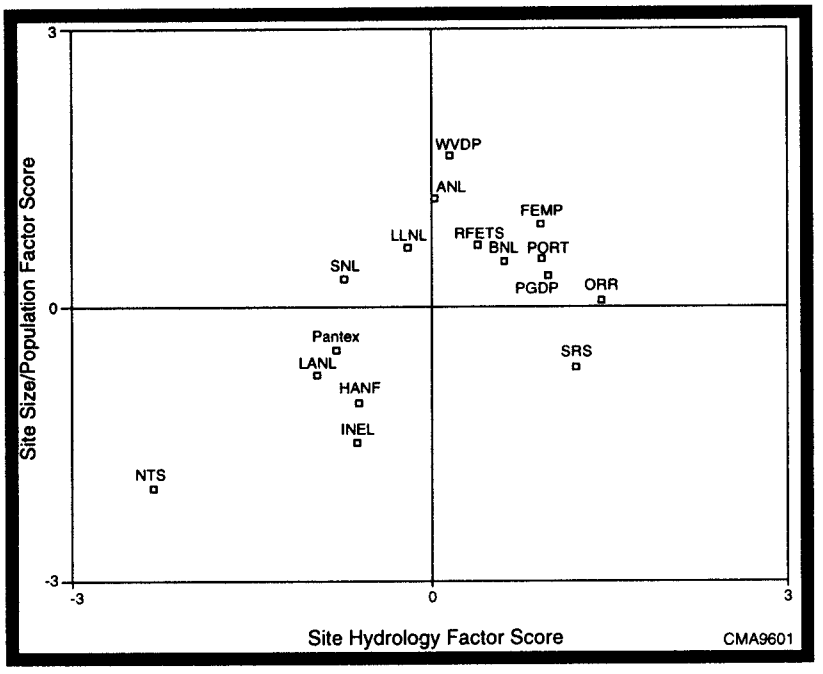

Figure 5.4–1. Sites Arrayed According to Their Scores on the First Two Principal Factors of Environmental Data

to conclude would be directly related to the levels of population doses and risk. DOE proceeded further to identify distinct groups of sites representing similar levels of potential for population risk from waste disposal using a cluster analysis of the same six site characteristics.

In the cluster analysis, DOE used the site environmental data on the six variables to calculate measures of overall difference among the 16 sites. These difference measures were used to combine sites into clusters. The difference measures are greater between clusters than they are for sites within a cluster. By labeling the factor plots with the cluster membership of each site, distinct risk vulnerability groupings were identified. Details of the cluster analysis for the 16 proposed disposal sites are presented in Appendix C.

The cluster analysis was used to identify three general site groups according to their expected relative population risk vulnerability (PRV). The group number of each site is plotted against the two principal factors of the site data in Figure 5.4–2. The groups are listed with the basis of their relative population risk vulnerability ratings in Table 5.4–2.

Population risk vulnerability was judged to increase from left to right in the factor diagram (Figure 5.4–2). Group 3 sites were judged to have a relatively higher offsite population risk vulnerability for waste disposal (Table 5.4–2) because these sites scored highest on the first environmental factor—and those scores are expected to be directly related to the level of eventual leaching of contaminants from the LLMW or LLW disposal facilities and the rate of transport of contaminants through the groundwater. Group 1 sites were considered to have a relatively lower population risk vulnerability because their scores on both factors are lower than the other site clusters. Group 2 sites generally scored high on the population/site size factor but lower than Group 3 sites on the groundwater hydrology factor. Because the first factor is considered a more important determinant, they are considered intermediate in terms of population risk vulnerability.

5.4.1.2.4 *Comparison of Alternatives for Population Risk Potential*

LLMW and LLW disposal alternatives were arrayed in terms of greater or lesser potential for population risk based on the final PRV group designation of the sites proposed for disposal under each alternative and the waste volume, total radioactivity, and number of disposal units proposed under each alternative at each of the sites. LLMW and LLW alternatives were then summarized in terms of the total waste volume, total

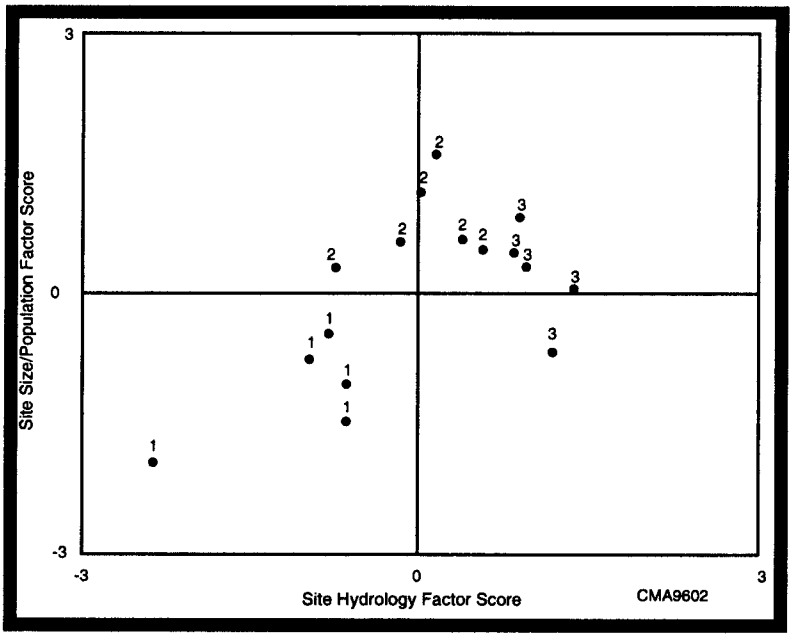

Figure 5.4–2. Sites Labeled by Population Risk Vulnerability Group Number Arrayed According to First Two Principal Factors of Environmental Data

Table 5.4–2. Population Risk Vulnerability Groups of the 16 Proposed Disposal Sites

Population Risk Vulnerability Group	Relative Offsite Population Risk Level	Sites in Population Risk Vulnerability Group	Relative Score on Groundwater Hydrology Factor	Relative Score on Site Size/Population Factor
3	Higher Relative Risk	FEMP, PGDP, PORTS, ORR, SRS	High	Intermediate to High
2	Intermediate Risk	ANL, BNL, LLNL, RFETS, SNL, WVDP	Intermediate	Intermediate to High
1	Lower Relative Risk	HANF, INEL, LANL, NTS, Pantex	Very Low to Low	Very Low to Intermediate

radioactivity, and number of disposal units required at all sites within each population risk vulnerability group. Those alternatives with greater volume, total radioactivity, and number of disposal units at PRV Group 3 sites could generally be considered to represent a relatively greater risk to populations than alternatives that concentrate disposed wastes at PRV Group 1 and 2 sites. From a population risk perspective, alternatives that concentrate disposed wastes at PRV Group 1 sites would represent the lowest potential risk.

5.4.1.3 Exposure Pathways

Different groups were assumed to be exposed through different pathways during each waste management phase. The exposure pathways and potentially affected populations and individuals are summarized in Table 5.4–3. The exposure pathways considered for the different receptor groups are shown in Figures 5.4–3 through 5.4–6. The exposure pathway for storage was assumed to be direct radiation from the storage containers.

The potential exists for human exposure to radiological and chemical contaminants in surface water. Receptors can be exposed through the use of contaminated surface water for drinking water, bathing, swimming, or irrigation. In addition, ingestion of fish or shellfish taken from contaminated surface waters may be another source of exposure through bioaccumulation of the contaminants in the tissues of these organisms. Potential pathways for surface water contamination from waste management practices include deposition of contaminants released to the atmosphere to surface water bodies, overland runoff to surface waters, releases of contaminants in aqueous effluents from treatment and storage facilities, and recharge of surface waters by groundwaters potentially contaminated through waste disposal.

A limited analysis was performed to show the potential health effects from the deposition of airborne contaminants on surface water bodies. Preliminary estimates described in Appendix D for the Columbia and Clinch Rivers indicated that the potential dose received from ingestion of surface water contaminated by deposition of airborne contaminants was a thousand to millions of times lower than that received from inhalation in a gaseous plume of hazardous or radioactive material. Other potential pathways of surface water contamination can be controlled or are more affected by the technical design and relative location of the waste management facilities with respect to the location of surface water bodies. Releases of contaminants in aqueous effluents from treatment and storage facilities are expected to be small because

Table 5.4–3. Exposure Pathways for Treatment, Storage, Transportation, and Disposal Activities

Waste Processing Phase	Pathway	Potentially Exposed Populations and Individuals
Treatment • Routine emissions • Accidents	Atmospheric • Inhalation • Ingestion of crops and animals[a] Direct radiation	• Public within 50-mile radius • Onsite employees, evenly distributed within site borders (atmospheric only) • Onsite MEI (atmospheric only) • Offsite MEI (atmospheric only) • Waste management worker (inhalation and direct radiation only)
Storage • Routine emissions • Accidents	Atmospheric • Inhalation • Ingestion of crops and animals Direct radiation	• Public within 50-mile radius • Onsite employees, evenly distributed within site borders (atmospheric only) • Onsite MEI (atmospheric only) • Offsite MEI (atmospheric only) • Waste management worker (inhalation and direct radiation only)
Disposal • Routine emissions	Atmospheric • Inhalation Groundwater • Ingestion of drinking water • Irrigation of crops • Watering of livestock • Bathing Direct radiation	• Waste management worker (atmospheric and direct radiation during disposal operations only) • Hypothetical farm family (ingestion of groundwater and food) • Hypothetical intruder (ingestion of crops and soil, inhalation of soil particulates, direct radiation)
Transportation • Routine emissions • Direct radiation • Accidents	Atmospheric (accident only) • Inhalation • Ingestion of crops and animals[a] Direct radiation	• Population living and traveling along the route and present at rest stops • Workers

Note: MEI = maximally exposed individual.
[a] Radiological only.

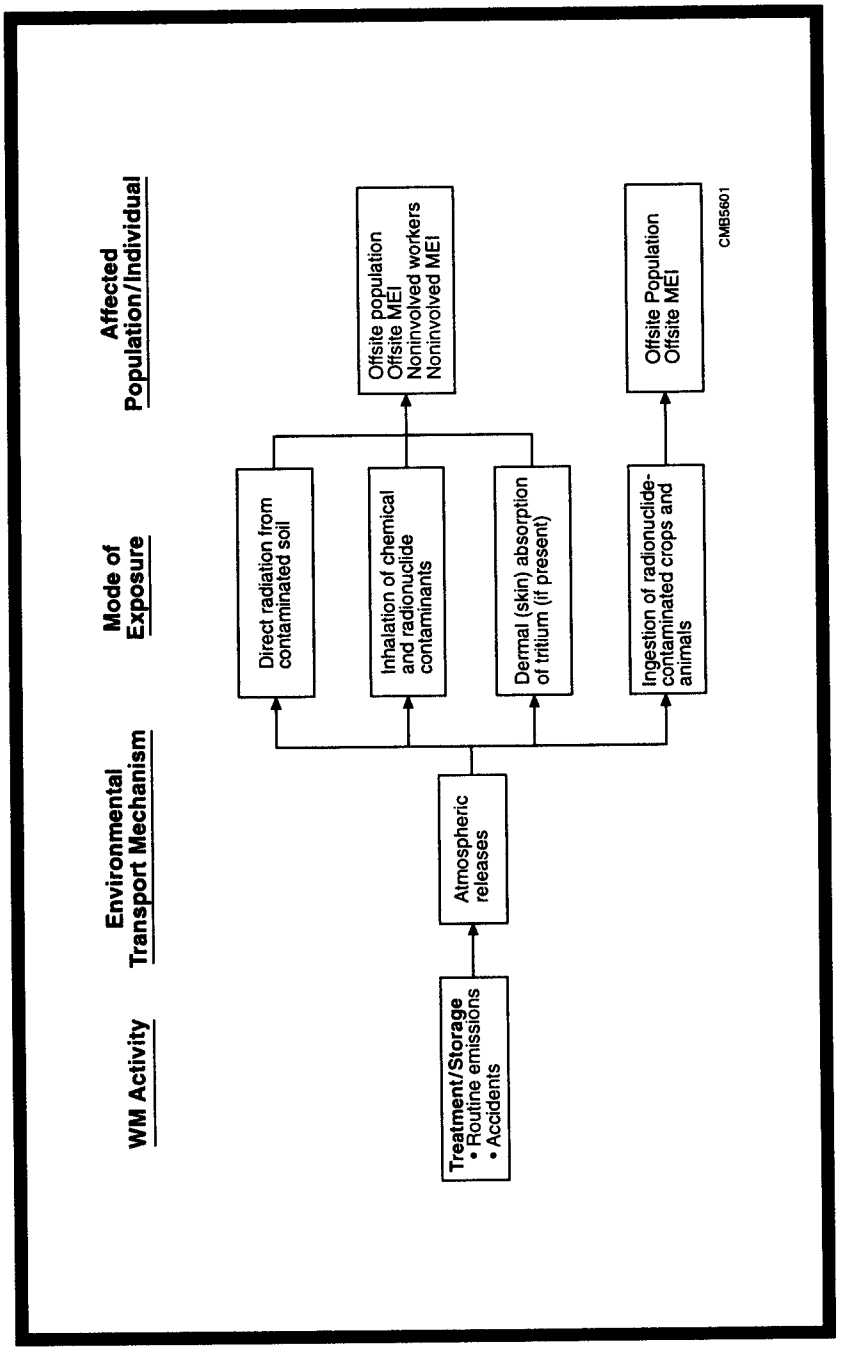

Figure 5.4–3. Exposure Pathways for the Offsite and Noninvolved Worker Populations for Treatment and Storage Activities

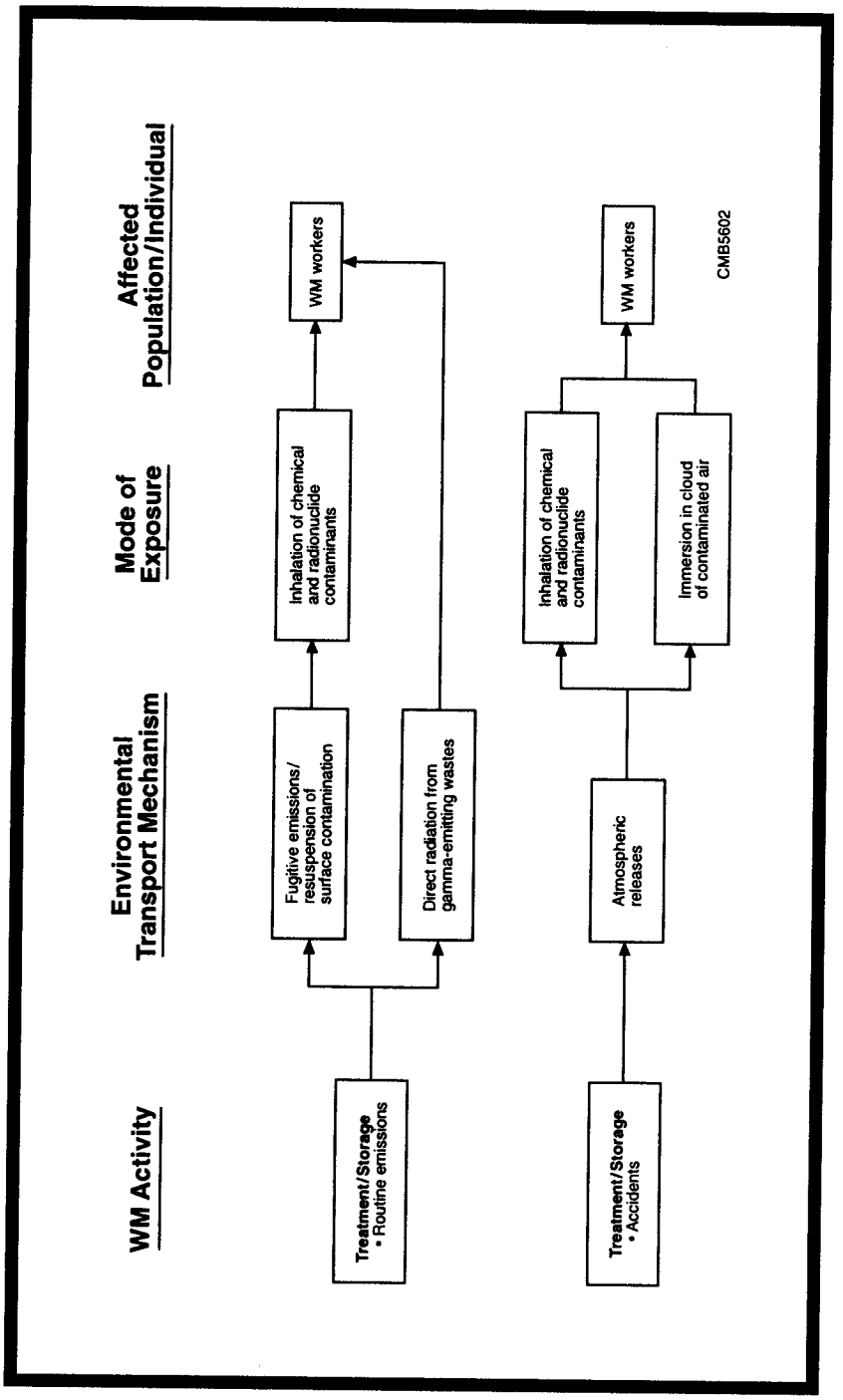

Figure 5.4-4. Exposure Pathways for Waste Management Workers for Routine Operations and Accidents During Waste Treatment and Storage

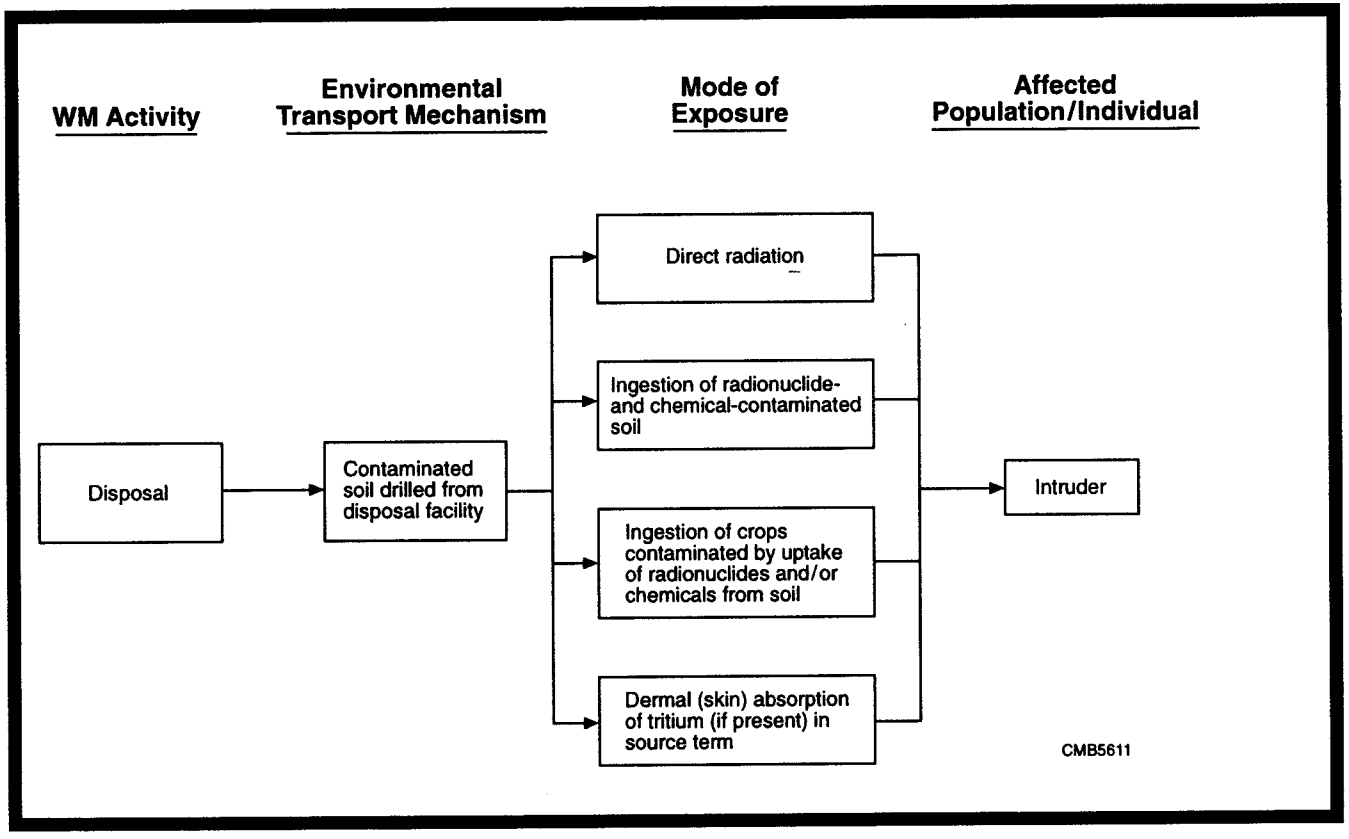

Figure 5.4–5. Exposure Pathways for the Intruder for Disposal Activities

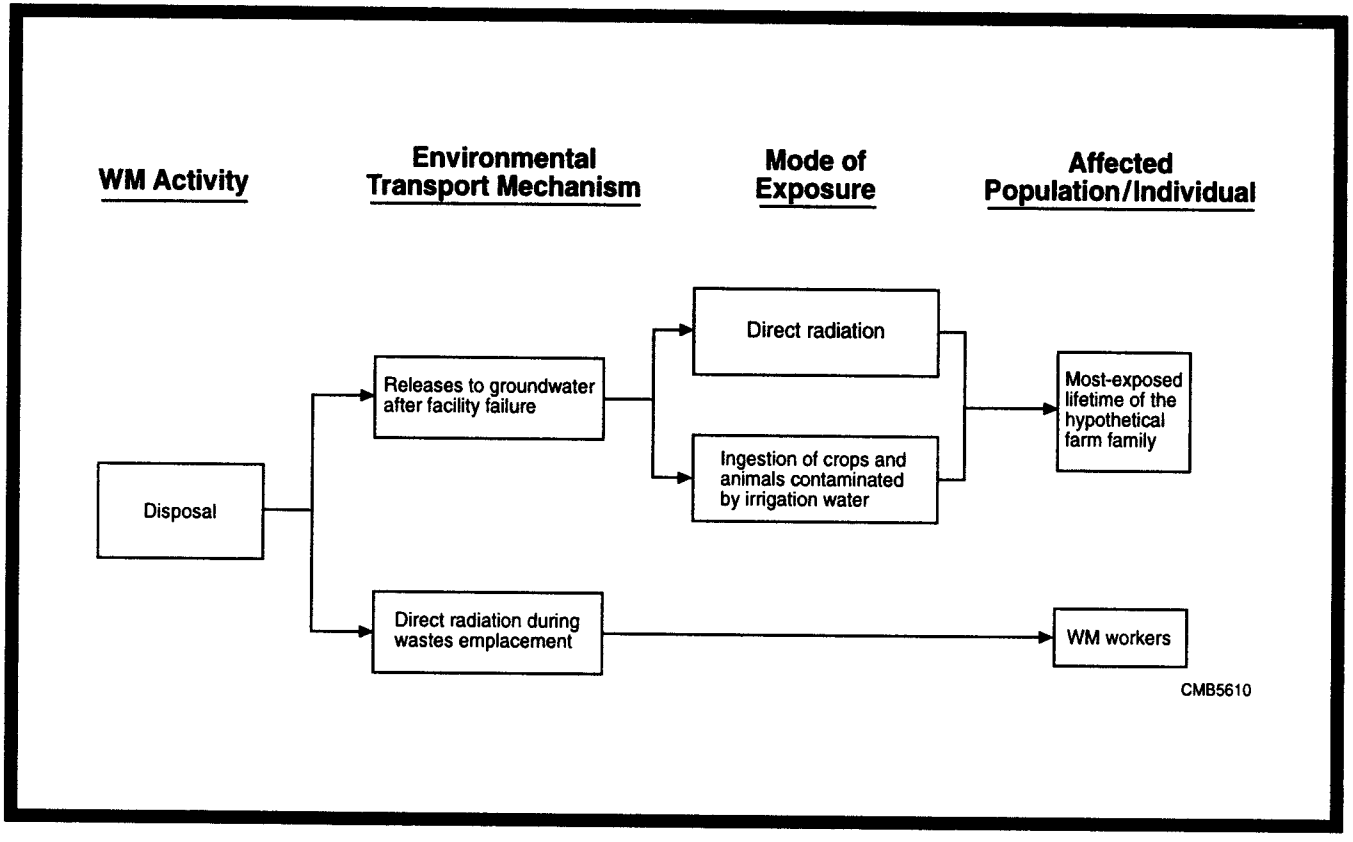

Figure 5.4–6. Exposure Pathways for the Farm Family and Waste Management Workers for Disposal Activities

process wastewaters from these facilities would be discharged to aqueous waste treatment facilities. After treatment, wastewaters would be recycled or discharged from these plants. All wastewaters, including storm waters, would be discharged in compliance with site-specific DOE, National Pollutant Discharge Elimination System (NPDES), or industrial wastewater discharge limits, which are established based upon consideration of the potential health and environmental effects of contamination of the receiving body. Disposal facilities may eventually degrade and release contaminants to the groundwater. Resultant contamination of surface water from the groundwater is dependent on the specific location of the disposal facility with respect to the surface water; however, dilution of the contaminants in "clean" surface waters is likely to result in surface water concentrations that are much lower than the concentrations in the groundwater.

Since the WM PEIS does not attempt to make waste management facility technology or siting decisions, there would be a high degree of uncertainty associated with any quantitative surface water pathway exposure estimates. Consequently, the WM PEIS did not conduct a detailed evaluation of this pathway. Surface water pathway analyses are appropriate for sitewide or project-level NEPA reviews where potential impacts may appear important to decision making.

Radioactive decay and the ingrowth of daughter products are taken into account in the estimation of radiological dose from direct radiation, ingestion of contaminated groundwater, and inhalation of contaminated air. Since treatment and storage periods are assumed to be 10 years in duration, radioactive decay and ingrowth are estimated for external radiation for an average of five years in order to capture the doses of photon-emitting daughters. For the groundwater pathway, radioactive decay is considered at several points in the exposure assessment. The first point is prior to the breach of the disposal facility, where decay is evaluated and the contaminant inventory is modified accordingly. Decay then occurs after the breach of the disposal facility and during transport to the vadose zone is accounted for prior to the transfer of flux rates to the MEPAS model. The MEPAS model then accounts for radioactive decay and ingrowth involved in transport through the vadose and saturated zones. All doses from daughter products are attributed to the parent radionuclide. The GENII model used in estimating exposure from inhalation of airborne radionuclides also accounts for radioactive decay and ingrowth, and assumes, as in the groundwater pathway, that all doses from daughter products are attributed to the parent radionuclides.

Offsite population and noninvolved onsite workers were assumed to be exposed to radionuclides through inhalation of airborne vapor and dust. This aspect of exposure lasts throughout waste treatment, storage,

and disposal operations. Onsite and waste management workers, during nonworking hours, are counted among the individuals living near the site (offsite population).

Onsite workers were assumed to experience chemical and radiological exposure from treatment, storage, and disposal facilities. The exposure pathways for these workers were assumed to be inhalation of vapor and dust, and direct external radiation. These workers are also subject to a variety of construction- or operation-related accidents. Workers were assumed to be wearing the proper industrial safety and health equipment for the task being performed (construction in a nonradioactive environment, operations in a radioactive environment).

The population living and traveling along the transportation routes are assumed to be exposed to radionuclides by way of direct radiation under routine conditions and both direct radiation and inhalation of airborne vapor and dust under accident conditions (SNL, 1993). Onsite industrial and transportation accidents were evaluated using the RISKIND model (ANL, 1993). Exposure to hazardous chemicals under accident conditions is assumed to occur only by inhalation of vapors and dust. Direct exposure by other pathways such as dermal (skin) absorption, is possible, but these routes are expected to result in much lower exposure than the inhalation pathway doses. The public is assumed to be exposed to vehicle exhaust fumes. The exposure pathways for transportation workers are assumed to be the same as those for the general population.

5.4.1.4 Health Impacts

Health impacts, which may range from bodily injury or illness to death, can result from exposure to radionuclides; exposure to chemicals or exhaust fumes; or physical trauma (crushing, burning, electrocuting). The effects on people of radiation that is emitted during disintegration (decay) of a radioactive substance depends on the kind of radiation (alpha and beta particles and gamma and x-rays) and the total amount of radiation energy absorbed by the body. The total energy absorbed per unit quantity of tissue is referred to as the absorbed dose. The absorbed dose, when multiplied by certain quality factors and factors that take into account different sensitivities of various tissues, is referred to as the effective dose equivalent, or where the context is clear, simply dose. The common unit of effective dose equivalent is the rem or millirem (1 rem equals 1,000 millirem).

An individual may be exposed to ionizing radiation externally, from a radioactive source outside the body, and/or internally, from ingesting or inhaling radioactive material. The external dose is different from the internal dose. An external dose is delivered only during the actual time of exposure to the external radiation source. An internal dose, however, continues to be delivered as long as the radioactive material remains in the body, although both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time. Health impacts from radiation exposure, whether from sources external or internal to the body, generally are identified as "somatic" (affecting the individual exposed) or "genetic" (affecting descendants of the exposed individual).

Adverse health impacts associated with chemical exposure include cancer and a range of noncancer toxicity effects, including organ system toxicity (e.g., liver, respiratory, cardiovascular), neurotoxicity, immunotoxicity and developmental and reproductive toxicity. The risk of cancer incidence from exposure to hazardous chemicals is not directly comparable to the risk of cancer incidence from exposure to radionuclides. Section D.2.6.3 of Volume III provides additional information about comparing the potential health impacts of radionuclide versus hazardous chemical exposures.

The details of the methodologies used to estimate cancer fatalities, cancer incidence, adverse genetic effects, and noncancer toxic effects are discussed in Appendix D, Section D.2. An overview of uncertainties in health impacts is given in Appendix D, Section D.2.15.

Cancers and some birth defects are believed to result from certain genetic changes in specific individuals in a given generation; however, not all genetic effects result in disease. Genetic effects include gene mutations (alterations in the elementary units of heredity—the genes) and gross chromosomal aberrations (alterations in the structure or number of chromosomes). For the purposes of this PEIS, risks for genetic effects were calculated only for radionuclides; genetic toxicity from chemicals is more difficult to assess because of its diverse nature.

Cancer Fatalities. Cancer fatalities are the excess deaths (deaths that would not otherwise have occurred) resulting from all types of cancer over the lifetime of an individual measured as a frequency (or incidence) in a population, or a probability for individuals. Cancer fatalities resulting from airborne exposures to radionuclides are calculated over an assumed 70-year lifetime. Cancer fatalities resulting from groundwater exposures to radionuclides are calculated over a period of up to 10,000 years after the disposal facility has been breached.

Because of the nature of the biological processes by which chemicals or radiation are currently understood to induce cancer, the conservative approach used in this PEIS assumed that there is no threshold below which there is no risk for cancer, and that the risk of cancer from multiple exposures to different sources is additive. As described in Section D.2.8.2 of Volume III, cancer risks from radiological exposure were estimated using the radiological risk factors developed by the International Commission on Radiological Protection (ICRP). A certain percentage of radiologically-induced cancers were assumed to be fatal (ICRP, 1990). Similar assumptions regarding fatalities from chemically induced cancers are not possible because of the diverse nature of chemically induced cancer.

Cancer fatalities are used in the WM PEIS as a representative health risk endpoint because the occurrence of the other health impacts evaluated (except noncancer toxicity) generally follows the same pattern as radionuclide-induced cancer fatalities. Cancer fatalities in the offsite population were calculated for radionuclides released during routine operations of treatment or storage facilities, during facility accidents, and in the public along transportation routes.

Cancer Incidence. Not all cancers are fatal. The total cancer incidence encompasses all cancers, not just cancers that result in death. The concepts discussed above with regard to cancer fatalities also apply to the consideration of total cancer incidence. For the purposes of this PEIS, radiation cancer incidence and chemical cancer incidence are separately evaluated and reported.

With respect to radiation-induced cancers, the number of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases. Note that both the total cancer incidence and the nonfatal cancer incidence values are overestimated by a factor of about two. The ICRP dose conversion factors used in the WM PEIS to convert radiation exposure to estimates of total cancer incidences contain a relatively large component of skin cancers. Such cancers generally result from external exposures to radiation. However, the exposure pathways evaluated in the WM PEIS (e.g., inhalation or ingestion of radionuclides) are largely internal pathways. These internal exposures to radionuclides are not likely to induce large numbers of skin cancers.

Noncancer Toxic Effects. Although carcinogens (cancer-causing agents) are emphasized because they are believed to have no threshold, most mechanisms of noncancer toxic effects do have thresholds below which no toxic effects are observed. For noncarcinogens, a procedure for comparing hazards has been developed by comparing the exposure concentration or dose to the concentration or dose believed to have no

appreciable adverse effects. For members of the offsite population (including sensitive subgroups of the offsite population) assumed to be continually exposed to a chemical throughout their lifetime, or portions of their lifetime, this comparison standard is the reference dose or reference concentration. The quantitative ratio of the exposure concentration (or dose) to the reference concentration (or reference dose) is called the "Hazard Quotient." The sum of all chemical-specific Hazard Quotients is the Hazard Index, which is used by EPA (and in the WM PEIS) to measure the risk of noncancer health effects.

Offsite Population. Health impacts to the offsite population resulting from releases of chemical and radiological contaminants from treatment and storage facilities were evaluated as potential latent cancer fatalities, cancer incidences, genetic effects, and noncancer toxic effects (for chemical contaminants). Offsite population sizes were based upon 1990 U.S. Census data (DOC, 1992a).

Health Impacts to Workers. In addition to potential impacts from airborne exposures estimated for the offsite population, onsite workers will be at risk for health effects resulting from construction and operation injuries. This category includes all significant physical injuries sustained by workers in various job classifications. Injuries are considered together regardless of their nature and are measured as a statistical frequency per labor hour. Some percentage of construction and operation injuries were assumed to result in death. The percentages of construction and operational injuries resulting in death were obtained from the Bureau of Labor Statistics records concerning the Sanitary Services occupational group, which includes plant operations (BLS, 1992, 1993).

For noncarcinogenic risks for waste management workers, estimated exposures were compared to the established chemical-specific occupational exposure limit values. This ratio is referred to in the WM PEIS as the "Exposure Quotient" and it is analogous to the "Hazard Quotient" used to estimate noncancer effects in the offsite population. Unlike carcinogenic risk, the hazard/exposure quotient is not directly related to frequency of disease, but provides a standard way to compare different exposures to noncarcinogens. The sum of all Exposure Quotients is the Exposure Index. Exposure Quotients and Exposure Indices were calculated only for chemical contaminants.

Note that WM worker population radiation exposures are presented as "person-rem" estimates in Volume I and as "FTE-rem" estimates in Appendix D of Volume III. In Appendix D, to make it possible to compare estimated worker exposures to regulatory criteria, staffing was expressed as the number of "full-time equivalents" (FTEs). An FTE was assumed to be commensurate to one individual working full-time in a

waste management facility. In reality, one FTE could represent several individuals who are not exposed full-time to waste management activities, but whose *cumulative* work time totals one FTE. Because the risk of exposure could be shared by more than one worker working less than full-time in a waste management facility, risks to actual individual workers might be overestimated. Therefore, when interpreting the Volume I risk analysis results for WM workers readers may find it useful to interpret person-rem as FTE-rem.

Health Impacts to Workers and Offsite Population From Transportation. The same exposure-related health impacts discussed above for treatment and storage facilities can result from transportation of waste. Transportation risks were estimated for workers and the public for routine operations and accidents. These risks were based on State data on the frequency of accidents for trucks and trains per mile traveled. The number of shipments by truck or train were calculated for the WM PEIS based on waste load, whereas mileage was dependent on the sites proposed for the waste management facilities. Calculation of truck mileage was done using the HIGHWAY 3.1 model, and calculation of rail mileage was done using the INTERLINE 5.0 model. These models are the standard means of DOE estimation of truck and rail shipping distances.

National average rural, suburban, and urban population densities were used in the WM PEIS transportation risk analysis for all transportation routes, consistent with DOE practice. This approach was considered appropriate because of the programmatic nature of the WM PEIS. In general, these averages tend to be conservative (i.e., overestimate) compared with route-specific values. Therefore, the estimated risks in the WM PEIS are somewhat higher than if route-specific population densities were used. For complexwide programmatic purposes, the WM PEIS used an external dose rate of 1 mrem/hour at 1 meter from the surface of the shipment for all DOE LLW shipments. This dose rate is based on historical shipment data. The shipment external dose rates for LLMW, TRUW, and HLW are identified in Section E.6.2 of Volume IV.

Interpreting Risk Results. The goal of the WM PEIS risk analyses is to provide estimates of health risk to aid in determining the advantages and disadvantages of implementation of the various waste management alternatives. The risk results are best interpreted as *relative* differences among alternatives rather than as absolute point estimates of risk.

For example, consider a decentralization alternative (Decentralized Alternative 1) that affects the populations at 12 sites and a centralization alternative (Centralized Alternative 1) that affects the population at only one site. If the number of cancer fatalities in the offsite populations of all sites in Decentralized Alternative 1 is *numerically* higher than the number of cancer fatalities in the offsite population of the one site in Centralized Alternative 1, Decentralized Alternative 1 is the highest risk case, for the offsite population cancer fatality endpoint, at the *program level*. Note that each health risk endpoint should be considered independently; values for different endpoints should *not* be added to obtain overall estimates for a given group of receptors. That is, radiation exposure cancer fatalities for waste management workers should *not* be added to physical hazard fatalities to obtain an estimate of the total number of fatalities for this receptor group.

The WM PEIS risk analyses also provide estimates of *site-level* risks. For example, suppose the overall programwide risk of latent cancer incidence from radionuclide exposure under Decentralized Alternative 1 is 0.8 (or 8E–01), and this total risk is distributed across 23 million people, the sum of the offsite populations at all 12 sites involved in that alternative. If this programwide risk (8E–01) is divided by the total affected population (23 million), the resulting number, 0.000000035 (or 3.5E–08), might be considered the "average" risk to an individual member of the programwide offsite population. Note that this number is *not* the risk to the MEI and will in all cases be less than the risk to the MEI. This is because on the average, members of the general population receive less exposure, by definition, than the MEI. Although this "average" individual risk is *not* a formal construct in risk analysis, it may be helpful to the reader for comparing the risk estimates among alternatives or sites. Common activities that produce a comparable risk of death per year are found in Table 5.4–4.

For air emissions a comparison benchmark is the National Emission Standards for Hazardous Air Pollutants (NESHAP) for radionuclides (40 CFR 61), which has a goal of individual lifetime risk no greater than 1 in 10,000, which is approximately equivalent to the standard of 10 mrem/year. All measures of risk, including population risk, should be examined to determine if the MEI risk should be allowed to exceed this value or be constrained to a lesser value.

Another relevant benchmark is the disposal standard for spent nuclear fuel, HLW, and TRUW (40 CFR 191), which states that disposal of these materials in compliance with the containment requirements should not result in MEI exposures of greater than 15 millirem/year. Other standards include drinking water standards, with individual risk goals of 1 in 10,000 or lower for carcinogens, worker radiation protection

Table 5.4-4. Risks Estimated to Increase Chance of Death in Any Year by One in a Million

Activity	Cause of Death
Smoking 1.4 cigarettes	Cancer; heart disease
Traveling 16 km (10 mi) by bicycle	Accident
Flying 1,600 km (1,000 mi) by jet	Accident; cancer caused by cosmic radiation
Existence of potassium-40 in a human body	Cancer caused by naturally occurring radiation
Drinking 30 12-oz cans of diet soda	Cancer caused by saccharin

Sources: Slovic (1986) and Eisenbud (1987).

standard (5 rem per year), and the maximum annual allowable radiation dose to the members of the public from DOE-operated nuclear facilities (100 mrem per year) (DOE, 1990).

Finally, exposure to direct radiation and radionuclides should be considered in the context of background radiation. The average individual in the United States is estimated to receive a dose of about 360 mrem (0.3 rem) per year from all sources combined, including medical sources of radiation (such as x-rays — e.g., chest x-ray dose is about 8 mrem, diagnostic hip x-ray dose is about 83 mrem), and natural background radiation (such as radon gas). This dose results in a calculated individual lifetime risk of fatal cancer of about 1 in 100 (40 CFR 61).

With respect to accident scenarios, where individuals such as waste management workers may receive high short-term (or acute) doses, a person must receive a dose approaching the LD50 dose level before there is a high probability of near-term death (NAS, 1983).

5.4.2 Air Quality Impacts

Air quality impacts were assessed for the construction of new treatment, storage, and disposal facilities; for the operation and maintenance (O&M) of the facilities; and for shipment of wastes between sites. The air quality impacts analysis estimated the air emissions effects for criteria air pollutants, hazardous air pollutants

(HAPs, including radionuclides), and toxic air pollutants (TAPs). Descriptions and assessment criteria for these classes of pollutants are presented below. The potential impacts of emissions of ozone-depleting substances (e.g., chlorofluorocarbons (CFCs) and halons) were also evaluated. Air quality impacts were analyzed only for those pollutants where emissions estimates were provided. A summary of the air quality impacts analyzed in the WM PEIS is presented in Table 5.4–5.

Criteria Air Pollutants. In compliance with the Clean Air Act (CAA) (42 USC 7401), EPA has promulgated National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants (40 CFR 50): carbon monoxide (CO), sulfur dioxide (SO_2), particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb). These pollutants are

Table 5.4–5. Air Quality Impacts Analysis: Summary of Emissions Evaluated

		DOE Site-Level Analysis			National Analysis	
			O&M Emissions			
Pollutant Class	**Relevant Waste Types**	**Construction Emissions**	**Local Stationary Source Emissions**	**Local Transportation Source Emissions**	**Transportation Corridor Emissions**	**Total National Emissions**
Criteria Air Pollutants	All Five Waste Types	Local Construction Equipment Emissions and Worker Vehicle Emissions (Tons/Yr)	Local Stationary Source Emissions from Proposed Waste Management Facilities (Ambient Concentrations and Tons/Year)	Offsite Emissions from Worker Vehicles and Waste Transport Within 50 Miles (Tons/Year)	Total Emissions From Waste Transport outside 50-Mile Radius of Sites (Tons/Year)	Sum of Onsite, Offsite, and Transportation Corridor Emissions (Tons/Year)
Radio-nuclides	TRUW, LLW, & LLMW[a]	No Emissions During Construction	Local Stationary Source Emissions From Proposed Waste Management Facilities (Total Airborne Radionuclides Based on Radiation Dose From All Exposure Pathways)	Not Calculated for Worker Vehicles. Assumed to Be Negligible From Routine Waste Transport	Assumed to Be Negligible From Routine Waste Transport	Assumed to Be Negligible
Other Hazardous and Toxic Air Pollutants	TRUW, HW, & LLMW[a]	Assumed to Be Negligible	Local Stationary Source Emissions From Proposed Waste Management Facilities (Pollutant-Specific Ambient Concentrations)	Not Calculated for Worker Vehicles. Assumed to Be Negligible From Routine Waste Transport	Assumed to Be Negligible From Routine Waste Transport	Assumed to Be Negligible

[a] Emissions of radionuclides and other hazardous constituents from the storage of vitrified HLW are assumed to be negligible due to the physical form of the HLW. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals, such that releases to the atmosphere are negligible.

regulated both in terms of annual production in tons per year and in terms of ambient concentrations emanating from point and mobile sources. Unlike the other five criteria air pollutants, ozone is not a direct emission but is formed in the atmosphere through a complex reaction of ozone precursor pollutants, sunlight, and temperature. Ozone precursor pollutants include nitrogen oxides (NO_x) and nonmethane hydrocarbons (NMHCs), which include the class of compounds known as volatile organic compounds (VOCs). The analysis of ozone impacts was performed by evaluating NO_x and VOCs emissions.

Hazardous Air Pollutants. Section 112 of the CAA requires EPA to establish technology-based standards for sources of 189 pollutants listed in the statute, and to specify categories of sources subject to the emission standards. The NESHAP are promulgated in 40 CFR 61. HAPs include cancer-causing agents, such as arsenic, benzene, carbon tetrachloride, formaldehyde, and radionuclides, as well as materials with noncancer health hazards, such as fluoride, ammonia, and hydrochloric and sulfuric acids. EPA regulates radionuclides as a total annual dose limit under the NESHAP. Radionuclides are also regulated by the Department of Energy (DOE Order 5400.5 [DOE, 1990] and proposed 10 CFR 834 [DOE, 1993b]) as a total dose limit.

Toxic Air Pollutants. Toxic air pollutants include cancer-causing agents and compounds with noncancer health hazards. These substances are regulated by the EPA and on a state or local basis, through allowable ambient standards or guidelines.

Ozone-Depleting Substances. Ozone-depleting substances are regulated through the CAA and by the Montreal Protocol on Substances that Deplete the Ozone Layer. The CAA includes requirements for controlling ozone depleting substances that are generally consistent with, but in some cases more stringent than those in the Montreal Protocol. Title VI of the CAA calls for a phaseout of CFCs by January 1, 2000. In addition to the phaseout of ozone-depleting substances (ODSs), Title VI includes a variety of other provisions intended to reduce emissions of ODSs and promote the recycling of these substances.

Air Quality Impacts Analysis. The air quality impacts analysis estimated annual criteria pollutant emissions in tons per year (tpy) for construction and O&M activities. HAPs/TAPs concentration impacts were not estimated for construction activities but were estimated for the treatment of waste by thermal destruction during O&M.

Annual criteria air pollutant emissions in tons per year from construction activities were estimated based on emission rate data for construction equipment and worker vehicles traveling to and from the work site on a daily basis. Annual criteria pollutant emissions in tons per year from waste management activities were estimated based on standard EPA emission rate factors for O&M facilities (see EPA, 1995), thermal destruction of waste, worker vehicles, and transportation of waste.

Criteria air pollutant ambient concentration impacts were estimated based on thermal destruction emission rate factors and concentration impact estimates obtained from computer dispersion modeling. The HAPs and TAPs concentration analysis assumed that the most conservative estimate of impact would be from concentrations that the offsite MEI would be subject to in the human health risk assessment. Therefore, the HAPs and TAPs air quality impacts analysis for thermal destruction emissions used data on emissions, airborne concentrations, and MEI doses assembled for the human health risk assessment. The estimated concentrations of criteria air pollutants were compared to the NAAQS, while HAPs and TAPs concentrations were compared to applicable EPA or State ambient concentration guidelines.

The air quality analysis assumed that transportation sources may be an important source of criteria pollutant emissions in addition to those from the facilities. Transportation sources were not assumed to contribute significantly to hazardous or radioactive airborne contaminants in routine operations. Therefore, for criteria air pollutants only, in addition to estimating ambient concentrations from facility sources, the analysis estimated local transportation source annual tonnage of criteria air pollutants, intersite transport annual tonnage of criteria air pollutants, and a national annual tonnage of criteria air pollutants from all activities proposed for each waste type under each alternative.

The focus of the air quality analysis for proposed onsite waste management activities was on estimating potential emissions of criteria air pollutants, HAPs (including radionuclides), and TAPs from operating treatment facilities, where the treatment facility is a stationary source of those emissions. Because ozone is formed photochemically, at a substantial distance downwind from an ozone precursor emission source, the analysis of ozone effects from these operations was done separately and used a different estimation technique.

Airborne concentrations of criteria air pollutants and HAPs from proposed thermal destruction operations were estimated by calculating the highest concentration of each substance likely to be emitted at each site using the "ISC2" computer dispersion model used in the human health risk assessment. The model estimates

downwind concentrations of contaminants as they originate from a known source and disperse with the wind. The model requires input of appropriate local weather data and important facility data, including stack heights, diameters, and discharge rates.

Emission rate data for waste management facility fuel use were obtained from the most recent version of EPA's *Compilation of Air Pollutant Emission Factors, Volume I: Stationary, Point, and Area Sources* (EPA, 1985). Fuel use emission estimates were based on emissions for an industrial boiler using either gaseous or liquid fuels. Criteria air pollutant emission rate data for thermal destruction were obtained from a review of EPA literature.

Rather than estimating individual radionuclide concentrations downwind from proposed treatment facilities, a screening analysis was used to determine whether radionuclides as a group would exceed the overall NESHAP dose standard of 10 millirem (mrem) per year. Annual doses to the offsite MEI were obtained from the GENII model for each site and waste management alternative. The dose values were compared to the NESHAP annual dose standard and discussed if they exceeded 10% of the standard. Comparison to the standard is not intended to demonstrate compliance for permitting purposes.

The potential impacts of transportation on air quality were estimated. Specifically, the analysis examined:

- Exhaust emissions from on-road vehicle and railroad diesel engines during transport of wastes between sites
- Increased vehicle traffic at each site based on the total shipments reaching a site and on the privately owned vehicles used by workers going to and from the waste management facilities

Local impacts for truck or rail shipments were based on emissions estimates for that segment of each waste shipment within a 50-mile radius of the site. Shipment emission estimates outside the 50-mile radius were added to national transportation source emission estimates for each waste management alternative. Worker vehicle trips were based on a daily round-trip distance of 40 miles for a work period of 240 days per year. A quantitative analysis of the contribution of vehicle exhaust was performed for the exhaust compounds CO, NO_2 (as NO_x), PM_{10}, and VOC (EPA no longer considers airborne lead to be a problem because unleaded fuels are now the norm). NO_x and VOC are ozone precursor pollutants and are of particular concern in ozone nonattainment areas. Emission factors for the quantitative analyses were estimated using the most recent version of the EPA-approved vehicle emissions model, Mobile5a.

Criteria air pollutant effects were assessed for each of the six criteria air pollutants based on the air quality attainment status of each site's air quality control region. In general, a sites applicable air quality control region is in attainment for a particular criteria air pollutant if monitored ambient concentration levels are below the NAAQS for that pollutant. The site's applicable air quality control region is in a nonattainment area for a particular criteria air pollutant if ambient concentration levels are equal to or exceed the NAAQS for that pollutant.

Any predicted increases to ambient concentration levels in areas designated as "in attainment" by EPA were compared to the NAAQS. If the increased estimated ambient concentrations equaled or exceeded the NAAQS, then that alternative and the affected area were identified in the WM PEIS. The annual criteria emissions, in tons per year, were compared to the allowable increase levels specified in 40 CFR 52.21, "Regulations for the Prevention of Significant Deterioration (PSD) of Ambient Air Quality." PSD regulations are applicable to attainment areas for each of the criteria air pollutants. These allowable increases are referred to as PSD increments and PSD significant emission levels (SELs). PSD increases account for all stationary source emissions that can be reasonably attributed to the action but do not account for emissions from mobile sources. If the estimated annual emissions for an alternative are equal to or exceed the allowable PSD SELs increments, then that alternative and the affected area were identified in the WM PEIS text. Sites that exceed the allowable PSD increments may require additional control measures to reduce criteria pollutant emissions to acceptable levels.

New major stationary sources or major modifications of existing sources located in attainment and nonattainment areas for any criteria air pollutant must conform to New Source Performance Standards (40 CFR 60). In addition, Federal actions that are located in nonattainment areas are required to follow the guidelines of EPA's General Conformity Rule (GCR) (40 CFR 93) (EPA, 1993). The conformity rule establishes specified minimal levels for criteria air pollutant emissions, in tons per year, based on the air quality control region's nonattainment designation. Actions producing emissions that are below the minimal levels are considered to conform, while those at or above the limits are required to perform a conformity determination as outlined in the conformity rule. The conformity rule accounts for all stationary and mobile sources of emissions that can reasonably be attributed to the action.

Ozone pollution can be caused by reactions between VOC and NO_x in the presence of sunlight, and it generally reaches its maximum concentration many miles downwind of the sources of these substances. The impacts of the alternatives on ambient ozone levels were assessed by assuming that if emissions and

concentrations of VOC and NO_x associated with each alternative are within applicable PSD, GCR, or NAAQS, ozone production would be minimal.

Impacts to the stratospheric ozone layer due to emissions from waste management activities were estimated. The analysis was performed at all treatment sites in an alternative since emissions of ozone depleting substances is a global rather than a site issue. The analysis was performed for waste types where treatment of waste containing hazardous constituents occurs (e.g., LLMW, TRUW and HW). The compounds analyzed include the ozone depleting substances identified by EPA in 40 CFR 82. Emissions of ozone depleting substances from thermal treatment were tallied from information supplied by the health risk assessment. The total emissions from each alternative were found to be exceedingly small for all waste types, and in fact were less than 0.1 pound per year for all LLMW alternatives (DOE, 1996a). These minor emissions would not be expected to have any measurable affect on upper atmosphere ozone levels. Emissions of ozone depleting substances from other treatment, storage and disposal operations were assumed to be small due to the nature of these activities, and the mandated phase-out of the use of ozone depleting substances.

Construction activities could affect air quality by causing fugitive dust emissions and contributing vehicle, heavy equipment, and mobile power generator exhaust emissions. Estimates of fugitive dust and exhaust emissions were made for each site under each alternative. The estimates were based on the extent of land clearing required to build the proposed facility, the size of the construction workforce, and the requirements for trucks, heavy equipment, and mobile generators.

5.4.3 Water Resources Impacts

The analysis evaluated water resource effects based on engineering estimates of expected water use and liquid discharges from the waste management activities under each waste type. The analysis quantified water quality effects for those waste types for which disposal is proposed at DOE sites under the assumption that the disposal facilities would deteriorate after closure and that such disposed wastes might contaminate groundwater. Other potential water resources impacts are discussed qualitatively.

At certain DOE sites, impacts from normal operations to surface water or groundwater or both can be ruled out, given the source of water or the receiving body for effluents, as follows:

- Municipal water is used as the source of water for RFETS, SNL-NM, and WIPP; therefore onsite surface and groundwater resources would not be affected by water withdrawals.
- Groundwater is used as the source of water for the water supply at ANL-E, BNL, FEMP, INEL, LANL, LLNL-Site 300, NTS, the Pantex Plant, PORTS, and SRS; therefore, impacts to surface water resources are likely to be small as a result of groundwater withdrawals.
- Surface water is used as the source of water at the Hanford Site, ORR, Paducah, and WVDP; therefore, impacts to groundwater resources are likely to be small as a result of surface water withdrawals at these sites.
- Wastewater is discharged to municipal wastewater treatment systems at SNL-NM; therefore, onsite surface water resources would not be affected by effluent discharges.
- Wastewater is not discharged to natural flowing surface water bodies at the Hanford Site, INEL, LANL, LLNL-Site 300, NTS, the Pantex Plant and WIPP; therefore, impacts to surface water resources are likely to be small as a result of effluent discharges at these sites.

5.4.3.1 Water Availability

Impacts on water availability were analyzed by comparing the rates of water use and wastewater discharge estimated for each site during construction and operation of proposed waste management facilities to volumes or use rates for current water sources. For sites that obtain water from surface water sources, a comparison was performed for both current use and stream flow.

For each waste type, water use rates for construction and operation activities at each site under each alternative were taken from technical reports prepared for specified alternatives or interpolated from the technical reports for the remaining alternatives. Total water use at a site was computed as the sum of water use for waste treatment, storage, or disposal operations.

The analysis assumed that water for the proposed waste management activities would be withdrawn from the current water source at each site. The surface, groundwater, or municipal water source at each site is part of the water resources affected environment data in Chapter 4. Where surface water is the current source, surface flow rate data were also assembled.

5.4.3.2 Water Quality Impacts From Disposal of LLMW and LLW

Groundwater quality may be affected in the future assuming there is a loss of institutional control at disposal sites and subsequent deterioration of disposal facility integrity. Disposed waste contaminants could then leach into groundwater and subsequently appear downgradient in well water. Analysis of this possible effect used the modeling for the human health risk assessment. The transport and fate of disposed radionuclides, and hazardous constituents were estimated using the Disposal Unit Source Term (DUST) and Multimedia Environment Pollutant Assessment System (MEPAS) models that tracked the contaminants as they moved from the disposal location to the point of exposure for a hypothetical farm family living 300 meters downgradient of the disposal facility.

Input data for the water quality analyses were assembled for LLMW and LLW, the only two waste types that will be disposed of at DOE sites under this PEIS. These data were taken from two sources:

- DUST/MEPAS modeling that estimated human health risks from use of contaminated groundwater for drinking and for crop irrigation
- Estimated quantities of radionuclides and hazardous chemicals in the waste

The water quality impacts analysis applied the radionuclide and hazardous constituent inventory data to the health risk modeling results in order to calculate contaminant concentrations in a hypothetical well located 300 meters downgradient from each disposal unit. The analysis accounted for the degradation of the wastes during the time period between disposing of the wastes and loss of containment (ranging from 0 to 700 years depending on the technology), and for creation of radioactive daughter products from the decay of disposed radionuclides (ORNL, 1995b). Disposal of 36 radionuclides was evaluated for LLMW and LLW; disposal of 15 hazardous constituents was evaluated for LLMW. The constituents analyzed in the WM PEIS are listed in Section C.4.3.5 of Volume III.

Estimated radionuclide and hazardous constituent concentrations in the hypothetical downgradient well were compared to drinking water standards promulgated by EPA in the Primary Drinking Water Regulations (40 CFR 141) and in DOE Order 5400.5 (DOE, 1990). These drinking water standards are listed in Section C.4.3.5 of Volume III. Drinking water standards promulgated under the Safe Drinking Water Act are applicable to treated drinking water at the tap, and therefore are not directly applicable to groundwater quality. Since there are no Federal standards for groundwater quality protection, predicted concentrations of contaminants in the groundwater are compared with drinking water standards to provide an indication of the level at which adverse impacts to water quality may occur. These criteria are commonly used as

Applicable or Relevant and Appropriate Requirements (ARARs) to determine appropriate levels for groundwater cleanup under RCRA and CERCLA cleanup actions. Since drinking water standards adequately protect human health, groundwater contamination at or below these levels is considered to result in low risk to human health. Federal water quality standards, rather than state standards, were used to provide a consistent means of comparing among sites.

DOE will evaluate the performance of disposal facilities at each site in detail in the DOE's Performance Assessment process. If significant groundwater contamination were predicted by the Performance Assessment process, changes in the waste acceptance criteria would be made to limit disposal of the waste causing the significant groundwater contamination. The waste would require further treatment prior to disposal, would be disposed of at another DOE site where the waste meets the waste acceptance criteria, or would be stored until a method was found to treat or dispose of the waste. In no case would DOE knowingly dispose of waste in violation of legal requirements.

5.4.3.3 Other Water Resources Impacts

Some impacts on water resources were assumed to be minimal at all sites or at particular sites regardless of which waste type and alternative are being considered. In order to focus the analysis on significant environmental impacts that could influence the choice of alternatives, these potential minimal effects are discussed here and therefore not addressed in the waste type impacts analyses in Chapters 6–10. Further evaluations of these potential effects could be conducted as part of sitewide or project-specific NEPA reviews.

The impacts of waste management activities on floodplains cannot be estimated at this time because the specific locations of the waste management facilities at the DOE sites are not analyzed in the WM PEIS. If possible, no new waste management facilities would be located in floodplain areas. As a minimum, facilities managing LLMW or HW would be required to meet additional design criteria and/or siting requirements to obtain a RCRA permit. Compliance with floodplain and wetland review requirements, including Executive Order 11988 (Floodplain Management) and 10 CFR 1022 (Compliance with Floodplain/Wetland Environmental Review Requirements), would be examined in detail when specific locations are proposed in sitewide or project-specific NEPA reviews.

During the construction period, impacts to surface water resources could occur from runoff and sedimentation as a result of site clearing. During operations, impacts to water resources could occur through increased runoff from buildings, parking lots, and cleared areas. The impacts would generally be proportional to the amount of land disturbed during construction and occupied during operations. In all cases the impacts would be minimized by implementation of best management practices for stormwater runoff and erosion control. These practices include the use of silt fences, run-on and runoff diversion ditches, and stormwater retention and sedimentation ponds. Therefore, impacts from these activities are not expected to be major, and should not influence the choice of alternatives. If necessary, these impacts would be considered in sitewide or project-specific NEPA reviews.

During waste management operations, stormwater runoff may be contaminated with materials deposited from airborne emissions. Most of the potentially contaminated stormwater runoff would be contained within onsite stormwater collection ponds. The stormwater runoff would evaporate or infiltrate into the ground, although the ponds may discharge to surface water bodies during high flow conditions. Stormwater runoff would be routinely monitored and any discharges would be in compliance with site-specific permit limits. Stormwater runoff that is not contained within the stormwater management system may contaminate surface waters. This runoff may contain small amounts of contaminants. Controls would be implemented at each site to minimize the potential for contaminated stormwater runoff. Impacts from stormwater runoff are expected to be minor, but are highly site-specific and would depend on the design of the stormwater management system, meteorologic conditions, topography, soil type, and the affected surface water body at the site. These impacts should not influence the choice of alternatives but would be considered in sitewide or project-specific NEPA reviews, if necessary.

During normal waste management operations, no untreated sanitary or process wastewater would be discharged to surface or groundwater. Wastewater would be treated and recycled to the extent possible and then discharged to existing sanitary or process treatment plants, as appropriate. After additional treatment, wastewaters would be discharged from these plants in compliance with all NPDES and industrial wastewater discharge permits. Onsite surface water resources would not be affected by effluent discharges at SNL-NM, because wastewaters are discharged to municipal wastewater treatment systems. Surface water resources have a low potential to be affected by effluent discharges at the Hanford Site, INEL, LANL, LLNL–Site 300, NTS, the Pantex Plant, or WIPP, because generally, wastewaters are discharged to dry stream beds or man-made ponds, and not natural flowing surface water bodies. Even at sites such as ORR and SRS where surface waters could be affected by effluent discharge, it is not always possible to determine

which water course(s) would be affected, since the locations of the waste management facilities have not been selected. If necessary, these impacts would be considered in sitewide or project-specific NEPA reviews.

The majority of new aqueous waste would be sanitary waste generated by the employees needed to operate the facilities associated with each alternative. Sanitary wastes by definition are nonhazardous and would be discharged to existing sanitary wastewater treatment facilities. After treatment, sanitary wastewaters would be recycled or discharged from these plants in compliance with site-specific NPDES or industrial wastewater discharge permit limits. The impacts on existing sanitary wastewater treatment facilities are discussed in the infrastructure section of this chapter (Section 5.4.9).

Although the volume of sanitary wastewater may vary between alternatives, it would remain similar in quality. Therefore, current conditions would not change appreciably unless the discharge volume was a large percentage of the flow in the receiving water body. The impacts of combined sanitary and process wastewater discharges on surface water volume were evaluated in the WM PEIS and show only minor (less than 1%) changes in flow. Since the quality of effluent discharges from sanitary wastewater treatment facilities would not change, and the flow would not be a significant fraction of the average flow in the major receiving water body, current monitoring captures most of the water quality effects of sanitary wastewater treatment plant discharges for the alternatives. Therefore, impacts from these activities are not expected to be major and should not influence the choice of alternatives. If necessary, these impacts would be considered in sitewide or project-specific NEPA reviews.

Process wastewater is wastewater potentially contaminated by hazardous or radioactive constituents during treatment, storage or disposal activities. In the WM PEIS, it was assumed that easy-to-treat and hard-to-ship wastes, such as aqueous wastes and slurries (process wastewater), would be treated at the generating site and would not be shipped offsite for treatment. After treatment, wastewaters would be recycled or discharged in compliance with site-specific DOE, NPDES, or industrial wastewater discharge limits. Because process wastewater treatment would continue at the sites where it presently occurs, and the volumes of process wastewater treated at each site would vary only slightly between alternatives, the effects of process wastewater treatment on surface and groundwater quality are largely accounted for in the existing conditions information reported in the affected environment section. Therefore, the impacts from these activities should be similar for all alternatives and should not influence the choice of alternatives. If necessary, these impacts would be evaluated in sitewide or project-level NEPA documents.

Wastewater released by sanitary wastewater treatment plants may enter small onsite water courses before entering the major surface water body near the site. Additional effluents in these small streams may cause erosion and/or sedimentation in the stream channel. Water quality may also be affected since the facility effluents may form a large fraction of the natural stream flow. The effects of effluent discharge on natural surface water bodies would be minimized during the site selection and permitting process. Impacts on small onsite water bodies could be considered in sitewide or project-specific NEPA reviews.

During normal operations of waste storage facilities, no water (including surface water and groundwater) would be allowed to come into contact with the waste. Therefore, surface water or groundwater quality would not be affected because there would be no contaminated runoff. During normal operations of waste treatment facilities, there would be no releases to groundwater. Therefore, groundwater quality would not be affected.

Withdrawals of groundwater to supply water for waste management facilities could cause detrimental movement of existing groundwater contamination plumes. This could occur where water levels are lowered by water withdrawals. Since existing wells will be used to the extent possible, and new wells would be located to minimize their impact on contaminant plume migration, impacts of this sort are unlikely. Potential impacts on existing areas of contamination could be considered in sitewide or project-specific NEPA reviews.

Seepage of contaminated groundwater from disposal facilities could contaminate surface water. This would be expected to occur at sites with shallow groundwater, and surface water bodies that are fed by groundwater discharge (springs). Some sites (INEL, NTS, and Pantex) are located above deep groundwater such that surface water would not be expected to become contaminated. Other sites (LANL, LLNL, SNL-NM, and WIPP) have a low potential for surface water contamination due to the intermittent nature of most of the site streams. Where contaminated groundwater discharges to the surface, dilution in "clean" surface waters would cause concentrations of contaminants in surface water to be lower than concentrations in groundwater. Therefore, the groundwater pathway was assumed to be the major pathway for movement of contaminants beyond the disposal facility boundary, and was the pathway that was examined in detail.

Routine transportation would involve the intersite movement of waste by truck or rail, and the travel of workers to and from work. Waste materials would not be released during routine transport of wastes; therefore, impacts from transportation would be limited to the deposition and runoff of vehicle emissions

to surface waters, and the infiltration of materials deposited on the surface to groundwater. The vehicle emissions at any one place from transportation of waste are assumed to be minimal. Therefore, potential impacts to surface water and groundwater from routine transportation would be minimal.

Because the waste would be shipped in NRC or DOT approved containers, impacts to water resources would be unlikely unless a ruptured container fell directly into a surface water body. In the unlikely event that waste was released from a shipping container, cleanup response to the accident would be swift, and the release would be contained and cleaned up as quickly as possible. The spill response and cleanup, and any subsequent remediation, would be conducted in accordance with CERCLA (42 USC 9601 *et seq.*), the National Oil and Hazardous Substances Pollution Contingency Plan, and DOE emergency response requirements. Because cleanup would be swift, no long-term impacts to water quality would be expected. For waste transported in Type B NRC certified containers, the probability of container leakage would be very low during an accident. In addition, it is unlikely that there would be any significant release of radionuclides or hazardous constituents from vitrified waste during an accident. Therefore, it is unlikely that transportation accidents involving Type B containers or vitrified wastes would result in impacts to surface water or groundwater resources.

The primary water-related impacts from WM activities are likely to be through groundwater. Nevertheless, there may be sites at which WM activities could cause surface water impacts. The vulnerability of a site to surface water impacts was estimated by comparing selected environmental data at the site. These data include: (1) precipitation, (2) the characteristics of major surface water bodies near the site such as distance to the site and flow rate, (3) the presence of groundwater discharge to surface water bodies near the site, and (4) the presence of nearby surface water supply intakes downstream from the site.

Several of the sites are located in arid climates with limited rainfall and have no discharges to major surface water bodies (i.e., INEL, NTS, Pantex, and WIPP). Site wastewater discharges and stormwater runoff are unlikely to reach major surface water bodies, and little or no groundwater discharges into streambeds. These characteristics make it unlikely that WM activities would produce major surface water impacts near these sites.

At three other arid sites (LANL, LLNL, and SNL-NM), discharges offsite occur only rarely and are made up of stormwater runoff or snowmelt. At these sites, groundwater can seep into the streambeds of the

intermittent streams at times during the year. These characteristics also make it unlikely that major surface water impacts would occur near these sites.

At RFETS, annual average precipitation is also low, but groundwater discharges into the nearby creeks. Parts of the site originally drained via small creeks to two reservoirs that are used for drinking water supplies by the Towns of Broomfield and Westminster. Since 1989, all discharges from RFETS are contained in onsite manmade ponds and diverted to the Broomfield Diversion Ditch, which bypasses the reservoirs and discharges to Walnut Creek downstream from the reservoirs. Although past activities at RFETS have impacted surface water resources, it is unlikely that major impacts to surface waters would occur from the incremental addition of WM activities.

ANL-E, FEMP, Hanford, ORR, PGDP, PORTS, and SRS are located near major water bodies that have large to very large average flows. Groundwater at these sites recharges into the nearby streams and rivers. These characteristics indicate that although some impacts to surface water are likely to occur near these sites, it is unlikely that major surface water impacts would occur.

BNL and WVDP are located near water bodies with small to medium average flows. During wet periods, groundwater discharges to onsite streams. Although these sites are more vulnerable to surface water contamination than the sites discussed in the previous paragraphs, in the near term, surface water impacts from the incremental addition of WM activities are not expected to be major. As described in the Draft WVDP closure EIS (DOE, 1996b), significant impacts to surface water could occur in the future if erosion breaches the waste disposal facilities.

Nearby water supply intakes are not present downstream from most of the sites, although there are nearby water supply intakes downstream from Hanford, ORR, and RFETS. At RFETS, site discharges are routed around the water supply reservoirs. At Hanford and ORR, the large surface water bodies provide a great deal of dilution for any contaminants released from the sites. Therefore, major impacts to downstream drinking water supplies from WM activities are unlikely.

Impacts on surface water resources and drinking water supplies would be considered after the WM facility locations on the sites are selected in sitewide or project-specific NEPA reviews.

5.4.4 ECOLOGICAL RESOURCES IMPACTS

Waste treatment, storage, disposal, and transportation activities may affect communities of plants and animals on and near DOE sites and in the transportation corridors. Three types of impacts were quantitatively evaluated: (1) loss or degradation of terrestrial habitats; (2) toxicity resulting from exposure to radioactive and hazardous contaminants released from waste treatment facilities; and (3) toxicity resulting from spills of radioactive contaminants following transportation accidents.

5.4.4.1 Habitat Impacts

The WM PEIS evaluated the potential for waste management actions to eliminate or disturb portions of existing nonsensitive terrestrial habitat as a result of the site clearing and excavation activities required to build waste treatment, storage, and disposal facilities. Because the specific location of any proposed facility at a given site is not addressed in this PEIS, site-specific impacts on nonsensitive terrestrial habitats at individual sites are difficult to predict or evaluate. However, the WM PEIS analysis assumed that the severity of these impacts would generally be related to the amount of land disturbed in building waste management facilities compared to the overall extent of the range of the plant and animal species that constitute these habitats. Site disturbance is expected to be on the order of acres or tens of acres; plant and animal ranges are on the order of hundreds or thousands of square miles. These comparisons are made in each waste-type impacts chapter.

The potential for site clearing and excavation to affect nearby sensitive habitats, including wetlands and designated critical habitats of Federally- and State-listed endangered and threatened species, was evaluated based on the assumption that the potential for such effects would be proportional to waste management acreage requirements compared to the acreage of nonsensitive land on site. The premise was that the smaller the fraction of available nonsensitive lands that waste management construction required, the greater DOE's flexibility in siting the facility to avoid placement that might affect nearby sensitive habitats. The analysis therefore compared total waste facility acreage requirements at each site having sensitive habitats with the amount of available, nonsensitive land area at each site for each waste type under each alternative. The available land area was determined from site development plans and site environmental reports as either land specifically designated for waste management facility development or as the amount of land remaining after subtracting from the site's total acreage the acreages of wetlands, wildlife management areas, topographic features, existing roads and structures, cultural properties, and other areas and features that

would make development unfeasible. The analysis in each waste-type chapter presents percentage figures for those sites and alternatives under which land requirements equal or exceed 1% of the available land. These are noted as those situations that pose the greatest likelihood of effects to nearby sensitive habitats. Site-specific analyses, tiered from this PEIS, would be conducted to evaluate the extent and severity of these potential impacts.

5.4.4.2 Toxicity From Exposure to Contaminants

The impacts of airborne releases of radionuclides to terrestrial animals living in the vicinity of waste treatment facilities was estimated using atmospheric emission/deposition modeling using the GENII model. This modeling, which used the same atmospheric emissions estimates as used in the human health risk assessment, provided estimates of doses of radioisotopes deposited downwind on soils close to the source and soils distant from the source over the 10-year period of operations. The model also estimated uptake from the soils and transfer in a terrestrial food chain leading to exposure of a small mammal used as a model terrestrial receptor (ORNL, 1995d).

All nonvolatile hazardous chemicals expected to be released from waste treatment facilities were included in the analysis; volatile chemicals are not expected to be significantly redeposited to surface soils. Radionuclides that contributed up to 80% of the total released activity were included in the analysis. The remaining activity was contributed by smaller emissions of a large number of radionuclides. Not including these minor radionuclides may be compensated for by the conservative assumptions used to characterize the scenario (e.g., accumulation of contaminants in surface soils for 10-year period of operation with no loss due to decay or transport).

Total internal and external doses for the model receptors were compared to a benchmark value of 100 millirads per day established by the International Atomic Energy Agency (IAEA, 1992). (A millirad—one thousandth of a rad—is a unit of measure for small amounts of energy absorbed by a material.) No-observed-effect levels (NOELs) were used as benchmarks for exposures to chemicals. The resulting ratio of chemical doses to NOELs, the Hazard Index (HI), is used to identify alternatives that may be of concern for potential ecotoxicity. When the dose exceeds the benchmark, that is, when the HI is greater than 1 ($HI > 1$), there is a potential concern for the development of adverse effects in terrestrial receptor populations as a result of the exposure.

5.4.4.3 Effects on Sensitive Species

The ecological impacts analysis in this PEIS does not determine the likelihood and severity of habitat impact effects on sensitive species, including Federally and State-listed endangered and threatened species, because the specific waste management facility locations at the various sites are not yet proposed. These evaluations would be included in sitewide or project-level NEPA analyses. However, the WM PEIS analysis does provide information to the decisionmaker concerning the sensitive species that may be affected by the proposed waste management facilities at each site. Chapter 4 describes the sensitive species at each site and provides a summary table of the Federally- and State-listed species known to occur, or with the potential to occur, at the 17 major sites. The waste-type impacts chapters list in tabular form the numbers of Federally- and State-listed endangered and threatened species that might be affected at each site under each alternative where DOE is proposing to build waste management facilities.

In addition to impacts through disturbance of habitat, sensitive species may be affected by exposure to contaminants released from waste treatment and storage facilities. These impacts are expected to be similar to those estimated for nonsensitive species, as described previously in this section (see discussion under the heading "Toxicity From Exposure to Contaminants"). However, unlike for nonsensitive species, estimated adverse impacts to a single organism may have a significance for the entire population. Therefore, careful consideration of potential actions to mitigate toxic effects to sensitive species is required. Potential toxicity effects on sensitive species can be better addressed in sitewide or project-specific NEPA analyses tiered from the WM PEIS.

5.4.4.4 Toxicity From Transportation Spills

The ecological impacts of waste transportation accidents were evaluated as consequence assessments that estimated the potential impacts of releases of radionuclides or hazardous wastes under certain spill scenarios but did not include estimates of the probability of these events occurring.

The postulated transportation accident scenario involves a rail shipment spill of waste directly into surface waters of different classes. Assessments were performed for stream-size classes ranging from a small second order stream (e.g., flow rate of a few meters per second) to a tenth order major continental river (e.g., the Mississippi River). For aquatic biota exposed to contaminants released as a result of waste transportation accidents, short-term, acute toxic effects are assumed to occur if the estimated doses exceeded the maximum

safe dose of 1 rad per day (rad/day) recommended by the National Council on Radiation Protection and Measurements (NCRP, 1991). Spills of hazardous chemicals were not assessed quantitatively due to the extreme variability in the types and amounts of chemicals that would be shipped. Although it is unlikely that an accident involving wastes with hazardous constituents (LLMW, TRUW, HLW and HW) would involve releases into a surface water body or wetland area, this type of accident could cause adverse impacts to aquatic organisms. The severity of the impact would depend largely on the type of waste involved, the amount of waste released, and the characteristics of the surface water body affected.

Accidents involving wastes contaminated by metals would be unlikely to cause major impacts due to their generally low acute toxicity, and low solubility of most metals in natural surface waters. Clean-up efforts mandated by EPA and DOE regulations would reduce the possibility of any long-term effects. Accidents involving wastes contaminated by low concentrations of organic chemicals would be unlikely to cause major impacts due to the small amount of contaminants present, and the volatile nature of many of these compounds. Accidents involving large releases of liquid organic compounds (e.g., spent solvents) are likely to cause significant mortality of aquatic organisms due to acute effects. Chronic effects are less likely due to mandated clean-up efforts. These impacts would also vary with the amount of dilution provided by the surface water body; large rivers would provide more dilution than small streams or stagnant marshlands.

5.4.4.5 Toxicity From Facility Accidents

Toxicity impacts due to facility accidents on terrestrial and aquatic ecosystems on and near the sites were not specifically evaluated. DOE assumes that facility accidents would affect all or portions of these ecosystems, potentially causing acute and chronic effects to exposed communities. The human health risk assessment of facility accidents provides information on the predicted frequency of occurrence and severity of these accidents. That analysis indicated that for the more severe, lower frequency accidents, human health effects, including acute and chronic illnesses and death would result. Effects on ecosystems exposed during these accidents would likely be of the same severity, at least on a local basis. Emergency response procedures should limit the areal extent of severe effects, especially chronic effects.

5.4.5 ECONOMIC IMPACTS

The economic impacts analysis used changes in disposable income, output (monetary value of industry sales), job-years, and employment. In addition, baseline data were available for disposable income and employment, so percent changes in the baseline income and employment were analyzed at both the regional and national levels.

Economic Impacts in the Host Communities. Expenditures for labor and materials to build and operate waste management facilities were evaluated for effects in terms of job creation, changes in personal income, and changes in economic output in the regional economy at each of the 17 major sites. For these sites, the region of influence (ROI) for economic effects was determined based on the residence patterns of the site employees. In addition to the host county, counties were included in the ROI if they contained 5% or more of the current site workforce. If the total represented by these counties did not represent at least 90% of the total site workforce, counties with progressively lower percentages of site workforce were included until the 90% threshold was met. Contiguous counties were included by exception (DOE, 1993c).

To determine the total regionally based economic effects across all the waste management sites, a parallel analysis was conducted for the minor sites, although these sites are not addressed individually in the impacts chapters. To minimize data and analysis requirements, the ROI for the minor sites consisted of the host and contiguous counties.

DOE recognizes the potential for negative public perceptions associated with its waste management program; for example, real estate property values in the vicinity of a radioactive waste disposal facility may decline, or the region may experience some effect on its ability to attract a diversified business base. However, the extent of such impacts is not amenable to analysis at the programmatic level without specific information on the location of any proposed facility and, thus, has not been included in this PEIS.

Impacts in the National Economy. Changes in National employment, personal income, and economic output were calculated based on complexwide expenditures for labor and materials required to construct and operate all waste management facilities for each waste type under each alternative. National level economic impacts were also estimated on the basis of total expenditures for intersite transportation and (where applicable) commercial treatment and disposal of waste.

Economic Impacts Evaluation. The economic impact analysis assumed that direct expenditures on labor and materials for constructing and operating waste management facilities would lead to subsequent cycles of spending. An initial expenditure by DOE becomes income to the recipient, who in turn spends a portion of the money, thereby increasing income in the economy for the second time. This process of multiple rounds of spending continues until all the money is used for savings, taxes, or the purchase of imported goods.

The first step in the analysis was to estimate general regional economic multipliers, which quantify how responsive the various regional economies and national economy were to changes in the level of expenditures. These economic multipliers quantify the change in employment, personal income, or industry output per unit input of money. Each site ROI and each industry within an ROI had a unique degree of responsiveness to changes in the level of expenditures. General multipliers for employment, personal income, and economic output were developed for 80 industries for the site ROIs and the national economy (DOC, 1992c). A simplifying assumption was made that the average (mean) multiplier was an unbiased and efficient estimator of the 80 separate industry multipliers.

A set of behavioral assumptions was applied in the calculation of multipliers. A national savings rate of 5% of personal income was deducted from the first cycle expenditures. An additional 32.1% was deducted for taxes and benefits. The full economic consequences of waste management activities (construction phase and operations phase) were assumed to continue for an additional 5-year period beyond the end of each phase (Cuthbertson and Nitzsche, 1994).

Economic Impacts Data. The baseline data come from the U.S. Department of Commerce, Bureau of Economic Analysis. The Bureau's "Regional Economic Information System" provides historical data on employment and personal income (DOC, 1992b).

5.4.6 Population Impacts

The population impacts analysis evaluated effects associated with any large-scale industrial or public works project, such as the introduction of new workers to the surrounding region or increased demand on services.

5.4.6.1 Population Impacts Evaluation

The ROI for population impacts was the same as the ROI defined for the economic impacts analysis.

Estimates of worker in-migration were derived from predicted labor requirements for the treatment, storage, or disposal facilities proposed under each alternative for each site. Total in-migration to the region surrounding each site was calculated based on the average household size of worker families; calculations for both construction and operations phases were made. The potential for impact on community characteristics and on the provision of social services was derived by comparing the size of potential in-migrating populations with the current regional population (Canter, 1977; Halstead et al., 1984).

Sites experiencing an estimated in-migration greater than 1% of the total 1990 ROI population were considered to have a significant potential for creating change to the social environment. This criterion is based on the assumption of a minimum 1% surplus capacity in public service delivery systems, infrastructure, and other health and welfare services. An increase of less than 1% would also not normally be expected to change the general distribution of demographic characteristics within the population as a whole (e.g., change the character of the population by changing the percentage of the population in a given category such as gender, marital status, etc.). These sites were identified for the analysis of each alternative under each waste type. Additionally, sites with estimated population increases over 0.5% were assumed to have a potential for minor impact to social characteristics and social services and are noted in the waste-type impacts discussions where appropriate. Where labor requirements during construction and operations were insufficient to stimulate a large in-migration to the ROI (less than 0.5%), associated impacts were considered to be unlikely to affect the local social environment.

The analysis assumes that the in-migrating workforce will be distributed throughout the ROI in the same proportions and densities as the current ROI population, since the precise location of any new facilities on a given site and the likely residence location preferences of the new workers are not available at this time. Although this analysis used the 1% population increase as a general guideline in estimating the potential effect of population change on the region as a whole, noticeable effects may occur at much lower levels if new in-migrants would be concentrated in one or two communities, rather than distributed throughout the ROI.

The potential for a rapid or sudden increase in population migration to the region of influence resulting from the cumulative effect of this action when overlapped with other planned or foreseeable projects at the site is a serious consideration for the analysis of site-level impacts associated with this analysis. Population impacts are therefore conservatively assessed to highlight those actions and alternatives that can cause rapid change. This is especially important during the construction phase, when peak periods for multiple projects may cause a sudden sharp increase in temporary employment at the site. Since the actual timing of peak employment periods is not available for this analysis, only a very general discussion is possible at the programmatic level. However, peak period employment is provided in *Waste Management Environmental and Socioeconomic Impacts Methods and Results* as a guide to later site-specific analysis and for local planners in the affected regions (DOE, 1996a).

5.4.6.2 Population Impacts Analysis Data

Statistical descriptions of population and demographic characteristics for the ROI were developed from 1990 U.S. Census data (DOC, 1992a). New workforce estimates were based on the full-time equivalent (FTE) labor requirements developed from the engineering analysis of waste management facilities and waste management activities required at each site for each alternative. Estimates of worker family size were based on 1990 census data for the national average population per household for 1991, or 2.63 persons (DOC, 1992a). The estimate of in-migration was developed by calculating the total number of potential new workers (direct, indirect, and induced) from the engineering analysis estimates, and adjusting it for the estimated percentage of the workforce that might be drawn from the ROI itself (see Appendix C for a discussion of the analytical approach to influences on worker in-migration). Potential in-migration was then estimated on the basis of the remaining percentage of the total workforce anticipated to come from outside the ROI multiplied by average household size.

5.4.7 Environmental Justice

In February 1994, Executive Order 12898, entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (FR 1994), was issued. This order directs Federal agencies to achieve environmental justice as part of their missions. As such, Federal agencies are specifically directed to identify, and address as appropriate, disproportionately high and adverse human

health or environmental effects of their programs, policies, and activities on minority populations and low-income populations.

5.4.7.1 Status of Guidance on Environmental Justice

In addition to describing environmental justice goals, Executive Order 12898 directs the Administrator of the EPA to convene an interagency Federal Working Group on Environmental Justice (referred to as the Working Group). The Working Group is directed to provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. The Working Group is also directed to coordinate with each Federal agency to develop an environmental justice strategy, if a strategy is required by the proposed activities. Although the Working Group has not issued final guidance on the approach to be used in analyzing environmental justice, it has issued draft definitions of terms in the *Draft Guidance for Federal Agencies on Key Terms in Executive Order 12898*, dated November 28, 1994. These definitions, with slight modifications, were used in the WM PEIS environmental justice analysis. Further, in coordination with the Working Group, DOE has issued draft internal guidance for the implementation of the Executive Order. Because both DOE and the Working Group are still in the process of developing final guidance, the approach used in this analysis might depart somewhat from whatever guidance is eventually issued.

For the environmental justice assessment, the following Working Group definitions were used:

- **Disproportionately high and adverse human health effects**—Any human health effect from exposure to environmental hazards that exceeds generally accepted levels of risk and affects minority or low-income populations at a rate that appreciably exceeds the rate for the general population. Adverse health effects are measured in risks and rates that could result in latent cancer fatalities and other fatal or nonfatal adverse impacts to human health.
- **Disproportionately high and adverse environmental impacts**—A deleterious environmental impact determined to be unacceptable or above generally accepted norms. A disproportionately high impact refers to an environmental hazard with a risk or rate of exposure for a low-income or minority population that appreciably exceeds the risk or rate of exposure for the general population.

5.4.7.2 WM PEIS Analysis of Environmental Justice Impacts

In order to determine potential environmental justice impacts for this assessment, DOE first identified and mapped the distribution of minority and low-income populations. DOE examined the composition of the population residing within 50 miles of the 17 major sites and then reviewed the human health effects and environmental impacts on the general public associated with alternatives for the five waste types. The review included potential impacts under each of the major disciplines evaluated for the waste-type alternatives, including health risk, air quality, water resources, ecology, economics, population impacts, land use, and infrastructure impacts, which are the sciences pertinent to the identification of the waste-type alternative environmental impacts. Regarding health effects, normal facility operations were examined and evaluated in terms of the risk to the public. The examination of transportation included both normal and potential accident conditions for both truck and rail transportation of the waste types. As described more fully below, these impacts were then examined to determine whether they were expected to be high and adverse. Except as noted below, because the risks to the general population resulting in the 50-mile zone of impact at each site are not expected to be high, DOE would not expect minorities or low-income populations to experience disproportionately high and adverse health effects from the alternatives considered in the WM PEIS.

5.4.7.2.1 *Identification and Mapping of Minority and Low-Income Populations*

For each of the 17 major waste management sites, demographic maps (see Appendix C) were generated through a geographic information system that used 1990 census data available from the U.S. Bureau of the Census. Data were resolved to the census tract group level. A census tract is an area defined for the purpose of monitoring census data that is usually composed of between 2,500 and 8,000 persons. Figures C.4–7 through C.4–40 illustrate census tract distributions for both minority and low-income populations residing within 50 miles of the 17 DOE sites being considered for the management of the five waste types. Native American Tribal lands within 50 miles of each site were also identified and mapped and are included in Appendix C, where applicable, with the minority distribution maps C.4–7 through C.4–23. These maps are based on an analysis of 1990 United States Bureau of the Census Tiger Line files, which contain political boundaries and geographical features, and Summary Tape Files 1 and 3, which contain demographic information (DOC, 1992d,e). (Data from the 1990 Bureau of the Census files are the latest

data available on a national level.) Appendix C provides the data definitions and methods used to develop the maps.

A ***minority population*** is a group of people and/or community experiencing common conditions of exposure or impact that consists of persons classified by the U.S. Bureau of the Census as Negro/Black/African-American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, or other nonwhite, based on self-classification by the people according to the race with which they most closely identify. For purposes of this analysis, a minority population consists of any census tract within the 50-mile zone of impact with a minority population proportion greater than the national average of 24.4%. A ***low-income population*** refers to the U.S. Census Bureau data definitions of individuals living below the poverty line. The poverty line is defined by a statistical threshold that considers family size and income (see Appendix C). For purposes of this analysis, low-income population consists of any census tract within the 50-mile zone of impact with a low-income population proportion greater than the national average of 13.1%.

Native Americans. While recognizing the unique Tribal Nation Status, DOE has also included Native Americans as part of the overall regional minority populations when analyzing for disproportionately high or adverse impacts to minorities. Since the interests of Native American groups are unique to each site, the analysis of impacts to these groups and resources is more appropriate to a site-level assessment. This PEIS identifies those sites where recognized Native American groups are present in the region. Where Native Americans do not comprise a recognized group, they are still considered as a part of the site minority population. Known Native American traditional and historic properties are also identified in Chapter 4, The Affected Environment.

5.4.7.2.2 *Review of High and Adverse Health Risks and Environmental Impacts*

The environmental justice analysis presented in each waste type chapter reviewed the findings of the risk assessment for public health effects from proposed waste management activities at each site. Screening criteria (see Appendix C) based on WM PEIS population risk modeling were applied at each site to determine potential high and adverse health effects. Because the WM PEIS human health risk assessment findings indicated that risks to the general population residing in the 50-mile zone of impact at each site

would be low, it was reasonable to conclude that no segment of the population, including any minority or low-income populations, would experience disproportionately high and adverse health risks.

5.4.7.2.3 *Subsistence Consumption*

With regard to the impacts analyzed in this PEIS, and in the absence of subsistence consumption data by population subgroups, DOE prepared Table 5.4–5 using the following criteria and assumptions, listed in order of importance, to identify groups of sites that may be near minority and low-income populations potentially engaging in subsistence consumption:

- Proximity of Tribal Lands to DOE sites (the presence of Native Americans near DOE sites is assumed to create a greater possibility of subsistence consumption)
- Distance of the DOE site to major surface water bodies (populations nearer water are assumed to have a greater possibility of subsistence consumption of fish)
- Population density in the 50-mile region of influence around the site (rural residents are assumed to have a greater possibility of engaging in subsistence hunting and fishing)
- Proximity and concentration of minority and low-income populations to DOE sites (higher concentrations of minority and low-income populations are assumed to have a greater potential for subsistence consumption)

The 17 major DOE sites appear in the table in three groups: those with the highest possibility for subsistence consumption, those with intermediate possibilities for subsistence consumption, and those with the lowest possibilities for subsistence consumption. As Table 5.4–6 shows, more rural sites with recognized Native American groups are assumed more likely to engage in subsistence hunting and fishing. These include Hanford, INEL, LANL, RFETS, SNL, SRS, WIPP, and WVDP. Sites of intermediate concern include NTS, ORR, PGDP, and PORTS because of the respective site's rural surroundings, the presence of Native American populations, the presence of minority or low-income populations, or the presence of surface water on site. While sites like ANL and LLNL have a large percentage of minorities, both sites are in urban areas with populations of 8 and 6.3 million, respectively. Because of these factors, ANL and LLNL are listed along with BNL, FEMP, and Pantex as having a lower possibility of populations who principally rely on fish and/or wildlife for subsistence. Subsistence consumption analyses performed for other DOE EISs generally show no high and adverse impacts or are inconclusive. The notable exception

Table 5.4–6. Factors Contributing to the Possibility of Subsistence Consumption of Fish and Wildlife

Site	Federally Recognized Native American Groups[a]	Distance to Major Surface Water Bodies	Population in the 50-Mile Region of Influence (in millions)	Percent Minority (within a 50-mile radius)	Percent of Low-Income Populations
Sites With Higher Possibility of Subsistence Consumption					
Hanford	Yes	On site	0.35	25.8	18.8
INEL	Yes	NA[b]	0.11	10.2	12.5
LANL	Yes	At site boundary	0.27	48.1	13
RFETS	Yes	On site	1.98	19.7	9.8
SNL	Yes	6 miles	0.61	45.1	14.8
SRS	Yes	At site boundary	0.59	37.8	18
WIPP	Yes	NA	0.10	36.9	21.6
WVDP	Yes	On site	1.54	11.6	12.2
Sites With Intermediate Possibility of Subsistence Consumption					
NTS	Yes	NA	0.01	12.8	12.6
ORR	None	At site boundary	0.88	6.1	16.2
PGDP	None	<2 miles	0.50	9.1	19.1
PORTS	None	<1 mile	0.61	3.2	20.8
Sites With Lower Possibility of Subsistence Consumption					
ANL	None	<1 mile	8.03	33.5	11.4
BNL	None	On site	5.26	21.4	5.4
FEMP	None	<1 mile	2.64	13.2	11.8
LLNL	None	NA	6.31	40.9	9.5
Pantex	None	NA	0.27	19.8	15.2

[a] The presence of a Federally recognized Native American group was assumed to be the most important indicator of potential substance fishing and hunting. The remaining factors are listed in descending importance from left to right.
[b] No major surface water bodies within the Region of Influence.

is the Hanford Tank Waste Remediation System EIS, which identified potential disproportionate impacts to Native Americans. These are discussed in Appendix C, Section C.4.7.2.4.

5.4.8 LAND USE

The land resources analysis evaluated the potential for waste management alternatives for the five waste types to adversely affect land use at the sites. The evaluation was made by comparing the amount of land required for proposed waste treatment, storage, or disposal facilities with the amount of land designated for future waste management operations in the site development plans for the 17 major sites. If these sites did not have a portion of the site specifically designated for waste operations, the land required for a waste management facility was compared with an estimated amount of land considered suitable for waste management facility development. This estimate was made by subtracting from the total site acreage the known or estimated acreage of land in existing structures, sensitive habitats including wetlands, topographic and surface water features, and other features such as wildlife management areas and cultural resources.

At sites where the land requirement estimated for the proposed waste management facilities constituted 1% or more of designated or suitable land, a potential for impacts was noted in the waste type impacts discussion, and the percent required was listed in a summary table for the site/alternative. The 1% threshold was used as a general impact screening level. DOE assumed that, below the 1% level, significant impacts were unlikely and thus did not analyze these sites further. For sites above the 1% threshold, DOE assumed that there may be a potential for significant impacts. Additional analysis for sites above the 1% threshold includes the severity of impacts depending on the percentage required of the available land and an indication of the likelihood of conflicts with land uses adjacent to the site. If the land requirement for proposed facilities exceeded the amount of land designated or suitable, significant land use impacts were considered likely. The analysis also indicated whether the description of future uses given in a site's current development plans would potentially conflict with the uses proposed under the waste type alternatives.

The analysis also assumes that, regardless of the site, waste-type, or alternative, waste management facilities would not be located in the 100-year floodplain. If it is determined in sitewide or project-level NEPA analyses that the facilities are "critical actions" under the DOE floodplain regulations, they would not be located in the 500-year floodplain. Compliance with the requirements of Executive Order 11988, Floodplain Management (Executive Order 11988, 1977) and 10 CFR 1022, Compliance with Floodplain/Wetlands

Environmental Review Requirements, would be examined in detail in these sitewide or project-level NEPA reviews.

5.4.9 INFRASTRUCTURE IMPACTS

The infrastructure impacts analysis evaluated the impacts of the alternatives on onsite and offsite infrastructure by comparing the resource requirements of building and operating proposed waste treatment, storage, and disposal facilities to existing capacities of onsite infrastructure systems and to current offsite demand. The infrastructure resources considered in this evaluation include: (1) water supply (potable and process), (2) wastewater treatment facilities (sanitary and process), (3) electrical power supply, and (4) onsite transportation infrastructure. The impacts assessment evaluated the separate effects of the construction phase and the operations phase of each alternative for each of the waste types.

5.4.9.1 Onsite Impacts

The effects of the alternatives on each site's onsite infrastructure systems (except transportation) were assessed quantitatively by comparing the new demand under each alternative to the existing maximum capacity of the site's infrastructure. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current demand for each resource category.

DOE assumed that new resource requirements less than 5% of current capacity would have minor or negligible impacts. Increases in requirements of 5% or greater were assumed to have the potential to cause moderate or major impacts, and were further evaluated on a site-by-site basis. An increase of 5% or greater that, when added to current use, caused total demand to exceed 90% of maximum available capacity was assumed to have a major impact. These percentages were selected as a conservative approach to alert decisionmakers to the potential for significant impacts.

Onsite transportation impacts were evaluated by comparing new onsite employment to existing site employment. New employment totals of less than 5% of current totals were assumed to have negligible or minor impacts. Increases in employment of 5% or greater were assumed to have the potential to cause moderate impacts, and increases of 15% or greater were assumed to have potentially major impacts. As

with the new project demands, these percentages were selected in order to identify the potential for significant impacts.

5.4.9.2 Offsite Impacts

New resource requirement demands on offsite infrastructure for each alternative were compared with estimated current demand. New offsite demands under the alternatives was based on population increases from the social impacts analysis. Similarly, the estimated current demand was based on 1990 regional population data from the social impacts analysis. Evaluation of the transportation effects on infrastructure resources was based on forecasted increased traffic from employees directly or indirectly associated with the alternatives, based on population changes developed by the social impacts analysis.

New offsite demands of less than 5% of current demand were assumed to be negligible or to result in minor impacts. Increases in demand of 5% or greater were assumed to have the potential to cause moderate impacts, and increases of 15% or greater were assumed to have potentially major impacts. These conservative assumptions allow DOE to identify the potential for significant impacts.

The following assumptions were made in the evaluation of infrastructure impacts:

- Wastewater treatment demand was assumed to be equal to water use. Sanitary sewage and industrial wastes are derived principally from the water supply (McGhee, 1991), and the amount of water used by a city is a good indicator of the amount of sewage that will be generated (Viessman and Hammer, 1985). Where actual data on municipal rates of wastewater were unavailable, water supply records were used to estimate wastewater flow (Metcalf & Eddy, 1991).
- Existing capacity indicates either the capacity of the onsite infrastructure or the allocation to the site by an offsite infrastructure system. Where maximum capacity information was not available, it was assumed that a comparison of new demand to existing demand is an acceptable indicator of potential impacts.
- Offsite impacts to infrastructure were assumed to be limited in aerial extent to the ROI used in the socioeconomic analyses.

5.4.10 CULTURAL RESOURCES

The cultural resources addressed in the WM PEIS analysis include prehistoric and historic resources, and Native American resources. Paleontological resources, though not cultural in origin, are also included because of their recognized value and similar need for protection.

Prehistoric and Historic Properties. A "historic property" is an archeological site, standing structure, or traditional cultural property that is listed or is potentially eligible for listing on the National Register of Historic Places. Requirements for the assessment of historic properties are met through compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 470 *et seq.*), and with implementing regulations contained in 36 CFR 800.

Federal agencies are required to determine the effect that proposed actions may have on significant historic properties within the defined area of potential effects. The "area of potential effects" usually comprises the physical limits of disturbance or alteration that will result from implementing the proposed actions, such as construction or operation of a waste management facility. The presence or absence of historic properties within the area of potential effects (36 CFR 800.4) is then determined.

An adverse effect is assumed whenever the integrity of the cultural resources' property location, design, setting, materials, workmanship, feeling, or association may be diminished. Adverse effects on historic properties include, but are not limited to: (1) physical destruction, damage, or alteration; (2) isolation of the property or alteration of the character of its setting; (3) introduction of visual, audible, or atmospheric elements that are out of character; (4) neglect resulting in deterioration or destruction; and (5) transfer, lease, or sale of the property (36 CFR 800.9.b.1–5). If no cultural resources are identified that are eligible or potentially eligible for the National Register of Historic Places, then, in consultation with the State Historic Preservation Office and in the absence of any other significant cultural or Native American resources, it can be assumed that the project will have no effect on historic properties and the action may proceed.

Native American Resources. Native American resources refer to structures, regional locations, natural features, native plants, objects, and other materials considered to be of value to contemporary Native American groups for traditional, religious, or ceremonial purposes. Resources involve geographic locations and their settings such as: burial grounds; sacred sites or areas; materials for producing sacred objects and

traditional implements; botanical, biological, and geological resources of ritual importance; and natural elements. Impacts to these areas include both direct physical impacts (e.g., destruction, damage, or reduced access to sacred sites preserved in their natural settings) and indirect social and economic effects (e.g., disruption or intrusion on religious beliefs and cultural practices of tribal peoples closely connected to the earth and its resources). Several laws and Executive Orders are specifically applicable to the protection of Native American resources, including the American Indian Religious Freedom Act of 1978 (42 USC 1996 *et seq.*), the Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001 *et seq.*), and Executive Order 13007 regarding sacred sites. Implementation of these statutes as well as 36 CFR Part 800 depends on establishing government-to-government consultation with American Indian tribes that have treaty and traditional interests in DOE lands.

Paleontological Resources. Paleontological materials and features are the physical remains of life forms (fossils) from a former geologic age. These include the remains of animals, plants, or trace fossils, such as impressions, burrows or tracks. Although paleontological resources are not treated with the same level of specificity as archeological or historic properties, they are addressed in several Federal statutes, such as the Federal Land Management Policy Act of 1976 (43 USC 1701 *et seq.*).

Cultural Resources Approach. Cultural resources are not uniformly distributed across the landscape but are located with reference to physical and human geography. Therefore, the actual physical location selected for the construction of a facility is the most important factor in determining the nature and extent of any potential impact. Because the specific locations of proposed waste treatment, storage, or disposal facilities at any of the DOE sites are not being selected in the WM PEIS, potential impacts to cultural resources cannot be thoroughly analyzed in this programmatic document. DOE will evaluate the potential impacts to cultural resources, including Native American resources, in sitewide or project-specific NEPA reviews prepared to evaluate alternative locations on a particular site where a waste management facility should be constructed.

Table 4.3–8 lists the known archaeological resources for each site. Only ANL-E, RFETS, and SNL-NM have been completely surveyed. With one exception (SNL-NM), wherever surveys have been conducted archaeological sites have been found. At all but two DOE sites (RFETS and WVDP) where archaeological sites have been found, at least some of the archaeological sites have been found to be eligible for the National Register of Historic Places. Even where surface surveys have been completed, however, the possibility of significant archaeological remains that have left no surface indicators cannot be excluded. The

extent to which these archaeological resources may be affected by a given alternative can be assessed only when specific construction locations have been determined. Once identified and evaluated, a plan for the management of affected cultural resources must be developed in consultation with the relevant SHPO and any Native American group whose traditional resources may be affected. Management plans include provisions for protection, mitigation (often excavation), and access to cultural resources, as appropriate.

5.4.11 GEOLOGY AND SOILS

As indicated in Chapter 4, Affected Environment, DOE's review of the geology and soils at the 17 major sites indicated that it is unlikely that impacts to these resources would affect the selection of alternatives for any waste type. For this reason, the impacts analysis in the waste-type chapters do not address geology and soils.

While geology and soil characteristics are important determinants of where on a particular site a facility could be located, such determinations are not being made at this time. The exact location of waste management facilities at selected sites will be the subject of sitewide or project-level NEPA reviews. For the DOE sites that are candidates to host waste management facilities, the land use impacts analysis determined whether there is sufficient acreage available to allow a choice among several locations.

Most of the DOE sites are in stable geologic areas. However, seismic characteristics of the sites being considered for waste management facilities were taken into account in the health risk assessment by evaluating potential accident scenarios in which exposure to chemical or radiological constituents of the waste might occur.

An analysis of soil erosion is necessarily site-specific and can be mitigated by site-specific selection processes. Similarly, the assessment of the potential to deny access to mineral resources will be deferred until sitewide or project-level NEPA documents are prepared.

5.4.12 NOISE

Noise impacts to workers were not examined in the WM PEIS, because hearing protection would be provided to all WM workers as required by OSHA regulations, and noise impacts are especially dependent

on the WM technologies employed. In addition, noise from the construction and operation of waste management facilities, and increased vehicle traffic may cause adverse impacts to the offsite public and wildlife. Because waste management facilities will be placed on industrial type sites and added traffic will be largely on high-volume corridors, these activities should not substantially increase the general ambient noise levels. In certain cases, however, sensitive receptors may be affected. These localized effects were not evaluated in this PEIS because the specific locations of any new activities relative to the locations of sensitive noise receptors at the sites cannot be accurately predicted. Since the WM PEIS will not be selecting the locations of the WM facilities, nor the technologies to be employed, noise impacts cannot be evaluated at this time, but will be considered in future sitewide or project-specific NEPA reviews.

5.4.13 CUMULATIVE IMPACTS

In addition to the environmental impacts associated with each alternative under each waste type, this document analyzes the cumulative impacts of siting one or more waste management facilities for one or more waste types at specific sites. These cumulative impacts include not only the impacts of potentially managing more than one waste type at a site, but also the "past, present, and reasonably foreseeable future actions" at that site (40 CFR 1508.7).

Considering five waste types, the four alternative categories comprising 36 Alternatives, and 17 potential sites, numerous combinations of possible alternatives cumulative impacts could be analyzed. Performing all possible cumulative impact analyses and including those analyses in the WM PEIS is neither warranted nor desirable.

In order to accomplish a reasonable analysis framework, DOE displays "minimum" and "maximum" impact alternatives for each DOE site. The WM PEIS indicates which combination of alternatives would impose the least cumulative impacts on that site and which would impose the most cumulative impacts. All other combinations of alternatives applicable to that site would fall somewhere between the minimum and maximum impacts. Impacts not addressed in the WM PEIS that have occurred, are occurring, or will occur at the sites are also included in the cumulative impact analyses (these non-WM PEIS activities are assumed to be constant for all the combinations applicable to a specific site).

In addition, quantitative information regarding the impacts from each alternative for each waste type at a particular site is available from tables included in Volume II of the WM PEIS. From those tables, it is possible to quantitatively estimate the cumulative impacts of any particular combination of alternatives. Guidance for performing that calculation is provided in Chapter 11.

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CHAPTER 6
Impacts of the Management of Low-Level Mixed Waste

Chapter 6 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for low-level mixed waste (LLMW). This chapter provides information on existing and anticipated LLMW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to LLMW characteristics, the treatment and disposal technologies considered, and the rationale for selecting the specific sites analyzed under each alternative. The chapter discusses the health risk, environmental impacts, and costs of the alternatives, and provides a comparison of the alternatives.

The methods used to evaluate impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the LLMW analysis are contained in the Technical Report entitled "Low-Level Mixed Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports provided in Chapter 15.

6.1 Background

6.1.1 DEFINITION AND ORIGIN OF LLMW

- *LLMW contains both radioactive and hazardous components.*
- *LLMW is generated, projected to be generated, or stored at 37 DOE sites as a result of research, development, and production and dismantlement of nuclear weapons.*
- *Waste management activities will require management of an estimated 219,000 cubic meters of LLMW over the next 20 years.*
- *DOE must select treatment and disposal sites for LLMW.*

Low-level mixed waste contains Resource Conservation and Recovery Act (42 USC 6901 *et seq.*) (RCRA)-controlled substances and is radioactive. It is managed according to RCRA requirements because of its RCRA hazardous waste characteristics and according to the Atomic Energy Act (AEA) (42 USC 2011 *et seq.*) because of its radioactive components. The hazardous component of this LLMW is subject to either (1) EPA regulations promulgated under RCRA, (2) EPA regulations for polychlorinated biphenyls (PCBs) promulgated under the Toxic Substance Control Act (TSCA), or (3) State hazardous waste regulations promulgated under RCRA. LLMW has been generated by DOE as a result of research, development, and production of nuclear weapons; however, LLMW generation from nuclear weapons production and nuclear research is declining.

6.1.2 VOLUMES AND LOCATIONS

LLMW is generated, projected to be generated, or stored at 37 DOE sites. According to DOE estimates, waste management activities will require management of approximately 219,000 cubic meters of LLMW over the next 20 years. The total volume of wastes after treatment requiring disposal will be about 72,000 cubic meters. Additional LLMW generated by environmental restoration activities is discussed in Section 6.15.

Table 6.1-1 presents the estimated total volume of LLMW from waste management activities at each of the 37 LLMW sites. (Details of the amounts and characteristics of LLMW are provided in ANL [1996].) Both inventory wastes and 20-year projected wastes (1994–2013) are provided. The *Mixed Waste Inventory Report* (DOE, 1994) was used for all LLMW inventories and generation rates, except for Colonie, ETEC, and RFETS, which use late 1994 site estimates, and ANL-E and NTS, which use the *Mixed Waste Inventory Report* (DOE, 1995c). Where MWIR totals were provided for only 5 years, waste volumes were extrapolated to provide waste totals for the 20-year analysis period. PCB wastes have been included both in the data presented in Table 6.1-1 for each of the sites and in the analysis of impacts presented later in this chapter. Information on waste volumes updated from the Draft WM PEIS was used for ANL-E and NTS (DOE, 1995c). The analysis presented in the WM PEIS is based on this newer information for those two sites. A more complete discussion on data used in the WM PEIS analysis is presented in Appendix I.

This WM PEIS analyzed the impacts of managing LLMW at 16 major sites (WIPP, another major site, will not have LLMW). In general, the remaining 21 LLMW sites have very small existing and projected volumes and therefore were not considered major sites. Figure 6.1-1 presents the total LLMW volumes at the 16 major sites considered under the LLMW alternatives.

Owing primarily to improvements in waste characterization, projected waste volumes and inventories of LLMW have changed since the analysis of these wastes was carried out for the WM PEIS. A discussion of these changes in the waste volume estimates at each site, including updates taken from newer databases, is found in Appendix I. This appendix also identifies criteria for reanalyzing sites using the more recent data and describes DOE's conclusions about the need to analyze the more recent data for specific sites.

Table 6.1–1. Low-Level Mixed Waste Volumes (cubic meters)

Site	Inventory	20-Year Projected Generation	Estimated Inventory Plus 20 Years Generation
1. Ames Laboratory (Ames)	0.3	0.1	0.4
2. Argonne National Laboratory-East (ANL-E)[a]	34	125	159
3. Battelle Columbus Laboratories (BCL)	0	0.1	0.1
4. Bettis Atomic Power Laboratory (Bettis)	32	16	48
5. Brookhaven National Laboratory (BNL)	85	110	190
6. Charleston Naval Shipyard (Charleston)	0.3	3	3
7. Energy Technology Engineering Center (ETEC)[a]	3.7	13	17
8. Fernald Environmental Management Project (FEMP)	2,600	48	2,600
9. General Atomics (GA)	43	0.4	43
10. Grand Junction Project Office (GJPO)	0.6	0.9	1.5
11. Hanford[b]	3,100	33,000	36,000
12. Idaho National Engineering Laboratory (INEL)	25,000	9,600	35,000
13. Kansas City Plant (KCP)	0.8	0	0.8
14. Knolls Atomic Power Laboratory (KAPL)	3.1	220	220
15. Laboratory for Energy-Related Health Research (LEHR)	4	3	7
16. Lawrence Berkeley Laboratory (LBL)	6	270	280
17. Lawrence Livermore National Laboratory (LLNL)	230	4,100	4,300
18. Los Alamos National Laboratory (LANL)	670	2,100	2,800
19. Mare Island Naval Shipyard (Mare Is)	10	42	52
20. Mound Plant (Mound)	76	4	80
21. Nevada Test Site (NTS)[a]	300	2,700	3,000
22. Norfolk Naval Shipyard (Norfolk)	0	6	6
23. Oak Ridge Reservation[c] (ORR)	26,000	33,000	59,000
24. Paducah Gaseous Diffusion Plant (PGDP)	600	0	600
25. Pantex	130	560	690
26. Pearl Harbor Naval Shipyard (Pearl H)	2	4	6
27. Pinellas	0.01	0.01	0.02
28. Portsmouth Gaseous Diffusion Plant (PORTS)	7,500	25,000	33,000

Table 6.1-1. Low-Level Mixed Waste Volumes (cubic meters)—Continued

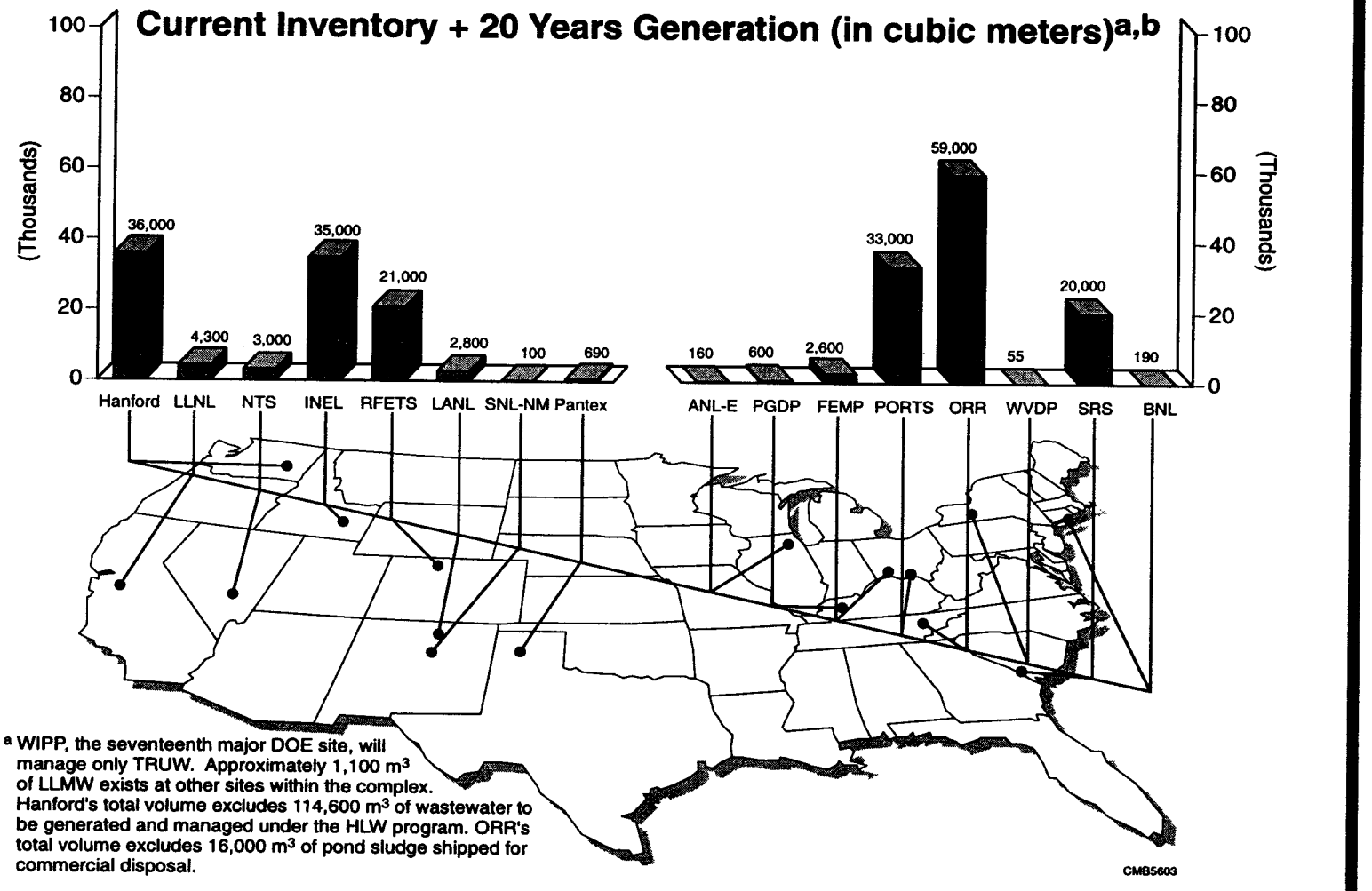
Site	Inventory	20-Year Projected Generation	Estimated Inventory Plus 20 Years Generation
29. Portsmouth Naval Shipyard (Ports Nav)	0.4	0.8	1
30. Princeton Plasma Physics Laboratory (PPPL)	0	0.02	0.02
31. Puget Sound Naval Shipyard (Puget So)	62	170	230
32. RMI Titanium Company (RMI)	22	7	29
33. Rocky Flats Environmental Technology Site (RFETS)[a]	8,300	13,000	21,000
34. Sandia National Laboratories-New Mexico (SNL-NM)	69	33	100
35. Savannah River Site (SRS)	6,600	13,000	20,000
36. University of Missouri (UofMO)	0.4	1.7	2
37. West Valley Demonstration Project (WVDP)	23	32	55
Total Complex	**82,000**	**137,000**	**219,000**

Note: Volume data are rounded from field estimates and columns do not add. Waste projections above, used for the WM PEIS analysis, are based on 1994 and 1995 data and may vary from latest site estimates. Updated inventories and waste generation rates are summarized in Appendix I. Variances include reduced LLMW projected at BNL (10 m^3 inventory and 30 m^3 projected generation versus the 85 m^3 and 110 m^3 shown above). Wastes transferred to WM from Environmental Restoration (ER) are not included in this table. A discussion of these wastes is included in Section 6.15 and Appendix B.
[a] Updated information on waste volume was used for ANL-E and NTS (DOE, 1995c). Other shaded cells indicate editing for round-off adjustments and other minor inaccuracies.
[b] Total volume excludes 114,600 m^3 of wastewater to be generated and managed under the high-level waste (HLW) program.
[c] Total volume excludes 16,000 m^3 of grouted pond sludge that is being shipped to commercial disposal.
Source: DOE (1994 and 1995c).

6.1.3 Existing and Planned Facilities Available at DOE Sites

DOE identified existing and planned LLMW facilities to establish the baseline capacities for LLMW treatment and disposal at major sites, and to determine the need for new or expanded facilities. Some facilities that are not currently operating were considered to be in existence for the analysis, based on the assumption that they could become operational if required. Planned facilities include only those facilities for which a Title II design has been initiated.

Analysis in the WM PEIS assumes use of existing and planned facilities until their capacities are met. If additional capacity is needed, use of new conceptual facilities is assumed. These conceptual facilities provide the difference in treatment, storage, and disposal capacity between the baseline reported in Table 6.1-2 and what is necessary to manage the source term which a given site would receive under any



[a] WIPP, the seventeenth major DOE site, will manage only TRUW. Approximately 1,100 m^3 of LLMW exists at other sites within the complex. Hanford's total volume excludes 114,600 m^3 of wastewater to be generated and managed under the HLW program. ORR's total volume excludes 16,000 m^3 of pond sludge shipped for commercial disposal.

[b] Updated inventories and waste generation rates are summarized in Appendix I.

Source: DOE (1994).

Figure 6.1–1. Low-Level Mixed Waste at the 17 Major Sites

Table 6.1-2. Capacities of Existing and Planned LLMW Facilities at Major LLMW Sites[a]

Site	Treatment (m^3/yr)			Storage (total m^3)	Disposal (m^3/yr)	
	Aqueous Treatment	Grout Solidification	Incineration	LLMW Container Storage	Engineered Disposal	Shallow Land
ANL-E[b]	47			101		
BNL				335		
FEMP	24,627					
Hanford[c]	120 100,000*	15,360		24,837		1,000[d]
INEL	47,472 3,921*	2,765	2,300	226,240		
LANL				28,541		
LLNL	6,822 147,000*			2,555		
NTS	3,000			3,000		12,648*
ORR	202,808		13,500	42,890		
Pantex		70		1,270**		
PGDP	156			2,719		
PORTS	84,528*			7,370		
RFETS	82,785	27,178		17,695		
SNL-NM		1		4,101		
SRS	501,500	40,000 208*	8,200*	13,760	6,800	

Notes: * = planned capacity; ** = permitted capacity. A blank indicates that a site does not perform the specified treatment or disposal operation. No onsite wastewater or wastewater treatment capacity at BNL and SNL-NM sites.
[a] The capacities of these existing and planned units may be divided among several waste types in accordance with site plans.
[b] Onsite reactive metals recovery capacity is 40 m^3/yr.
[c] Onsite reactive metals recovery capacity is 690 m^3/yr.
[d] Original disposal rate was estimated by dividing the planned total capacity of 10,000 cubic meters by 10 years of treatment operations. Trenches 31 and 34 have been constructed with an estimated total capacity of 42,000 cubic meters.

Source: INEL (1995b).

given alternative. Conceptual facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). Where necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of conceptual facilities. Table 6.1–2 lists the LLMW existing and planned facility capacities at major sites considered in the WM PEIS analysis (INEL, 1995b). Wastewater treatment is the most prevalent treatment capability for LLMW; however, some capabilities for grout solidification, thermal treatment, mercury separation, lead recovery, and reactive metals recovery exist at a limited number of sites. As the table illustrates, two principal methods of disposal are shallow land burial and disposal in engineered facilities, such as concrete vaults.

Both types of LLMW disposal facilities assumed in the WM PEIS were designed to meet all applicable RCRA disposal requirements.

6.2 Analytical Methods and Assumptions

Reported LLMW volumes and facilities were used to analyze the human health risk, environmental and socioeconomic impacts, and costs associated with each of the LLMW alternatives. In addition to examining the total waste volumes and existing LLMW capabilities, DOE identified the chemical and radiological characteristics of LLMW to define treatment and disposal requirements. The LLMW characteristics were used in determining the LLMW alternatives, including location and treatment methods, and in forming the basis for the risk and impacts analyses. The specific LLMW assumptions relating to facilities, treatment and disposal technologies, and transportation are discussed below.

6.2.1 CHARACTERISTICS

6.2.1.1 Physical/Chemical

The challenge in managing LLMW arises from its dual nature: it contains RCRA-classified hazardous components (or characteristics) and it is radioactive. The various physical states (e.g., solids, liquids) of the waste and the presence of friable asbestos fibers and polychlorinated biphenyls (PCBs) pose additional challenges. The MWIR categorized more than 2,000 individual DOE LLMW streams. To define required treatment and disposal technologies, DOE categorized the waste streams into treatment groups, and further

condensed those groups based on common physical/chemical characteristics. These characteristics dictate what types of treatment are necessary at each site. Further, emissions from selected treatment technologies are a function of input wastes and their quantities and characteristics, as well as the selected technologies. The waste treatment groups were further subdivided into 23 treatment categories.

Thus, for purposes of analysis, DOE examined five LLMW treatment groups: wastewater, organic liquids, solid process residues, soils, and debris wastes. Figure 6.2–1 illustrates the general treatment flow for each physical waste form (ANL, 1996). Additionally, DOE assigned consistent chemical profiles to identify the composition and concentration of 16 RCRA-hazardous chemical constituents expected to be present in each waste type. The RCRA hazardous constituents included are arsenic, barium, cadmium, chromium, lead, mercury, silver, selenium, cyanides, methylene chloride, soluble hydrocarbons (e.g., ketones), insoluble hydrocarbons (e.g., toluene), chlorofluorocarbons, and 2-, 3-, and 4-chlorinated organic solvents. One additional waste treatment group, special wastes, is not included in this analysis because these wastes each require specialized treatment technologies outside of the scope of the treatments identified in the WM PEIS. The special wastes represent a minor component, less than 2% of the LLMW volume.

6.2.1.2 Radiological Profiles

Because LLMW is both hazardous and radioactive, DOE also identified the radiological characteristics that impose special treatment and handling requirements and, ultimately, help determine emissions, risks, and impacts. Although the MWIR did not provide detailed data on radiological concentrations within the LLMW streams, radiological profiles were assigned based on waste origin. After categorizing the waste into the physical/chemical treatability groups, a site radiological profile was determined and assigned to each treatability group at the site, using an appropriate mix of radionuclides from six distinct radiological categories. The six radiological categories are presented in Table 6.2–1 (ANL, 1996; DOE, 1992).

DOE used the radiological categories to identify the radionuclides at each site that might present a risk to human health or the environment. For example, waste classified as a fission product would contain radionuclides such as cesium-137 or strontium-90, whereas cobalt-60 is commonly associated with waste generated from induced activity (from a reactor) and would most likely occur only at sites handling induced activity wastes, such as nuclear reactor components. Additionally, each radionuclide has a different decay

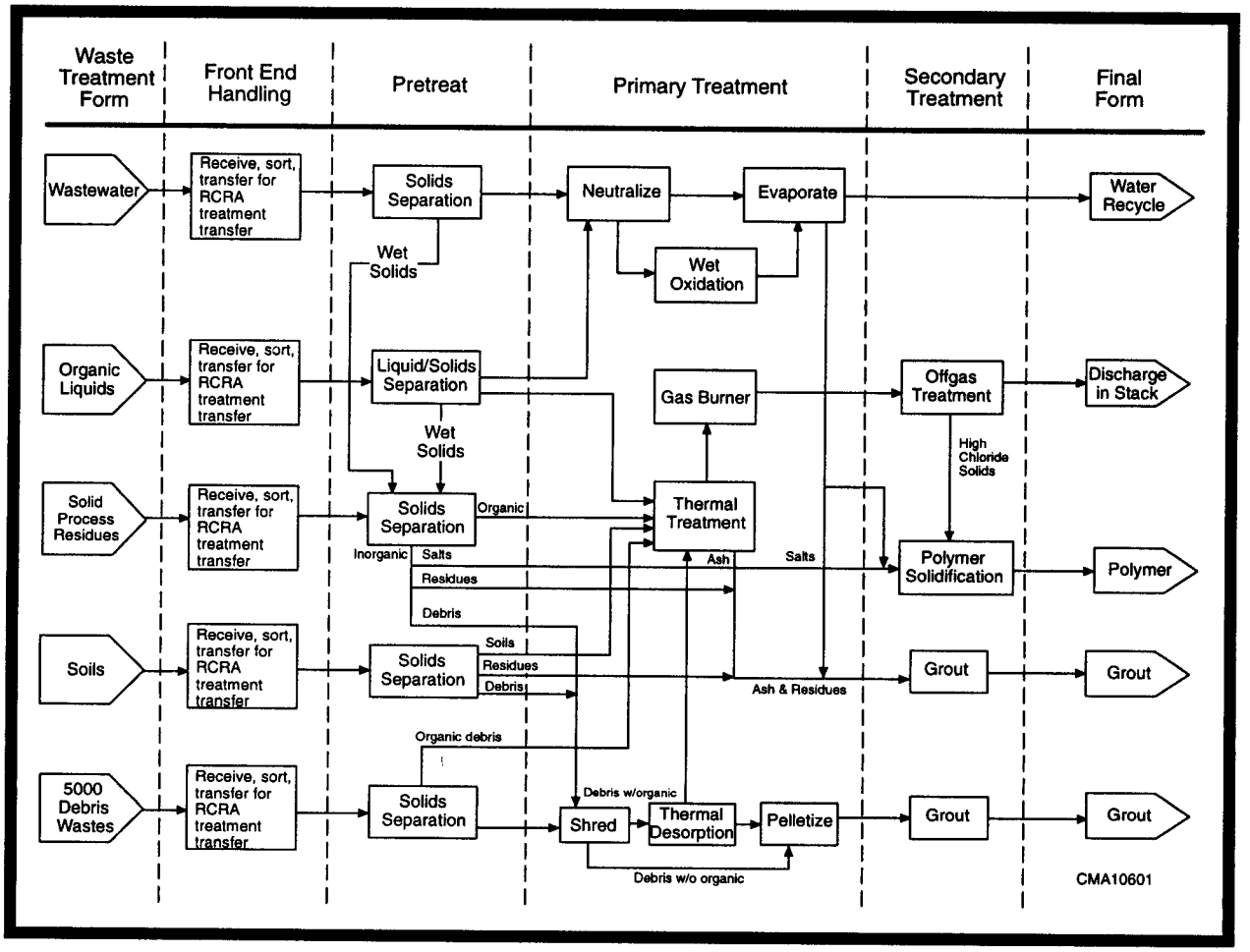


Figure 6.2–1. WM PEIS LLMW Flow Diagram

rate (or half-life) that dictates the persistence of the radioactivity for a specific waste stream at a given site. Over time, radioactive decay reduces the level of radioactivity of a material. For the WM PEIS analysis, decay rates were considered and levels of activity were adjusted to reflect more accurately the expected radiological profiles and doses at the time of treatment.

After the radiological categories of the waste streams were identified, LLMW had to be categorized as either contact-handled (CH) or remote-handled (RH), based on the level and type of radioactivity emitted. These handling categories determine the required level of protective shielding necessary to store and process the waste safely. CH waste containers can be handled directly by humans, whereas RH waste requires extra shielding and sometimes the use of robotics. DOE analyzed CH and RH LLMW separately in the WM PEIS to account for their different treatment and disposal requirements.

Table 6.2–1. Six LLMW Radiological Profiles

Category	Description
Uranium/thorium	Waste material primarily containing the naturally occurring radioactive elements of uranium or thorium
Fission products	Waste containing radioactive isotopes (e.g., cesium-137 and strontium-90) that result when a heavy nucleus is split
Induced activity	Waste that contains elements that were initially not radioactive, but became radioactive as a result of absorbing neutrons (e.g., cobalt-60)
Tritium	Waste material containing trace amounts of tritium (a synthetically produced radioactive isotope of hydrogen)
Alpha	Waste materials contaminated with alpha-emitting (helium nuclei) radionuclides not listed under uranium/thorium or low levels (less than 100 nCi/g) of transuranic isotopes
Other	Waste material that is combined or undefined

DOE further categorized LLMW by the type of radiation it emits. Radioactive materials emit alpha, beta, and gamma radiation. The LLMW analysis separately analyzed alpha-emitting waste, which contains significant quantities of plutonium and other elements whose atomic weights exceed that of uranium. These wastes require special containment and management because of the health threat posed by alpha particles if inhaled.

6.2.2 Technologies and Treatment Processes

DOE designed LLMW treatment systems based on the physical, chemical, and radiological characteristics of each treatment group. An approved treatment method recognized by the U.S. Environmental Protection Agency (EPA) was selected to process each treatability group. Most treatment facilities were assumed to be fixed facilities for LLMW. However, DOE also considered the use of mobile treatment facilities that could be moved from site to site to treat the small amounts of waste that exist at most of the 37 LLMW sites.

LLMW is treated by one or more treatment processes (or "modules"). Individual modules were linked together to form a complete treatment flow process for each treatability group and adjusted for the chemical and physical type of waste. The emissions and impacts were calculated from each module and then added

to help determine the overall impacts from each treatment process at a site. In general, each waste stream receives some front-end handling (e.g., sorting), pretreatment (e.g., separation), primary treatment (e.g., organic destruction and wastewater treatment), and secondary treatment, which transforms the waste into a final form suitable for disposal. Identical treatment flowsheets were used for each site to compare impacts, varying only the waste composition, throughput (based on volume), and site-specific environment.

DOE considered a variety of treatment methods and processes for LLMW consistent with the LDRs given in 40 CFR Part 268. For the difficult-to-treat LLMW containing organic material, two thermal treatment methods were analyzed: incineration, which EPA considers the best demonstrated available technology for organic waste; and thermal desorption, which bakes the wastes at temperatures lower than those used in incineration. An alternate treatment process that replaces thermal treatment (incineration and thermal desorption) with washing technologies was also analyzed and is available in a separate technical report (DOE, 1996). Table 6.2–2 presents the standard treatment steps assumed for both LLMW thermal and alternative organic treatment technologies (ANL, 1996a). The waste volumes in Table 6.1–1 contain small amounts of LLMW that require special treatment not covered by the treatment trains represented in Figure 6.2–1. Such LLMW is not analyzed in the WM PEIS.

The WM PEIS treatment steps may not reflect the treatment flow for specific waste streams at individual sites. Rather, DOE used generic treatment processes that have broad applicability to the LLMW sites, could provide consistent analysis among the sites, and could bound the impacts resulting from activities proposed in site-specific reports or in the site treatment plans (STPs) (and the equivalent *Report on the Hanford Site Land Disposal Restrictions for Mixed Waste* [Black, 1992–1995]) developed under the Federal Facility Compliance Act (FFCAct).

For both technologies, two types of disposal were considered: engineered disposal and shallow land burial. Engineered disposal facilities for LLMW are concrete structures with collection systems to prevent leaks into the environment. They are usually located above the natural grade of the land. Shallow land burial facilities are generally shallow earthen ditches.

With regard to privatization of DOE treatment, storage, and disposal (Sections 6.4 to 6.14), it is assumed that the environmental impacts will be essentially the same for the private versus the DOE approach, providing the facilities are located near or in similar locations to those analyzed within this document.

Table 6.2–2. Treatment Steps for LLMW Thermal and Alternative Organic Treatment Technologies

Treatment Steps	Base Technology Option (Thermal)	Alternative Organic Technology Option (Washing)
FRONT-END ↓	Receive, sort, & transfer	Receive, sort, & transfer
PRETREATMENT PROCESS ↓	Separate solids from liquids	Separate solids from liquids
PRIMARY TREATMENT PROCESS ↓	Neutralize and evaporate aqueous liquids, with wet oxidation of solids; thermally treat combustible liquids, solids, & off-gases; noncombustible solids, including ash, and solids from soils and debris are solidified; special treatments for recovery of mercury and lead, and for inherently hazardous materials	Neutralize and evaporate aqueous liquids, with wet oxidation of solids; organic destruction process for organic liquids; separate wash modules for sludges, soil, and debris; special treatments for recovery of mercury and lead, and for inherently hazardous materials
SECONDARY TREATMENT ↓	Recycle water from evaporation; treat off-gases before discharge; oxides from special treatment solidified	Recycle water from evaporation; treat off-gases before discharge; recycle solvents, including water, from washing of solids
STABILIZATION OF SOLIDS ↓	Grout solids from treatment; stabilize in polymer salts not suitable for grouting	Grout solids from treatment; stabilize in polymer salts not suitable for grouting
BACK-END HANDLING ↓ TO DISPOSAL	Prepare stabilized solid waste for shipment for storage and/or disposal; hold recovered metal and mercury for reuse	Prepare stabilized solid waste for shipment for storage and/or disposal; hold recovered mercury for reuse

6.2.3 WM PEIS ASSUMPTIONS: FACILITIES, TREATMENT, DISPOSAL, AND INDEFINITE STORAGE

Although DOE used LLMW volumes and existing facilities from well-documented data sources, the analysis of the alternatives required DOE to make additional assumptions. In addition to the estimating and extrapolating techniques used to identify the radiological and chemical characteristics of LLMW, the following general assumptions relating to LLMW facilities, treatment, disposal, and indefinite storage under the No Action Alternative, helped further define specific actions and operating parameters under each alternative.

Facilities

- All LLMW facilities are designed to treat waste to meet RCRA requirements.
- New facilities will be fully operational after a 10-year period of construction.
- LLMW currently in inventory (sometimes referred to as "legacy waste") plus annually generated waste during the period of construction will be treated during the 10-year period after construction (called a "work-off" period). After the designated work-off period, LLMW is assumed to be treated as it is generated on an annual basis; however, this was not analyzed in the WM PEIS.
- In the LLMW analysis, each site is assumed to build and operate facilities with capacities sufficient to handle only LLMW. This avoids linking the results of one waste type to decisions not yet made in another and results in conservative estimates of risk, cost, and impacts. However, the alternatives were structured to accommodate locating LLMW and LLW facilities at the same site to more accurately reflect the reality of coordinated treatment and disposal. Chapter 11 discusses the cumulative effects for sites hosting more than one waste type facility.

Treatment

- Wastewater treatment activities continue at every site for every alternative, since wastewater is difficult to transport but not to treat. However, residues resulting from wastewater treatment were assumed to be shipped for final treatment under all alternatives, except No Action. (Under the No Action Alternative, the residues are placed in storage for the 20-year analysis period. Sites with no LLMW wastewater treatment facilities, such as the Pantex Plant and LANL, are assumed to grout the aqueous waste and place it in onsite storage for the remainder of the analysis period).
- Under all alternatives, facilities are assumed to be designed to treat LLMW to meet land disposal restrictions (LDRs) using similar treatment modules at all sites. In addition, DOE scaled the treatment

facilities to the smallest size appropriate for treating all LLMW within the 10-year work-off period. Mobile treatment units are used for small waste streams under certain volume levels.

Disposal

- Two types of disposal were analyzed in the WM PEIS: engineered disposal and shallow land burial. However, when disposing of smaller quantities of waste (i.e., less than 700 cubic meters per year), aboveground silos were assumed. Both types of LLMW disposal facilities assumed in the WM PEIS were designed to meet all applicable RCRA disposal requirements.
- To conduct the risk analysis, DOE chose either an existing facility location when one was identified or a central location at the site. DOE used actual environmental settings for the analysis at each candidate site.
- No waste acceptance criteria limitations are imposed at disposal sites. That is, it is assumed that disposal sites can accommodate all waste targeted to them. In siting a disposal facility location on a site, a performance assessment analysis will be conducted to select a site location and define waste acceptance criteria.

Indefinite Storage Under the No Action Alternative

- The No Action Alternative continues current management practices. There would be full treatment to meet land disposal restrictions at only three sites and storage at all sites. Although such storage would be for an indefinite period, the analyses for storage used the same 20-year forecast for waste generation and evaluated impacts for the 20-year period in the same way as was done for 10 years of operation for the action alternatives. This was for consistency, to provide a baseline against which all other alternatives could be compared.
- The analyses assumed that all LLMW would be newly packaged. Existing storage was utilized for non-alpha waste when available; however, new storage facilities would be constructed for alpha LLMW and for any waste that exceeded the available storage capacity already on site.
- Risks, other environmental impacts, and costs were calculated for storage facilities using similar assumptions as for treatment and disposal facilities. The evaluation of human health risks includes worker risks from direct radiation and inhalation during operations and physical trauma during construction and operations. Waste containers in storage were assumed not to deteriorate, with very low emissions assumed to be released through the ventilation system from the waste containers. Potential accidents during storage are considered in the discussion of accidents in Section 6.4.

- After the initial packaging and construction of new storage facilities, no repackaging or replacement of storage was considered necessary for the remainder of the 20-year period of analysis. A longer period of storage (30–50 years) could require repackaging and facility replacement due to degradation, with corresponding impacts and costs.
- The results of the analysis of impacts in the following sections of Chapter 6 only consider the impacts for storage over the first 20 years of an indefinite period. Unlike the action alternatives, risks and other impacts that potentially exceed those predicted for the first 20 years could occur in the period beyond 20 years. The option of indefinite storage does not avoid impacts but rather causes impacts to occur every year for an indefinite period of time. A discussion of the longer term impacts for indefinite storage is presented in Section 6.16.

6.2.4 TRANSPORTATION ANALYSIS AND ASSUMPTIONS

DOE analyzed transportation impacts associated with each LLMW alternative. Both truck and rail transportation were analyzed using computerized routing models following the general principle of minimizing distance and transportation time. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines. However, these are conceptual routes determined for the purpose of risk assessments. They do not necessarily represent the actual routes that would be used to transport waste. Actual routes will be determined during the transportation planning process described in Section 4.3.10.

In general, the risk to populations or individuals from transportation of radioactive materials is directly proportional to the external dose rate, which is a measure of the external radiation (principally gamma radiation) emitted from the shipment. For analytical purposes, DOE assumed that the average dose rate of each shipment would not exceed 1 millirem per hour at 1 meter from the shipping container (consistent with DOE's historical practices), although DOT regulations allow a higher dose rate of 10 millirem per hour at 2 meters from the container (49 CFR 173).

The shipment of the hazardous components of LLMW is regulated by the DOT as a means to protect the public from harm in the event of a potential release. All DOE shipments of LLMW would meet the numerous packaging and containment regulatory standards based on the hazardous components and characteristics of the waste.

Transportation of hazardous and radioactive materials, substances, and wastes is governed by U.S. Department of Transportation, NRC, and EPA regulations, and the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

6.3 Low-Level Mixed Waste Alternatives

DOE analyzed seven alternatives for CH, nonalpha LLMW within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. Treatment and disposal activities vary by alternative and by site. The foldout table at the end of this chapter shows the sites at which LLMW would be treated and disposed of under each alternative. This table is designed to be used as a quick reference when reading the LLMW impact sections.

The LLMW analysis considered treatment and disposal separately, first focusing on treatment and then using treatment residues as inputs for the disposal analysis. Each alternative was developed in order to assess environmental impacts, human health risks, and costs associated with the range of LLMW treatment and disposal options, and to provide input for programmatic decisions about where to locate LLMW treatment and disposal facilities.

Remote-handled waste requires special handling facilities for treatment and disposal. Under all alternatives, RH waste is treated and disposed of at the same four sites which house the majority of RH waste: the Hanford Site, INEL, ORR, and SRS.

Alpha LLMW requires special handling and treatment because of the adverse health effects that can occur as a result of inhalation or ingestion of alpha particles. Alpha LLMW exists at 10 sites. Sites where alpha wastes are treated or disposed of are indicated in each of the alternative tables by the alpha symbol ($\propto$).

Tables 6.3–1 to 6.3–7 show, for each alternative, the percentage of waste received from offsite for each treatment or disposal site. The percentages are derived from the waste volumes presented in this chapter and include updated LLMW volumes for these two sites: ANL-E and NTS.

6.3.1 No Action Alternative

The No Action Alternative provides a baseline for the analysis by considering treatment of LLMW at facilities that are currently capable of treating to meet LDRs, and indefinite storage of the waste onsite at all LLMW sites. INEL, ORR, SRS, and other sites to a lesser extent, are capable of some treatment to meet LDRs. Other sites may experience impacts from the construction of expanded storage, onsite shipping, or certification facilities (where the waste would be examined, characterized, and certified for shipment). These storage impacts are included in the WM PEIS in totals listed under treatment for the No Action Alternative. Under this alternative, no new treatment facilities would be built. Figure 6.3–1 and Table 6.3–1 illustrate the No Action Alternative. Because the No Action Alternative involves less treatment than other alternatives and no disposal, it will generally have smaller impacts than the other alternatives for the 20-year period of analysis. Impacts and costs would be expected beyond 20 years, however, and are discussed in Section 6.16. The No Action Alternative would not comply with RCRA because all the waste would not be treated to meet LDRs and would be placed in indefinite storage rather than in disposal facilities.

6.3.2 Decentralized Alternative

The Decentralized Alternative considers treatment of waste to meet RCRA requirements at all 37 LLMW sites. No untreated waste will be shipped offsite to any of the 37 treatment sites. Treated wastes from the smaller sites will be shipped to the larger sites for disposal. For purposes of analysis, DOE examined the impacts from treatment at the 16 major sites. Two of the 16 sites (BNL and SNL-NM) have relatively small amounts of LLMW (less then 200 cubic meters). DOE assumed that the impacts at these sites could be used to estimate the health and environmental impacts at the other 21 sites, most of which likewise have less than 200 cubic meters of LLMW. However, costs were calculated using data from all 37 sites. Figure 6.3–2 and Table 6.3–2 illustrate the Decentralized Alternative.

6.3.3 Regionalized Alternatives

The Regionalized Alternatives consider the consolidation of waste for treatment and disposal. Four LLMW Regionalized Alternatives were analyzed. The Regionalized Alternatives were developed to bound a reasonable range of intermediate variations for treatment and disposal.

LLMW No Action Alternative—(Treatment at 3 Sites; Storage at 37)

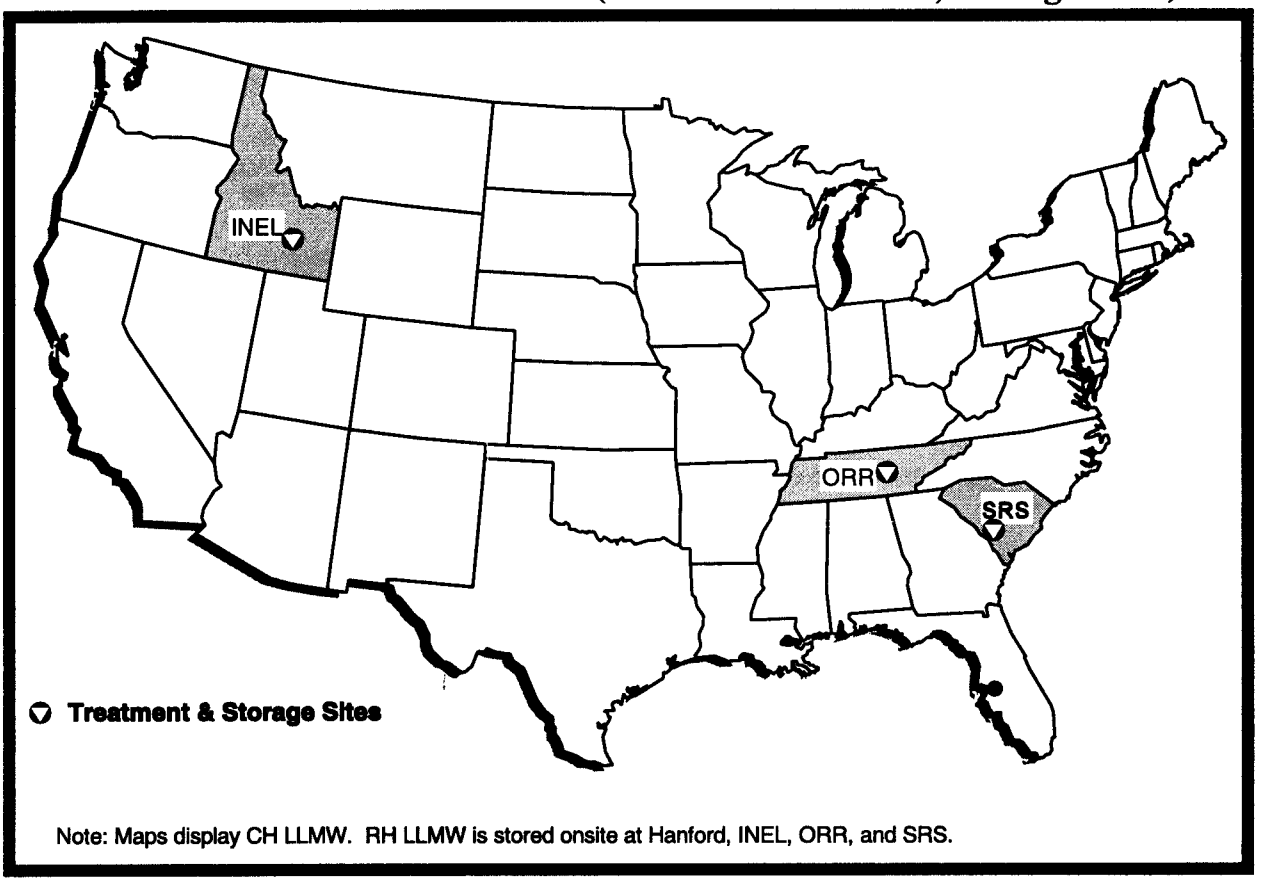


Figure 6.3–1. LLMW No Action Alternative

	Generating Sites			
	INEL	ORR	SRS	ANL-E, Ames, BCL, Bettis, BNL, Charleston, ETEC, FEMP, GA, GJPO, Hanford, KAPL, KCP, LANL, LBL, LEHR, LLNL, Mare Is, Mound, Norfolk, NTS, Pantex, Pearl H, PGDP, Pinellas, Ports Nav, PORTS, PPPL, Puget So, RFETS, RMI, SNL-NM, UofMO, WVDP
Treat (% Rec'd From Offsite)	INEL (0)	ORR (0)	SRS (0)	Onsite wastewater treatment only, as required
Store (% Rec'd From Offsite)	INEL (0)	ORR (0)	SRS (0)	Onsite

Note: Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–1. LLMW No Action Alternative

LLMW Decentralized Alternative—(Treatment at 37 Sites; Disposal at 16)

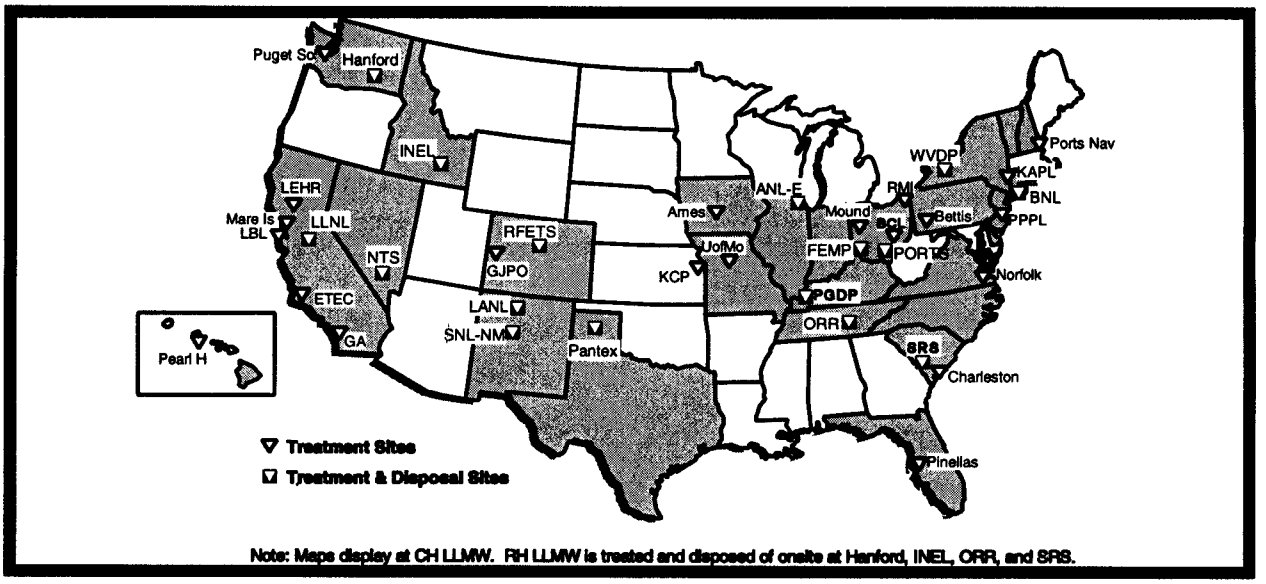


Figure 6.3–2. LLMW Decentralized Alternative

	Generating Sites								
	ANL-E Ames	BCL Bettis KAPL Mound Ports Nav PORTS PPPL RMI	BNL	Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS, SRS∝ UofMO∝ WVDP∝	ETEC GA LBL LEHR LLNL Mare Is	GJPO RFETS RFETS∝	FEMP	Hanford, Pearl H Puget So	INEL INEL∝
Treat (% Rec'd From Offsite)	ONSITE TREATMENT AT GENERATING SITES								
Dispose (% Rec'd From Offsite)	ANL-E (<1)	PORTS (1)	BNL (0)	SRS (1)	LLNL (11)	RFETS (<1)	FEMP (0)	Hanford (<1)	INEL (0)

	Generating Sites							
	SNL-NM	KCP PGDP UofMO	LANL LANL∝ SNL-NM∝	ORR	Pantex	WVDP	NTS	LLNL∝ LBL∝
Treat (% Rec'd From Offsite)	ONSITE TREATMENT AT GENERATING SITES							LLNL
Dispose (% Rec'd From Offsite)	SNL-NM (0)	PGDP (<1)	LANL (0)	ORR (0)	Pantex (0)	WVDP (0)	NTS (1)	

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–2. LLMW Decentralized Alternatives

Regionalized Alternative 1 considers treatment at 11 sites and disposal at 12 (those same 11 sites plus NTS). Regionalized Alternative 2 analyzes the impacts of treatment at seven sites with disposal at six sites. Under this alternative, two of the treatment sites (RFETS and PORTS) are not considered for disposal, but NTS is added for disposal only. Regionalized Alternative 3 analyzes the same seven treatment sites as Regionalized Alternative 2, but considers disposal at only one site, NTS. Regionalized Alternative 4 considers treatment and disposal at four sites—Hanford, INEL, ORR, and SRS, and disposal at six sites (the four treatment sites, plus LANL and NTS). Figures 6.3–3 to 6.3–6 and Tables 6.3–3 to 6.3–6 illustrate the Regionalized Alternatives.

6.3.4 CENTRALIZED ALTERNATIVE

The Centralized Alternative considers LLMW treatment and disposal at a single site within the complex, the Hanford Site. Regionalized Alternative 3 also considers disposal at a single site, NTS, to provide an alternative to Centralized disposal at the Hanford Site. Other sites may experience impacts from the construction of facilities where the waste would be examined, characterized, certified, and prepared for shipment. The other sites in the Centralized Alternative may also experience impacts from the treatment of wastewater that is not shipped offsite. Figure 6.3–7 and Table 6.3–7 illustrate the Centralized Alternative.

6.3.5 RATIONALE FOR SELECTING TREATMENT AND DISPOSAL SITES

How were the treatment sites selected?

The seven LLMW treatment alternatives were developed to cover the range of reasonable alternatives. One to 37 sites are available for treatment (the Centralized and Decentralized Alternatives, respectively). DOE selected four intermediate alternatives treating LLMW at 4 to 11 sites (the Regionalized Alternatives). To select the variations of the Regionalized Alternative, DOE focused on the sites where the largest volumes of LLMW are located and transportation would be minimized. Alpha and RH LLMW would be sent to the closest facility capable of treating those wastes. For all alternatives, DOE assumed that some treatment would be practical at every site. This practical treatment would include initial treatment of aqueous liquids at the site of generation using techniques such as evaporation, neutralization, precipitation, filtration, coagulation, or limited solidification.

LLMW Regionalized Alternative 1—(Treatment at 11 Sites; Disposal at 12)

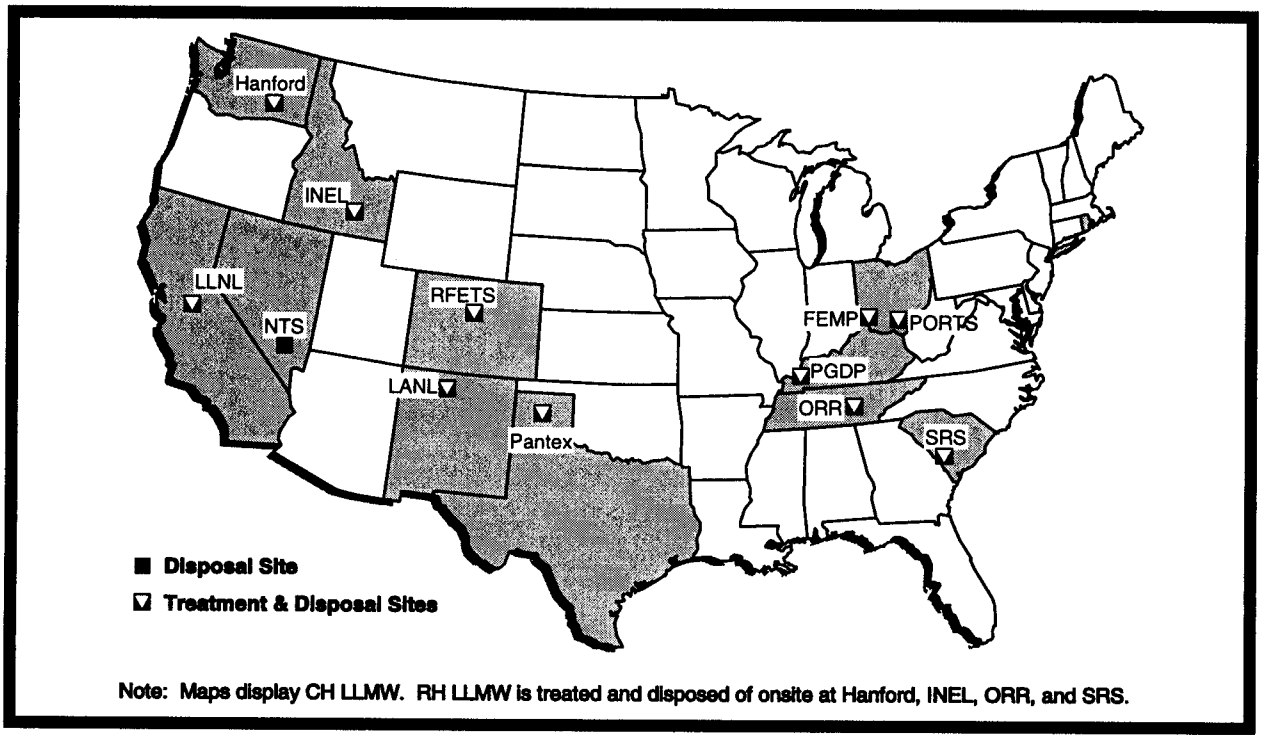


Figure 6.3–3. LLMW Regionalized Alternative 1

	Generating Sites												
	BCL BNL Bettis KAPL Ports Nav PORTS PPPL RMI WVDP	ANL-E Ames Mound	FEMP	Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS SRS∝ UofMO∝ WVDP∝	ETEC GA LBL LEHR LLNL Mare Is	LBL∝ LLNL∝	GJPO RFETS RFETS∝	Hanford Pearl H Puget So	INEL INEL∝ NTS	KCP PGDP UofMO	LANL LANL∝ SNL-NM SNL-NM∝	ORR	Pantex
Treat (% Rec'd From Offsite)	PORTS (14)	FEMP (9)		SRS (1)	LLNL (1)		RFETS (<1)	Hanford (<1)	INEL (10)	PGDP (<1)	LANL (4)	ORR (0)	Pantex (0)
Dispose (% Rec'd From Offsite)	PORTS (46)		FEMP (0)	SRS (1)	LLNL (11)	NTS (100)	RFETS (<1)	Hanford (<1)	INEL (10)	PGDP (<1)	LANL (2)	ORR (0)	Pantex (0)

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–3. LLMW Regionalized Alternative 1

LLMW Regionalized Alternative 2—(Treatment at 7 Sites; Disposal at 6)

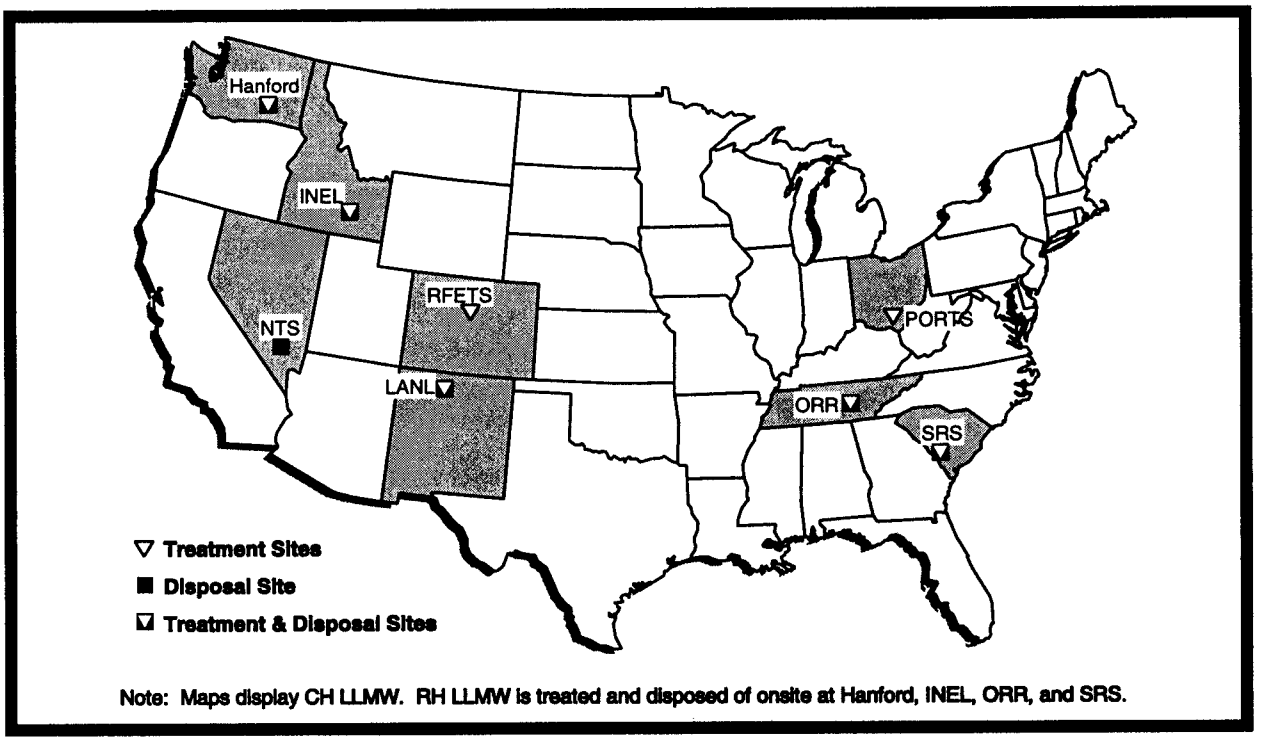


Figure 6.3–4. LLMW Regionalized Alternative 2

	Generating Sites							
	ANL-E Ames BCL BNL Bettis FEMP KAPL Mound Ports Nav PORTS PPPL RMI WVDP	ORR PGDP UofMO	Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS SRS∝ UofMO∝ WVDP∝	ETEC GA INEL INEL∝ LBL∝ LLNL∝ NTS	GJPO KCP RFETS RFETS∝	LANL LANL∝ Pantex SNL-NM SNL-NM∝	Hanford LBL LEHR LLNL Mare Is Pearl H Puget So	
Treat (% Rec'd From Offsite)	PORTS (9)	ORR (1)	SRS (1)	INEL (6)	RFETS (<1)	LANL (22)	Hanford (7)	
Dispose (% Rec'd From Offsite)	ORR (35)		SRS (1)	INEL (9)	LANL (97)		Hanford (7)	NTS[a] (0)

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] This site disposes residues obtained from onsite wastewater treatment.

Table 6.3–4. LLMW Regionalized Alternative 2

LLMW Regionalized Alternative 3—(Treatment at 7 Sites; Disposal at 1)

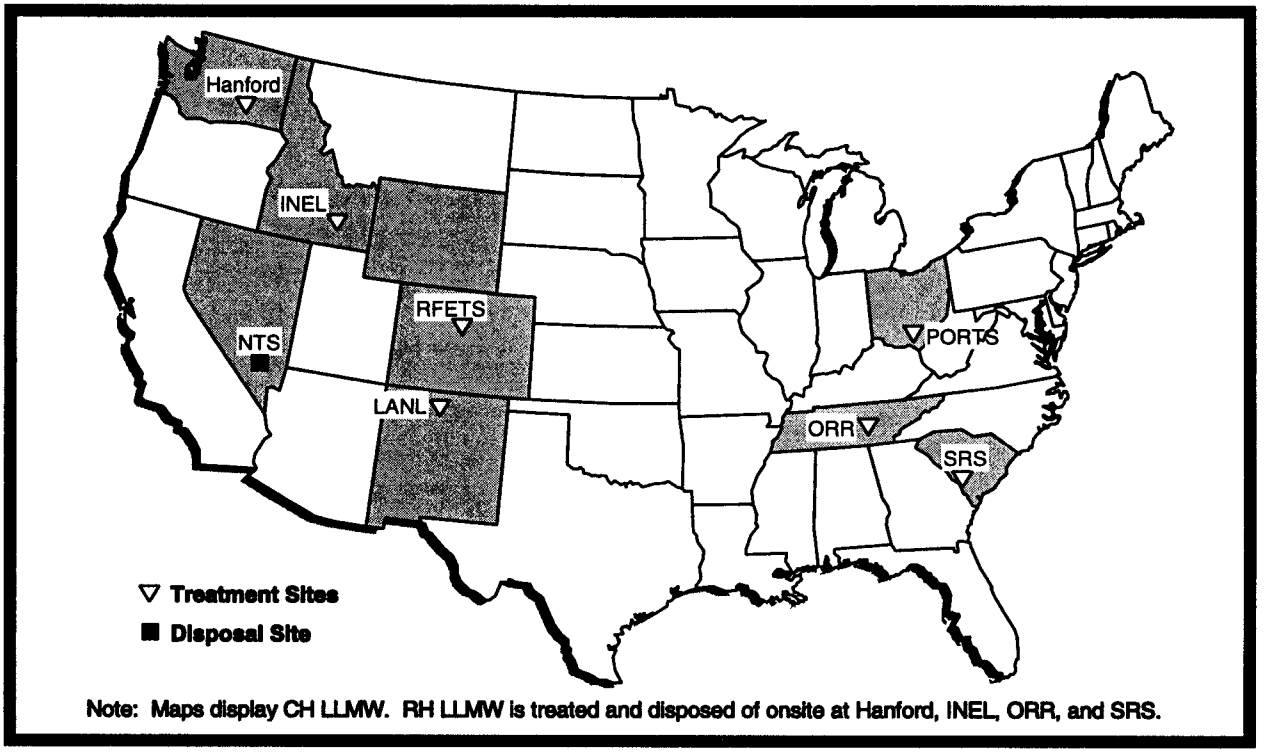


Figure 6.3–5. LLMW Regionalized Alternative 3

	Generating Sites						
	ANL-E Ames BCL BNL Bettis FEMP KAPL Mound Ports Nav PORTS PPPL RMI WVDP	Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS SRS∝ UofMO∝ WVDP∝	ORR PGDP UofMO	ETEC GA INEL INEL∝ LBL∝ LLNL∝ NTS	GJPO KCP RFETS RFETS∝	Hanford LBL LEHR LLNL Mare Is Pearl H Puget So	LANL LANL∝ Pantex SNL-NM SNL-NM∝
Treat (% Rec'd From Offsite)	PORTS (9)	SRS (1)	ORR (1)	INEL (6)	RFETS (<1)	Hanford (7)	LANL (22)
Dispose (% Rec'd From Offsite)	NTS (100)						

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–5. LLMW Regionalized Alternative 3

LLMW Regionalized Alternative 4—(Treatment at 4 Sites; Disposal at 6)

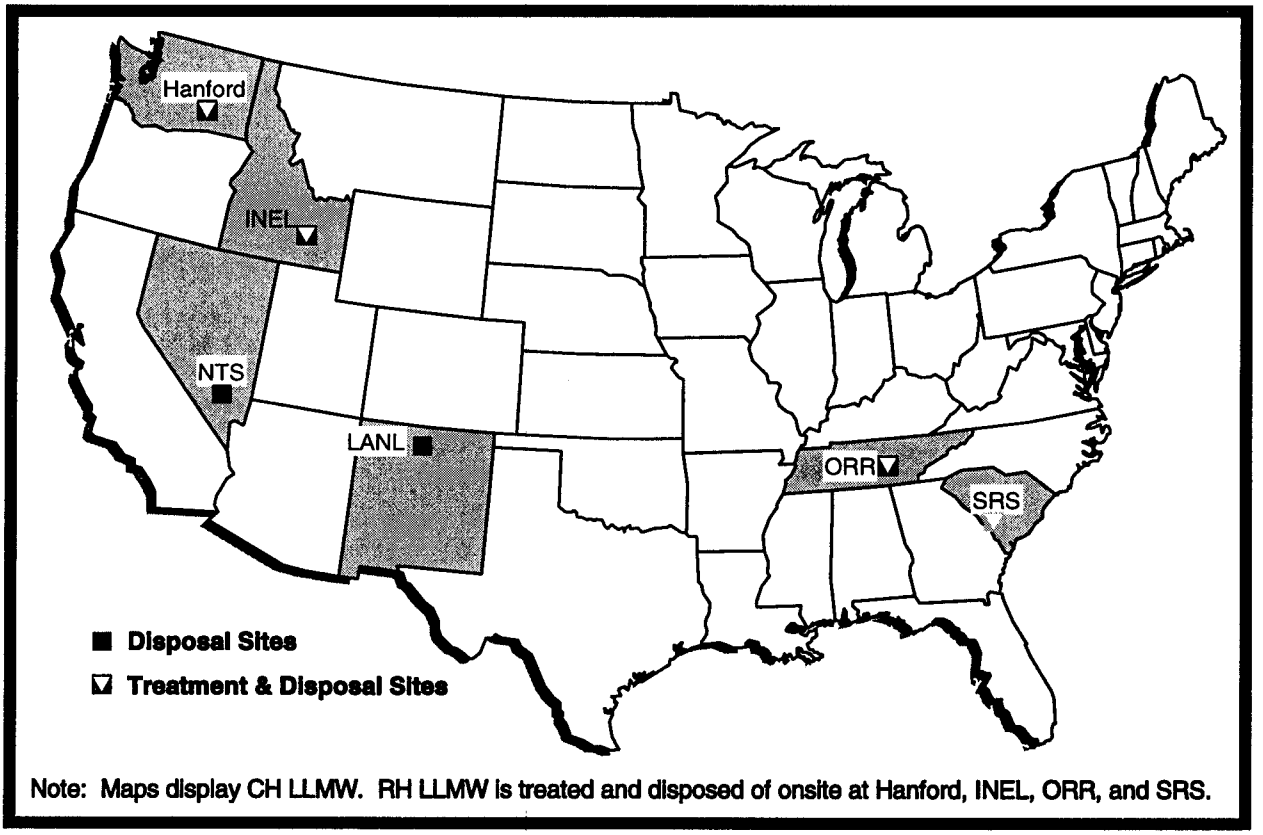


Figure 6.3–6. LLMW Regionalized Alternative 4

	Generating Sites					
		Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS SRS∝ UofMO∝ WVDP∝	ANL-E, Ames, BCL, BNL, Bettis, FEMP, KAPL, KCP, Mound, ORR, PGDP, Ports Nav, PORTS, PPPL, RMI, WVDP, UofMO	ETEC, GA, GJPO, INEL, INEL∝, LANL, LANL∝, LBL∝, LLNL∝, NTS, Pantex, RFETS, RFETS∝, SNL-NM, SNL-NM∝		Hanford, LBL, LEHR, LLNL, Mare Is, Pearl H, Puget So
Treat (% Rec'd From Offsite)		SRS (1)	ORR (38)	INEL (44)		Hanford (7)
Dispose (% Rec'd From Offsite)	NTS[a] (0)	SRS (1)	ORR (38)	INEL (76)	LANL[a] (0)	Hanford (7)

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] These sites dispose of residues obtained from onsite wastewater treatment.

Table 6.3–6. LLMW Regionalized Alternative 4

LLMW Centralized Alternative—(Treatment and Disposal at 1 Site)

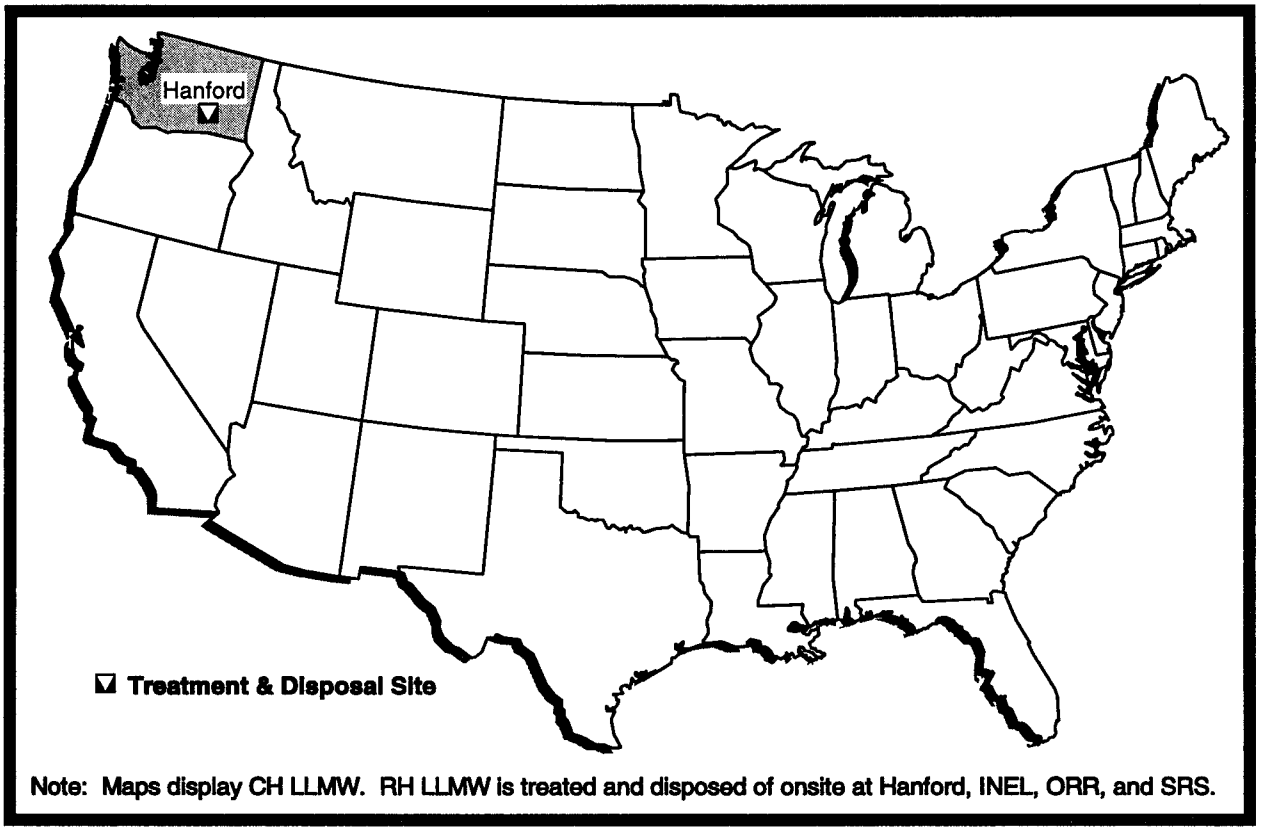


Figure 6.3–7. LLMW Centralized Alternative

	Generating Sites			
	Bettis∝, Charleston, Mound∝, Norfolk, Pinellas, SRS, SRS∝, UofMO∝, WVDP∝	ANL-E, Ames, BCL, BNL, Bettis, FEMP, KAPL, KCP, Mound, ORR, PGDP, Ports Nav, PORTS, PPPL, RMI, WVDP, UofMO	ETEC, GA, GJPO, INEL, LANL, LANL∝, LBL∝, LLNL∝, NTS, Pantex, RFETS, RFETS∝ SNL-NM, SNL-NM∝	Hanford, LBL, LEHR, LLNL, Mare Is, Pearl H, Puget So
Treat (% Rec'd From Offsite)	Hanford (83)			
Dispose (% Rec'd From Offsite)	Hanford (86)			

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–7. LLMW Centralized Alternative

The Regionalized Alternatives consider the impacts of treatment to meet LDRs at selected waste consolidation sites. Regionalized Alternative 1 considers treatment at 11 sites. This alternative was developed by identifying the location of most of the DOE LLMW and looking for logical site groupings. Nine sites have 20-year projected levels of LLMW that exceed 1,000 cubic meters. The next largest site contains approximately half as much waste, and the other small sites follow with decreasing amounts.

In Regionalized Alternatives 2 and 3, seven sites are considered potential treatment locations. DOE chose the six sites with the highest waste volumes, and added LANL because it has a larger volume of transuranic waste (TRUW) that eventually may be reclassified as alpha LLMW due to its radionuclide content. Regionalized Alternative 4 consists of the sites with the three highest volumes (Hanford, INEL, and ORR), as well as SRS, which has the sixth largest volume. SRS was chosen because of its high volumes of alpha LLMW and TRUW, some of which eventually may be reclassified as LLMW. In addition, SRS has under construction an incinerator with an annual LLMW treatment capacity of 8,200 cubic meters.

In the Centralized Alternative, all LLMW would be shipped to the Hanford Site for treatment. The Hanford Site currently has the second largest volume of LLMW. However, as Hanford's HLW is treated, a substantial portion of that waste will be separated and thereafter managed as LLMW, thereby making the Hanford Site the largest LLMW site.

How were disposal sites selected?

Candidate disposal sites were selected to reflect a reasonable range of alternatives. However, unlike the treatment analysis, the disposal analysis did not evaluate every site for disposal. Instead, 16 candidate sites were selected as the reasonable upper bound based on screening performed by DOE for consistency with the FFCAct.

To narrow the number of possible LLMW disposal sites, DOE applied three exclusionary criteria to the 37 sites with LLMW: (1) sites could not be within a designated 100-year floodplain, (2) sites could not be within 200 feet of a seismic fault, and (3) sites were required to have sufficient area for a 100-meter buffer zone between the disposal structure and the site boundary.

Using the three criteria, DOE reduced the number of reasonable sites to 22 locations. Three additional sites (General Atomics, Pinellas Plant, and ETEC) were removed with the concurrence of the States for technical and practical considerations, leaving 19 sites for disposal consideration.

DOE eliminated three other sites based on the following rationales: (1) KAPL is a Navy site and thus was not considered as a DOE disposal site, (2) Mound was not considered because it is relatively small and some of its land is being returned to the State, and (3) Bettis was not considered because of sloping terrain and unstable geologic conditions and because it is a Navy site.

The Decentralized Alternative looked at disposal at the remaining 16 sites and the Centralized Alternative looked at disposal at one site—the Hanford Site. The Hanford Site was analyzed because it is expected to have the largest volume of LLMW. In addition, NTS was analyzed as the only disposal site under Regionalized Alternative 3.

DOE selected two intermediate alternatives, disposing at 12 and 6 sites (under the Regionalized Alternatives). To select these Regionalized Alternatives, DOE focused on the 11 sites with the largest volume of LLMW and added NTS because it has a LLMW disposal facility that has a pending permit application. The next logical consolidation point for LLMW disposal was a 6-site alternative, to be consistent with the six currently operating LLW disposal facilities—the Hanford Site, INEL, LANL, NTS, ORR, and SRS. NTS was considered in Regionalized Alternative 3 to provide a comparison and an alternative to the single disposal location selected under the Centralized Alternative. The Centralized Alternative coupled the selection of a treatment and disposal site at the Hanford Site because of the anticipated onsite large volumes of LLMW.

6.4 Health Risks

The number of worker fatalities is about three times higher than for other receptor groups, driven by physical injury hazards. As the number of sites decrease, facilities become larger and programwide physical injuries decrease, reflecting an economy of scale and fewer workers. The most important influence on offsite population risk is LLNL treatment of tritium in the Decentralized and Regionalized 1 Alternatives. There are no other notable trends for offsite population risks. For disposal, concentrations of radionuclides and chemicals in the groundwater near disposal facilities are estimated to exceed applicable standards at several sites, demonstrating the need for performance-based waste acceptance criteria. More extensive pretreatment of chemicals than assumed for the WM PEIS analysis and careful management of radionuclide concentrations and waste forms would be required to assure acceptable water quality and human health risks. Transportation risks are low in all alternatives, reflecting low vehicle miles.

Health risk impacts can result from exposure to radiation and chemicals and from physical trauma associated with constructing and operating treatment and disposal facilities or transporting waste. Health effects resulting from radiation and chemical exposure, whether from sources external or internal to the body, can affect either the exposed individual (known as "somatic" effects) or descendants of the exposed individual (known as "genetic" effects). This section discusses the estimated adverse health impacts resulting from radiation and chemical exposures as well as from physical hazards for each LLMW treatment and disposal alternative. Details of the LLMW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5, Appendix D, and in ORNL technical reports (ORNL, 1995a-c).

Potential health risks to a number of receptor populations and individuals are presented including:

- The offsite population—those individuals living within a 50-mile radius of the site, as well as along transportation routes
- Noninvolved worker population—the workers on DOE sites who are not involved directly in waste management activities
- Waste management worker population (or "waste management workers")—onsite employees in a site's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste
- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose
- Farm family most exposed lifetime MEI—hypothetical individual in the most exposed lifetime of the farm family who would receive the highest dose from disposal of LLMW
- Hypothetical intruder—an individual who would experience maximum potential future risks from disposal of LLMW upon the loss of institutional control
- Most exposed waste management worker—an individual who would experience potential

The following sections present the impacts for the LLMW alternatives:

6.4 Health Risks
6.5 Air Quality Impacts
6.6 Water Resources Impacts
6.7 Ecological Resources Impacts
6.8 Economic Impacts
6.9 Population Impacts
6.10 Environmental Justice Concerns
6.11 Land Use Impacts
6.12 Infrastructure Impacts
6.13 Cultural Resources Impacts
6.14 Costs
6.15 Environmental Restoration Analysis
6.16 Comparison of Alternatives Summary

noncancer effects, as estimated using the Exposure Index, following exposure to the hazardous chemical constituents of LLMW

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer fatalities from radiation exposure
- Cancer incidences from radiation or chemical exposure
- Genetic effects from radiation exposure
- Noncancer effects from chemical exposure (e.g., headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

Maximally Exposed Individual

In keeping with standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of treatment operations analyzed in the WM PEIS.

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for further discussion of these issues.

Understanding Scientific Notation

Scientific notation is used in this WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10	***Negative Powers of 10***
$10^{1} = 10 \times 1 = 10$	$10^{-1} = 1/10 = 0.1$
$10^{2} = 10 \times 10 = 100$	$10^{-2} = 1/100 = 0.01$
and so on; therefore,	*and so on; therefore,*
$10^{6} = 1{,}000{,}000$ *(or 1 million), etc.*	$10^{-6} = 0.000001$ *(or 1 in 1 million), etc.*

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^{5} can also be written as 3E+05, and 3×10^{-5} is equivalent to 3E-05. Therefore, 3E+05 = 300,000 and 3E-05 = 0.00003.

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3E-06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., fatal cancer) will occur in the period covered by the analysis.

6.4.1 ROUTINE OPERATION IMPACTS

6.4.1.1 Treatment

For operations involving LLMW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in LLMW treatment ("noninvolved workers"), and waste management workers directly involved in treatment activities. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts. Note that risks from the storage of LLMW are included in the treatment risks for the No Action Alternative, as described in Section 6.3.1.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented.

The sizes of the offsite populations and waste management treatment worker populations used in the health risk analyses are presented in Table 6.4–1. The waste management treatment worker numbers are derived from generic baselines which established the number of personnel required to operate treatment facilities needed to manage a given amount of source term (defined by the respective alternative).

Individual impacts focus on the *probability* that the "maximally exposed individual" (MEI) within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk is presented as a probability (e.g., one in one million or 1E–06) of that individual experiencing an adverse health impact, rather than the total number of impacts for a selected population.

DOE analyzed effects of exposure to both radionuclides and chemicals on the receptor groups. The pathways of exposure analyzed were inhalation, ingestion of plants and animals, direct gamma radiation, and absorption of tritium through the skin.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment and disposal facilities, and a subsequent 10-year period of operation. However, worker and public risks from exposure to radionuclides or chemicals (received during the 10-year operation period) were evaluated for an entire lifetime (70 years), because health impacts from airborne contaminants or direct radiation could occur throughout the lifetime of the exposed individual. Table 6.4–2 provides an

Table 6.4–1. Offsite Populations and Waste Management Treatment Worker Populations

Site	Offsite Population*	WM Treatment Worker Population by Alternative[a]						
		NA	D	R-1	R-2	R-3	R-4	C
ANL-E	7,939,785	22	50	23	23	23	23	23
BNL	5,738,554	24	62	16	16	16	16	16
FEMP	2,764,589	165	533	1,233	269	269	269	269
Hanford	377,645	506	2,196	2,065	2,132	2,132	2,268	6,706
INEL	153,061	782	1,588	1,587	2,010	2,010	3,281	278
LANL	159,152	136	590	597	679	679	146	146
LLNL	6,324,234	220	831	915	136	136	136	136
NTS	14,266	330	785	305	305	305	305	305
ORR	881,652	2,434	2,530	2,162	2,177	2,177	3,116	490
PGDP	500,502	55	144	144	48	48	48	48
Pantex	265,185	46	145	145	48	48	48	48
PORTS	639,602	435	1,853	1,353	1,951	1,951	405	405
RFETS	2,171,877	2,407	2,305	2,307	3,506	3,506	1,972	1,972
SNL-NM	610,714	8	20	5	5	5	5	5
SRS	620,618	1,005	1,289	1,290	1,290	1,290	1,291	207
WVDP	1,698,391	9	11	10	10	10	11	11

Notes: NA = No Action, D = Decentralized; R1–R4 = Regionalized; C = Centralized; * = within 50-mile radius of sites.
[a] Waste Management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation period.

overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for LLMW treatment.

6.4.1.2 Disposal

Health risks resulting from disposal were evaluated for waste management workers handling the treated LLMW, for an onsite "hypothetical farm family" located 300 meters from the center of the disposal facility, and for a hypothetical "intruder" into the disposal facility after the facility has been closed.

Table 6.4–2. LLMW Treatment Health Risk Analysis Components

LLMW Treatment[a]					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20 years	6.4–4
Number of cancer fatalities	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–4
	Noninvolved workers		Inhalation, direct radiation		
	WM workers		Inhalation, direct radiation		
Number of cancer incidences	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–5
		Chemicals	Inhalation, ingestion		
	Noninvolved workers	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
	WM workers	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
Number of genetic effects	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–5
	Noninvolved workers		Inhalation, direct radiation		
	WM workers		Inhalation, direct radiation		
Probability of cancer fatality	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–7 6.4–8
	Noninvolved worker MEI		Inhalation, direct radiation		
Probability of cancer incidence	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–9
		Chemicals	Inhalation, ingestion		
	Noninvolved worker MEI	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
Probability of genetic effects	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–9
	Noninvolved worker MEI		Inhalation, direct radiation		
Noncancer risk	Offsite MEI	Chemicals	Inhalation, ingestion	10 years	6.4–10
	Noninvolved worker MEI		Inhalation		
	WM worker		Inhalation		

[a] Treatment risks under the No Action Alternative include risks from storage of LLMW.

The waste management workers were assumed to be exposed through direct radiation during disposal operations. Risks to the WM workers were estimated for one lifetime.

For the farm family and intruder analyses, DOE assumed that waste was disposed of in either aboveground or belowground disposal units, depending on the site, each with a capacity of 18,000 and 12,000 cubic meters, respectively. Additional units were added as needed to dispose all of the waste on a site. Each disposal unit was assumed to affect a separate farm family and a separate intruder. Thus, the effects on the farm family (and on the intruder) were assumed to come from a single disposal unit, rather than from a combination of all the units at a site.

Hypothetical Farm Family and Intruder

The "hypothetical farm family" is an imaginary family assumed to live 300 meters downgradient of the center of a waste disposal unit. The family engages in farming activities such as growing and consuming their own crops and livestock, and uses groundwater for drinking water and for watering the crops and animals. This is an estimated maximum exposure scenario taking place in the future at a time when institutional controls no longer exist. The scenario is analyzed to determine potential upper-bound exposures by ingestion of contaminated groundwater.

The hypothetical "intruder" is an imaginary adult who drills a well directly through a LLMW disposal unit to the groundwater. As a result of the drilling, soil contaminated with radionuclides and hazardous chemicals from within the unit is brought to the surface, where it mixes with the top layers of the surface soil. The individual farms the land and eats the crops. The intruder scenario occurs after the failure of institutional control. This scenario is consistent with the analysis required for disposal facilities under DOE Order 5820.2A (DOE, 1988).

The exposure pathways for the hypothetical farm family were ingestion of groundwater and ingestion of plants and animals contaminated by irrigation water. The groundwater was assumed to be contaminated by a breach in each disposal unit immediately after shallow land burial, 300 years after disposal in aboveground vaults, or 750 years after disposal in belowground vaults. The contaminants were assumed to leach over time from their solidified waste form to create a plume of contamination. Individual contaminated plumes were then assumed to migrate to the receptor wells without mixing with each other. The risks to the hypothetical farm family were estimated over a 10,000-year period because the maximum exposure would occur in the future when the peak of contaminant concentration passes the well. Results of the farm family analyses are presented as the probability of cancer fatality or cancer incidence for an individual during the 70-year lifetime that presents the greatest exposure of the 143 lifetimes (i.e., 10,000 years) analyzed. The 10,000 year period was selected for the analysis to maintain consistency with the "Guidelines for Radiological Performance Assessment of DOE Low-Level Radioactive Waste Disposal Sites" that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been changed; current guidance suggests that a 1,000-year time period should be used

in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A.

The exposure pathways for the hypothetical intruder were inhalation of resuspended contaminated soil, inadvertent ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and direct radiation from contaminated soil. A hypothetical intruder who drills into the disposal facility was assumed to be exposed to contaminated wastes, including radionuclides and hazardous chemicals, that remain at the site. Two hypothetical intrusions were assumed to occur: 100 years and 300 years after closure of the disposal facility. The risks to the hypothetical intruder were estimated for one lifetime (70 years).

Table 6.4–3 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for LLMW disposal.

The health risk impacts associated with the routine operation of LLMW treatment and disposal facilities are presented in Tables 6.4–4 through 6.4–16 of this section. The tables show the estimates of human health risk for both treatment and disposal of LLMW. Summary tables show programwide results by alternative. The site tables in Volume II present the health risk impacts for the 16 major LLMW sites.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases. Note that both the *total cancer incidence* and the *nonfatal cancer incidence* values are overestimated by a factor of about two because the estimates contain a relatively large component of skin cancers. The internal exposure pathways evaluated in this WM PEIS (e.g., inhalation or ingestion of radionuclides) are not likely to induce large numbers of skin cancer cases. However, the International Commission on Radiological Protection (ICRP) dose conversion factor used in this PEIS to estimate total cancer incidence values includes incidences of skin cancer (ICRP, 1990).

6.4.1.3 Estimated Number of Fatalities

Programwide Treatment and Disposal. Table 6.4–4 presents an overview, by alternative, of the total estimated programwide fatalities associated with both treatment and disposal of LLMW. This table presents

Table 6.4–3. LLMW Disposal Health Risk Analysis Components

LLMW Disposal					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20 years	6.4–4
Number of cancer fatalities	WM workers	Radionuclides	Direct radiation	10 years	6.4–4
Number of cancer incidences	WM workers	Radionuclides	Direct radiation	10 years	6.4–6
Number of genetic effects	WM workers	Radionuclides	Direct radiation	10 years	6.4–6
Probability of cancer fatality	Hypothetical farm family most exposed lifetime MEI	Radionuclides	Ingestion	70 years	6.4–11
	Hypothetical intruder		Inhalation, ingestion, direct radiation		6.4–15 6.4–16
Probability of cancer incidence	Hypothetical farm family most exposed lifetime MEI	Chemicals	Ingestion	70 years	6.4–12
	Hypothetical intruder	Radionuclides	Inhalation, ingestion, direct radiation		6.4–15
		Chemicals	Inhalation, ingestion		
Probability of genetic effects	Hypothetical intruder	Radionuclides	Inhalation, ingestion, direct radiation	70 years	6.4–15
Noncancer risk	Hypothetical intruder	Chemicals	Inhalation, ingestion	70 years	6.4–15

Table 6.4-4. LLMW Treatment and Disposal—Estimated Number of Fatalities Programwide

Alternative	Number of Sites		Treatment				Disposal	
			WM Workers		Number of Offsite Population Radiation Cancer Fatalities	Number of Noninvolved Worker Radiation Cancer Fatalities	WM Workers	
	T	D	Number of Radiation Cancer Fatalities	Number of Physical Hazard Fatalities			Number of Radiation Cancer Fatalities	Number of Physical Hazard Fatalities
No Action[a]	3	--	1	2	*	*	--	--
Decentralized	37	16	1	4	*	*	1	*
Regionalized 1	11	12	1	4	*	*	1	*
Regionalized 2	7	6	1	3	*	*	1	*
Regionalized 3	7	1	1	3	*	*	*	*
Regionalized 4	4	6	1	3	*	*	1	*
Centralized	1	1	1	3	*	*	*	*

Notes: T = treatment; D = disposal; -- = action not applicable for the alternative;* = greater than 0 but less than 0.5.

[a] Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

the estimated number of latent cancer fatalities to the offsite population, noninvolved workers, waste management workers, and hypothetical farm family caused by radiological exposure. In addition, the table shows the estimated number of waste management worker deaths resulting from physical hazards during facility construction and operation.

None of the treatment alternatives results in a fatal cancer to the offsite or noninvolved worker populations. For each alternative, there is at least one estimated fatality associated with treatment operations. Most of these fatalities occur within the waste management worker population, and result from physical hazards involved in construction and operation of LLMW treatment facilities. Waste management workers are the only receptor group exposed to these physical hazards, and therefore, have more estimated fatalities than other receptor groups.

Disposal operations show one estimated fatal cancer for waste management workers in all alternatives, except where disposal is consolidated at one site.

For all alternatives, for both treatment and disposal, the estimated number of fatalities in the waste management worker population due to physical hazards exceeds estimated radiologically induced cancer fatalities in the offsite population and noninvolved workers. In general, fatality risk to waste management workers appears to decrease with increased centralization of activities. Fewer fatalities from physical hazards occur because fewer facilities and worker hours are required when waste management activities are consolidated at one or a few sites.

Site-Level. For all treatment and disposal alternatives, one or more fatalities are estimated only at the Hanford Site in the Centralized Alternative within the waste management worker population as a result of physical hazards. Site-level results for all alternatives are presented in Appendix D and Volume II.

6.4.1.4 Estimated Number of Cancer Incidences and Genetic Effects

Programwide Treatment. Table 6.4–5 presents an overview, by alternative, of the total estimated programwide cancer incidences and genetic effects associated with treatment of LLMW. These impacts result from chemical and radiation exposures of the offsite population, noninvolved workers, and waste management workers. In addition, the table includes radiation dose estimates for each receptor group.

The offsite population and waste management workers are the only receptor groups with estimated cancer incidences greater than or equal to one. The estimated number of cancer incidences from radiation exposure generally exceeds those from chemical exposure for the offsite population and waste management workers.

For waste management workers, impacts are similar across the alternatives, with two cancer incidences in each case except for the No Action Alternative, which has three cancer incidences. For the offsite population, three alternatives (No Action, Decentralized, and Regionalized 1) result in at least one cancer incidence. As the table indicates, consolidating treatment lowers the number of cancer incidences in the offsite population. This is because fewer treatment sites result in potential offsite exposure to fewer people.

Site-Level Treatment. Only one site (the Hanford Site) is estimated to exceed one cancer incidence as a result of treatment activities. The exceedance occurs in the Centralized Alternative within the waste management worker receptor group from radiation exposure. Genetic effects incidence is not estimated to

Table 6.4-5. LLMW Treatment—Estimated Number of Cancer Incidences and Genetic Effects Programwide

Alternative	Number of Sites		Offsite Population				Noninvolved Workers				WM Workers			
			Radionuclide			Chemical	Radionuclide			Chemical	Radiation			Chemical
	T	D	Dose (person-rem)	Number of Cancer Incidences	Number of Genetic Effects	Number of Cancer Incidences	Dose (person-rem)	Number of Cancer Incidences	Number of Genetic Effects	Number of Cancer Incidences	Dose (person-rem)	Number of Cancer Incidences	Number of Genetic Effects	Number of Cancer Incidences
No Action[a]	3	--	570	1	*	*	25	*	*	*	2,100	3	*	*
Decentralized	37	16	340	1	*	*	5	*	*	*	1,300	2	*	*
Regionalized 1	11	12	330	1	*	*	5	*	*	*	1,400	2	*	*
Regionalized 2	7	6	40	*	*	*	1	*	*	*	1,400	2	*	*
Regionalized 3	7	1	40	*	*	*	1	*	*	*	1,400	2	*	*
Regionalized 4	4	6	30	*	*	*	1	*	*	*	1,600	2	*	*
Centralized	1	1	50	*	*	*	1	*	*	*	1,600	2	*	*

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.5.
[a]Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

exceed one for any site under any alternative. Site-level results for all alternatives are presented in Appendix D and Volume II.

Programwide Disposal. Table 6.4–6 presents an overview, by alternative, of the total estimated programwide cancer incidences and genetic effects associated with disposal of LLMW. These impacts result from exposure of waste management workers to direct radiation. Radiation dose estimates are also included in the table.

Each of the alternatives results in cancer incidences within the waste management worker receptor group. The alternatives involving only one disposal site (Regionalized 3 and Centralized) result in one cancer incidence each; all other alternatives each result in two. Thus, waste consolidation at one disposal site decreases the estimated number of cancers for waste management workers.

As shown in Table 6.4–6, less than one incidence of genetic effects resulting from radiation exposure is estimated to occur among the population of waste management workers under each alternative.

Table 6.4–6. LLMW Disposal—Estimated Number of Cancer Incidences and Genetic Effects Programwide

Alternative	Number of Sites		WM Workers		
	T	D	Radiation Dose (person-rem)	Number of Radiation Cancer Incidences	Number of Radiation Genetic Effects
No Action	3	--	--	--	--
Decentralized	37	16	1,400	2	*
Regionalized 1	11	12	1,400	2	*
Regionalized 2	7	6	1,300	2	*
Regionalized 3	7	1	1,000	1	*
Regionalized 4	4	6	1,600	2	*
Centralized	1	1	900	1	*

Notes: T = treatment; D = disposal; -- = action not applicable for the alternative; * = greater than 0 but less than 0.5.

Site-Level Disposal. Three sites (the Hanford Site, INEL, NTS) pose a risk of cancer incidence greater than one to waste management workers as a result of direct radiation exposure. NTS poses risk greater than one to waste management workers under Regionalized Alternative 3, INEL under Regionalized Alternative 4, and the Hanford Site under the Centralized Alternative.

6.4.1.5 Probability of MEI Cancer Fatalities

Table 6.4–7 summarizes, by alternative, the highest estimated *probability* at any site of fatal cancer from exposure to radiation associated with each LLMW alternative. This table presents the probability of cancer fatality to the MEI within the offsite and noninvolved worker populations. The numbers in this table are the estimated *probabilities* that the MEI will die of latent cancer from radiation exposure. The probability of a cancer fatality for the MEI was calculated at each site, and the highest value at a single site under each alternative is presented in Table 6.4–7. The MEI risk is not a combined total of risks across all of the sites.

Three treatment alternatives (No Action, Decentralized, and Regionalized 1) have estimated probabilities of fatal cancer for the offsite MEI that are approximately one order of magnitude higher than the values for the other alternatives.

Table 6.4–7. LLMW Treatment—Greatest Probability of Cancer Fatality at Any LLMW Site

Alternative	Number of Sites		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
	T	D		
No Action	3	NA	3E–06	9E–06
Decentralized	37	16	3E–06	7E–07
Regionalized 1	11	12	3E–06	7E–07
Regionalized 2	7	6	3E–07	3E–07
Regionalized 3	7	1	3E–07	3E–07
Regionalized 4	4	6	3E–07	3E–07
Centralized	1	1	5E–07	6E–07

Notes: T = treatment; D = disposal; NA = not applicable. Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

Table 6.4–8 presents the probability of a fatal cancer from radiological exposure for the offsite MEI for all sites by treatment alternative. The data in Table 6.4–8 are graphically presented in Figure 6.4–1. LLNL, under the Decentralized and Regionalized 1 Alternatives, is the site with the highest estimated cancer fatality probability. This risk is due to exposure to tritium that would be released during treatment operations if LLNL were used as a treatment site. It should be noted that the estimated releases of radionuclides that produce the cancer fatality probability estimates presented in Table 6.4–8 are based on the conceptual thermal treatment of LLMW. Emissions of particulate radionuclides from thermal treatment generally are limited by the use of effective engineering controls (e.g., HEPA filtration). However, tritium in the waste forms water vapor upon thermal treatment and readily escapes in the airborne emissions from the process. The largest estimated releases of radionuclides from the treatment of LLMW result from the thermal treatment of waste containing tritium. These estimated releases, and the resulting potential health risks, illustrate the need to carefully analyze and document risks associated with the use of thermal treatment of substantial quantities of tritium. DOE is exploring alternative technologies for treating LLMW for use when potential health risks from thermal treatment are determined to be unacceptable.

The release of tritium to the air based on updated waste loads would be projected to increase at LLNL. The resulting offsite MEI cancer fatality probability and other risks (e.g., MEI cancer incidence probability), driven by the release of tritium to the air at LLNL, could increase. This increase in tritium releases could also occur at Hanford in Regionalized and Centralized Alternatives, with similar increases in risk when the LLMW at LLNL is shipped to Hanford for treatment. As discussed in the preceding paragraph, mitigation measures would be employed, such as alternative technologies, to maintain safe emission levels (see Appendix I).

6.4.1.6 Probability of MEI Cancer Incidences and Genetic Effects

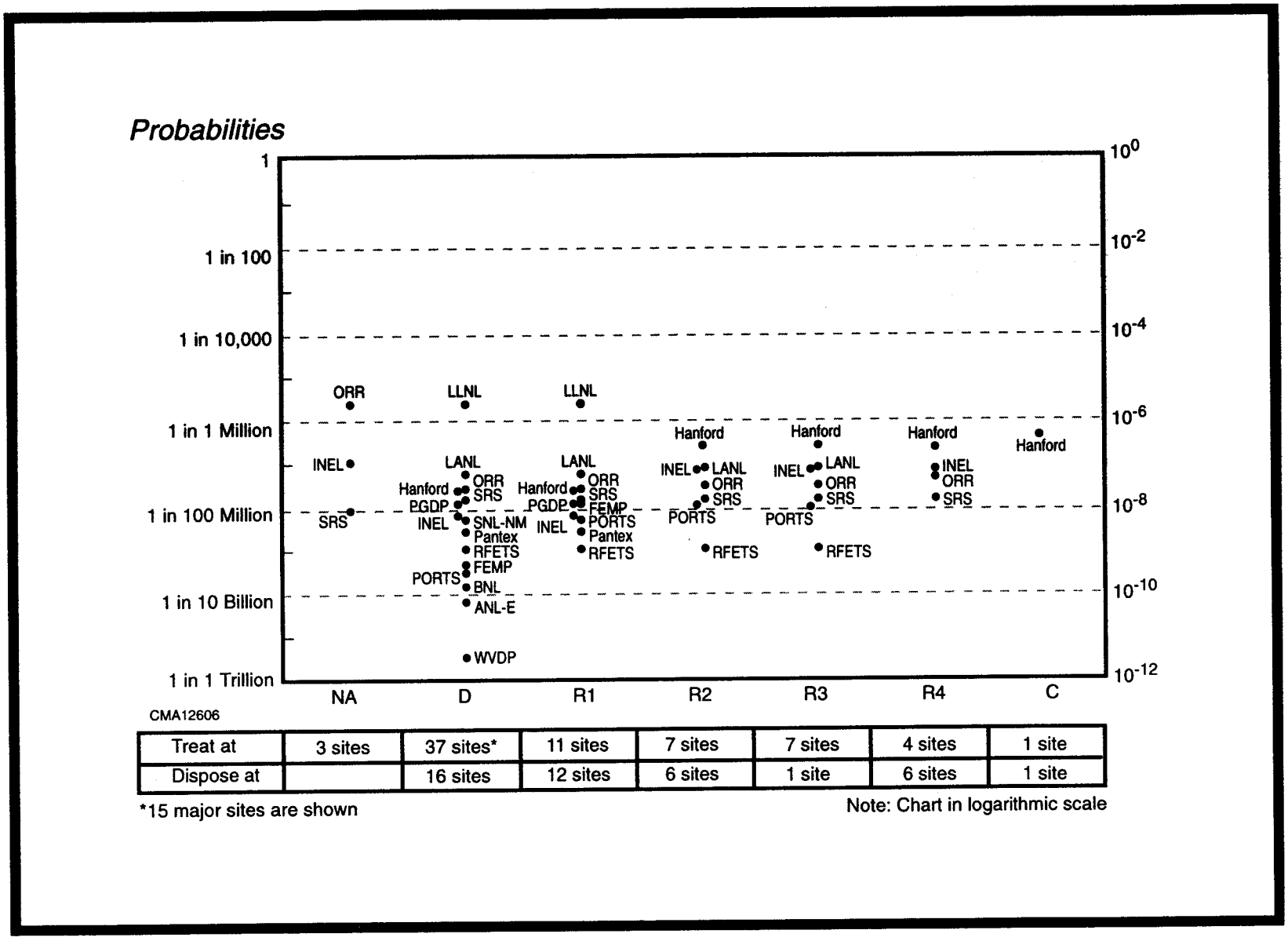
Table 6.4–9 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidences and genetic effects resulting from chemical and radionuclide exposure. The table presents these estimated risks for the MEI of the offsite and the noninvolved worker populations.

The highest radiation cancer incidence probability for the offsite MEI, under each treatment alternative, is greater than the highest chemical cancer incidence probability. The same trend can be seen in the cancer incidence probabilities for the noninvolved worker MEI.

Table 6.4–8. LLMW Treatment—Offsite MEI Cancer Fatality Probabilities

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	3	NA	--	--	--	--	7E-08	--	--	--	3E-06	--	--	8E-09	--	--	1E-08	--
Decentralized	37	16	9E-11	2E-10	5E-10	3E-08	7E-09	6E-08	3E-06	2E-10	3E-08	1E-08	3E-09	3E-10	1E-09	5E-09	2E-08	4E-12
Regionalized 1	11	12	--	--	1E-08	3E-08	7E-09	6E-08	3E-06	--	3E-08	1E-08	3E-09	6E-09	1E-09	--	2E-08	--
Regionalized 2	7	6	--	--	--	3E-07	8E-08	9E-08	--	--	4E-08	--	--	1E-08	1E-09	--	2E-08	--
Regionalized 3	7	1	--	--	--	3E-07	8E-08	9E-08	--	--	4E-08	--	--	1E-08	1E-09	--	2E-08	--
Regionalized 4	4	6	--	--	--	3E-07	8E-08	--	--	--	5E-08	--	--	--	--	--	2E-08	--
Centralized	1	1	--	--	--	5E-07	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; NA = not applicable; -- = action not applicable for the alternative. Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.



Treat at	3 sites	37 sites*	11 sites	7 sites	7 sites	4 sites	1 site
Dispose at		16 sites	12 sites	6 sites	1 site	6 sites	1 site

*15 major sites are shown

Note: Chart in logarithmic scale

Figure 6.4–1. LLMW Treatment—Probability of Cancer Fatality to Offsite MEI

Table 6.4-9. LLMW Treatment—Greatest Probability of Cancer Incidences and Genetic Effects at Any LLMW Site

Alternative	Number of Sites		Offsite MEI				Noninvolved Worker MEI			
			Radionuclide			Chemical	Radionuclide			Chemical
	T	D	Dose (rem)	Cancer Incidence Probability	Genetic Effects Probability	Cancer Incidence Probability	Dose (rem)	Cancer Incidence Probability	Genetic Effects Probability	Cancer Incidence Probability
No Action	3	NA	0.007	1E-05	7E-07	2E-08	0.02	3E-05	2E-06	3E-07
Decentralized	37	16	0.005	9E-06	5E-07	1E-09	0.002	3E-06	2E-07	7E-09
Regionalized 1	11	12	0.005	9E-06	5E-07	1E-09	0.002	3E-06	2E-07	6E-09
Regionalized 2	7	6	0.0005	9E-07	5E-08	1E-09	0.0006	1E-06	6E-08	6E-09
Regionalized 3	7	1	0.0005	9E-07	5E-08	1E-09	0.0006	1E-06	6E-08	6E-09
Regionalized 4	4	6	0.0005	9E-07	6E-08	2E-09	0.0006	1E-06	6E-08	9E-09
Centralized	1	1	0.001	2E-06	1E-07	4E-10	0.001	2E-06	1E-07	1E-08

Notes: T = treatment; D = disposal; NA = not applicable. Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

Offsite MEI radiation cancer incidence probability is highest at ORR under the No Action Alternative, at LLNL under the Decentralized and Regionalized 1 Alternatives, and at the Hanford Site under the Centralized Alternative. Uranium-238 is the radionuclide that accounts for most of the risk at ORR under the No Action Alternative, whereas tritium is the controlling radionuclide at LLNL under the Decentralized and Regionalized 1 Alternatives and at the Hanford Site under the Centralized Alternative.

Radiation cancer incidence probability for the noninvolved worker MEI followed a similar pattern. Genetic effects incidence probability is highest at ORR under the No Action Alternative for the offsite MEI and the noninvolved worker MEI.

6.4.1.7 MEI Noncancer Risks

The "Hazard Index" is an EPA standard indicator of potential noncancer chemical health risk. It is derived by comparing the estimated exposure concentrations of noncarcinogenic chemicals to concentrations presumed to not produce adverse human health effects over an entire lifetime, assuming continuous low-level exposure. If the Hazard Index exceeds one, the potential exists for adverse health effects. In this PEIS,

the Hazard Index was estimated for the offsite MEI, the noninvolved worker MEI and the hypothetical farm family most exposed lifetime MEI (Section 6.4.1.8).

For waste management workers, an "Exposure Index" rather than a Hazard Index was estimated. The Exposure Index is derived by comparing the estimated exposure concentrations to appropriate occupational exposure limits. The Exposure Index was considered to be a better measure for waste management workers because the Hazard Index uses standards designed to protect the health of the general population, including sensitive subgroups, such as children. Workers are generally assumed to be healthier than the general population, and worker populations do not contain sensitive subgroups. Therefore, the concentrations of noncarcinogenic chemicals presumed to be protective of human health are different for these two groups of receptors. If the Exposure Index exceeds one, the estimated concentrations exceed the concentrations presumed to be without adverse health effects.

Programwide. Table 6.4–10 summarizes, by alternative, the programwide noncancer health risks resulting from chemical exposures associated with each LLMW alternative. This table presents the greatest noncancer health risks (presented as "Hazard Index") to the MEI within the offsite and noninvolved worker receptor groups, and to an individual waste management worker (presented as "Exposure Index") across the treatment sites.

Table 6.4–10. LLMW Treatment—Greatest Noncancer Health Risks From Chemical Exposure at Any LLMW Site

Alternative	Number of Sites		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
	T	D			
No Action	3	NA	*	*	*
Decentralized	37	16	*	*	*
Regionalized 1	11	12	*	*	*
Regionalized 2	7	6	*	*	*
Regionalized 3	7	1	*	*	*
Regionalized 4	4	6	*	*	*
Centralized	1	1	*	*	*

Notes: T = treatment; D = disposal; NA = not applicable; * = greater than 0 but less than 1. Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

No Hazard or Exposure Index values equal or exceed one as a result of treatment operations; therefore, noncancer toxicity is not expected to be of concern for these receptors.

6.4.1.8 Hypothetical Farm Family Risks

In addition to the worker disposal risks already presented, disposal risks were evaluated for hypothetical receptors, a farm family and an intruder, as defined in Section 6.4.1. Risks to both the hypothetical farm family and the hypothetical intruder (Section 6.4.1.10) were analyzed in keeping with the requirements of DOE Order 5820.2A, "Radioactive Waste Management" (DOE, 1988). This order requires that site-specific performance assessments be conducted in order to demonstrate that a given disposal practice is in compliance with the set of performance objectives quantified in the DOE Order. These objectives specify concentrations and dose limits that are intended to be protective of the general public, an inadvertent intruder, and groundwater resources. Releases from the disposal facility occur as the result of natural causes (e.g., through leaching upon breakdown of the facility) and by inadvertent human intrusion.

The farm family scenario addresses potential contamination of groundwater resources as well as the potential health effect consequences of exposure of the general public to radionuclides and chemicals released from the disposal facility. The radionuclides and chemicals are assumed to leach from the disposal site through the unsaturated zone to contaminate groundwater that is used by a future farm family as a source of drinking water and irrigation water. See Section 5.4.1 for a further discussion of the presentation of farm family risk results.

Although the disposal facility risk analyses conducted in this WM PEIS use scenarios that are similar to those used in the performance assessment process, it is important to note that the objectives of the two types of analyses are different. The WM PEIS hypothetical farm family and intruder scenario analyses assume the use of generic disposal facilities and generic waste forms (e.g., grout or polymers), and that the entire inventory of waste will be disposed (i.e., no exclusion of particular radionuclides or chemicals). These assumptions lead to overestimates of contaminant concentrations in groundwater. The objective of the WM PEIS analyses is to provide a relative comparison of potential risk among LLMW management alternatives. The outputs of the analyses are risk estimates for the hypothetical farm family and intruder.

In contrast, the performance assessment analysis process involves the use of more detailed site-specific data in the design of a disposal facility at a particular location on a site. The objective of the analysis is to design

a facility that will satisfy the performance objectives specified in DOE Order 5820.2A. These performance objectives include, in practice, (1) modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration); (2) modifying the form of the waste to be disposed (such as changing to a vitrified waste form); (3) changing the specific location of the waste disposal facility so that it is sited over an area with more favorable hydrologic conditions; and (4) imposing waste acceptance criteria (i.e., restricting the amounts of radionuclides allowed in a given waste disposal facility). The output of the analysis is a set of waste disposal facility design criteria.

As a result of these differences, the WM PEIS analyses produce estimates of groundwater contamination and farm family risk that are higher than those that would be expected upon actual implementation of the LLMW disposal alternatives. For example, the generic WM PEIS analysis estimates that radionuclide groundwater contamination will exceed existing drinking water quality protection standards at certain sites (see Section 6.6.2). However, the drinking water resource protection performance objective contained in DOE Order 5820.2A would require that the waste disposal facility designs developed by the performance assessment analyses subsequently conducted at those sites ensure that drinking water standards would not be exceeded upon disposal of LLMW. Consequently, the hypothetical farm family risk estimates presented in this section have been adjusted to reflect groundwater contamination that does not exceed existing standards. That is, radionuclides whose estimated groundwater concentrations exceeded drinking water standards were adjusted to concentrations that represent 100% of drinking water standards. This assumes that mitigation has taken place and the appropriate groundwater standards will be met. If the standards cannot be met, the facility would fail the performance assessment analysis, and such a facility would not be built. The unadjusted risk estimates from the WM PEIS analysis are presented in the Volume II site tables and in Appendix D.

In addition, the concentrations of hazardous chemicals estimated to be released to groundwater from LLMW disposal facilities have been overestimated in the WM PEIS analyses as a result of assumptions used concerning the routing of wastes through LLMW treatment systems. Conventional technology assumed for pretreatment allowed some wastes containing solvents to bypass the thermal treatment processes used, as shown in the LLMW flow diagram (Figure 6.2–1). Some of the solvents contained in the wastes that would be destroyed by treatment instead remained in the disposed waste in concentrations that were estimated to produce groundwater contamination in excess of standards. In practice, more intensive pretreatment of LLMW would ensure that EPA land disposal restrictions (LDRs) were satisfied. Therefore, LLMW disposal should not produce major impacts to groundwater quality and subsequently to human health. In a manner

similar to radionuclides, the WM PEIS analysis estimates of hazardous chemical concentrations were adjusted to levels that did not exceed existing water quality standards.

The results of the hypothetical farm family analyses are presented in Table 6.4–11 for the MEI of the most exposed lifetime.

MEI cancer fatality probability estimates for each site that disposes under the various alternatives are presented in Table 6.4–11. The results of the WM PEIS analysis indicate that disposal of uranium-238 (U-238) must be carefully controlled at FEMP (under the Decentralized and Regionalized 1 Alternatives), the Hanford Site (under the Decentralized, Regionalized 1, 2, and 4, and Centralized Alternatives), and SRS (under the Decentralized and Regionalized 1, 2, and 4 Alternatives). Such controls are likely to result in additional costs and potentially to increased impacts in other resource areas. If the amount or form of U-238 is not controlled as previously described, the groundwater concentrations of the radionuclide at these sites are estimated to exceed drinking water standards. These elevated groundwater concentrations would produce cancer fatality probability estimates that are about four (at FEMP) to 10 (at the Hanford Site and SRS) times higher than those presented in Table 6.4–11 (see Volume II site tables and Appendix D). In a similar manner, the disposal of plutonium-240 (Pu-240) at SNL-NM would require careful control. The estimated times of maximum future radionuclide exposure at these sites are as follows:

- FEMP—U-238 at 4,010 years
- The Hanford Site—U-238 at 1,260 years
- SNL-NM—Pu-240 at 6,440 years
- SRS—U-238 at 11,460 years

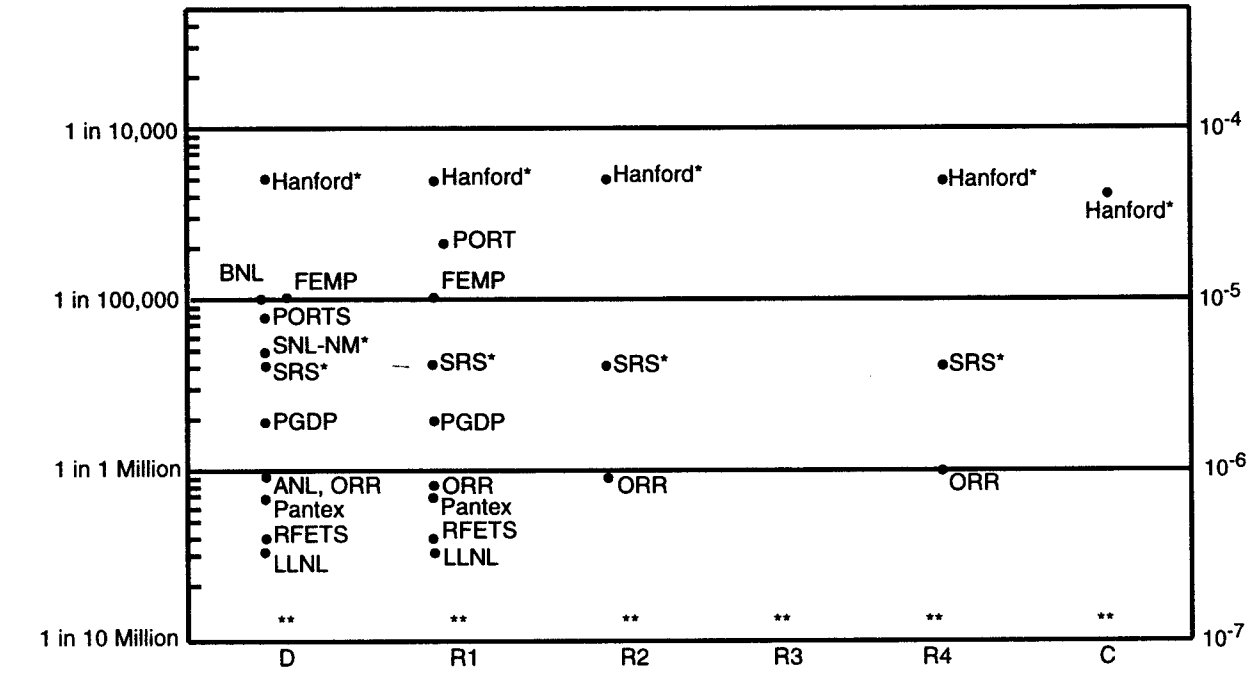
More recent estimates for the release of radionuclides to the groundwater based on updated waste loads project increases in the expected groundwater exceedances for particular radionuclides at these sites: FEMP (U-238), Hanford (U-238), SRS (U-238), and SNL-NM (Pu-240). Other risks associated with the release to the groundwater of these particular radionuclides at these sites could also be expected to increase for unconstrained disposal. Careful management would continue to be a requirement for these radionuclides at these sites (see Appendix I).

The results of this analysis, graphically presented in Figure 6.4–2, also indicate that, on the basis of estimated MEI cancer fatality probability, disposal of LLMW at ANL-E, BNL, INEL, LANL, LLNL, NTS, ORR, PGDP, the Pantex Plant, Portsmouth, and RFETS could be accomplished for

Table 6.4-11. LLMW Disposal: Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probabilities

Alternative	Number of Sites		ANL	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	9E-07	1E-05	1E-05*	5E-05*	~0	~0	3E-07	~0	9E-07	2E-06	7E-07	8E-06	4E-07	5E-06*	4E-06*	--
Regionalized 1	11	12	--	--	1E-05*	5E-05*	~0	~0	3E-07	~0	8E-07	2E-06	7E-07	2E-05	4E-07	--	4E-06*	--
Regionalized 2	7	6	--	--	--	5E-05*	~0	~0	--	--	9E-07	--	--	--	--	--	4E-06*	--
Regionalized 3	7	1	--	--	--	--	--	--	--	~0	--	--	--	--	--	--	--	--
Regionalized 4	4	6	--	--	--	5E-05*	~0	~0	--	--	1E-06	--	--	--	--	--	4E-06*	--
Centralized	1	1	--	--	--	4E-05*	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; -- = action not applicable for alternative; * = adjusted values. They represent the estimated risks when groundwater concentrations of radionuclides are adjusted to 100% of existing standards. Radionuclides that drive risks and exceed drinking water standards include uranium-238 at FEMP, the Hanford Site, and SRS, and plutonium-240 at SNL-NM. Unadjusted risk estimates are presented in the Volume II Site Tables and in Appendix D. At ORR, groundwater concentrations of radionuclides must be adjusted to meet existing standards for disposal of RH LLMW. This occurs under all alternatives except No Action. The cancer fatality probability values for RH-LLMW at ORR are 2E-06 for all disposal alternatives except No Action. These are adjusted values based on plutonium-239 as the risk driver. Cancer fatality probability values for disposal of RH-LLMW at INEL, the Hanford Site and SRS are near zero, 6E-08, and 5E-07, respectively. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.



Treat at	37 sites	11 sites	7 sites	7 sites	4 sites	1 site
Dispose at	16 sites	12 sites	6 sites	1 site	6 sites	1 site

Note: Chart in logarithmic scale

* Adjusted values = see text discussion.

** Waste disposed at INEL, LANL, and/or NTS did not produce a probability of cancer fatality.

At INEL, Hanford, ORR and SRS, the cancer fatality probability values for disposal of RH-LLMW are near zero, 6E-08, 2E-06, and 5E-07, respectively. The value for ORR was adjusted.

ANL-E values are higher than expected.

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Figure 6.4–2. LLMW Disposal—Probability of Cancer Fatality for Hypothetical Farm Family Most Exposed Lifetime MEI

WM PEIS-assumed wastes without additional radionuclide constraints. Of these sites, INEL, LANL, and NTS had the lowest (near zero) estimated cancer fatality probabilities.

Table 6.4–12 presents site-specific estimates of the most exposed lifetime MEI chemical cancer incidence probability. The data in Table 6.4–12 are graphically presented in Figure 6.4–3. The data indicate that, on the basis of chemical cancer incidence probability, 1,2-dichloroethane disposal would need to be controlled at ORR, Portsmouth, and the Hanford Site (under the Centralized Alternative), and that carbon tetrachloride disposal would need to be controlled at RFETS and SRS. The risk estimates presented for these sites in Table 6.4–12 have been adjusted to 100% of drinking water standards for these contaminants. The unadjusted risk estimates are presented in the Volume II site data tables. As previously described, these unadjusted values overestimate potential chemical cancer incidence probability because the pretreatment process stream used in this PEIS allows some solvents to remain in the buried waste, which would not occur upon compliance with EPA LDR requirements.

Noncancer adverse health risks from exposure to chemical contaminants in groundwater were also evaluated. They are of concern under the Decentralized and Regionalized Alternatives. Under Regionalized Alternatives 2 and 4, noncancer health risks are estimated to occur at ORR as a result of exposure to acetone. The acetone groundwater concentrations, like those of the other solvents, could be reduced to acceptable levels by providing more intensive treatment. Therefore, the noncancer risks at ORR under these alternatives could be mitigated. Under the Decentralized and Regionalized 1 Alternatives, noncancer risks occur at Portsmouth as a result of exposure to arsenic. Adjusting chemical contaminant concentrations to comply with drinking water quality standards is necessary to ensure that noncancer risks are not a concern at the Hanford Site (under all alternatives), RFETS (under Decentralized and Regionalized 1 Alternatives), and SRS (under Decentralized and Regionalized 1, 2, and 4 Alternatives). The chemicals that are estimated to drive the noncancer risks at these sites if groundwater concentrations are not adjusted include silver (at the Hanford Site) and carbon tetrachloride (at RFETS and SRS).

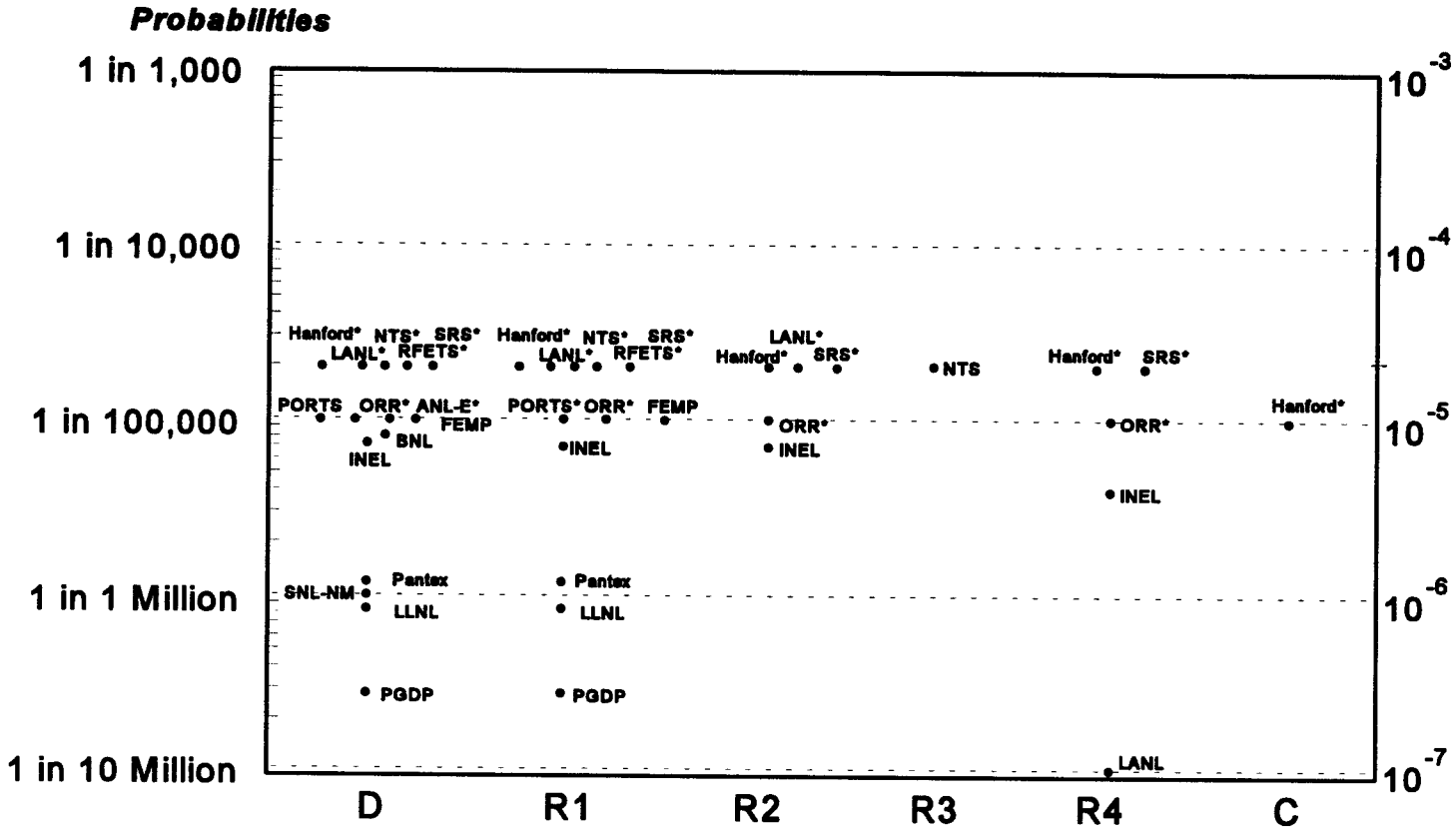
The hypothetical farm family risks represent individual receptors assumed to be exposed through location of a drinking water well at 300 m from the center of a single disposal unit. Concentrations of groundwater contaminants at this location are assumed to be higher than those that could be expected at greater distances from the unit due to dispersion of contaminants. Construction of multiple units is expected to be required at certain sites under the various LLMW alternatives to dispose of the projected waste volumes. While the farm family scenario evaluates only a single receptor 300 m from an individual unit, DOE assumes that each

Table 6.4-12. LLMW Disposal—Chemical Cancer Incidence Probability for Hypothetical Farm Family Most Exposed Lifetime MEI

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS[a]	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	1E-06	8E-06	1E-05	1E-04	7E-06	8E-05	8E-07	2E-06	1E-04*	3E-07	1E-06	2E-05	2E-04*	9E-07	2E-04*	--
Regionalized 1	11	12	--	--	1E-05	1E-04	7E-06	8E-05	8E-07	2E-06	1E-04*	3E-07	1E-06	3E-05*	2E-04*	--	2E-04*	--
Regionalized 2	7	6	--	--	--	1E-04	8E-06	4E-05	--	--	1E-04*	--	--	--	--	--	2E-04*	--
Regionalized 3	7	1	--	--	--	--	--	--	--	2E-04	--	--	--	--	--	--	--	--
Regionalized 4	4	6	--	--	--	1E-04	4E-06	1E-07	--	--	1E-04*	--	--	--	--	--	2E-04*	--
Centralized	1	1	--	--	--	1E-04*	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; -- = action not applicable for alternative; * = adjusted values. They represent the risks when groundwater concentrations of carcinogenic chemicals are adjusted to 100% of existing standards. Chemicals that drive risks and exceed drinking water standards include 1,2-dichloroethane at ORR, PORTS, and the Hanford Site (under Centralized) and carbon tetrachloride at RFETS and SRS. Unadjusted risk estimates are presented in the Volume II site tables and in Appendix D.

[a] The values for NTS overestimate potential risks at that site, since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years (Sully et al., 1995). Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.



Treat at	37 sites	11 sites	7 sites	7 sites	4 sites	1 site
Dispose at	16 sites	12 sites	6 sites	1 site	6 sites	1 site

* Adjusted values - see text discussion

note: chart in logarithemic scale

Figure 6.4–3. LLMW Disposal—Probability of Chemical Cancer Incidence for Hypothetical Farm Family Most Exposed Lifetime MEI

of these close-in receptors will be affected primarily by the contaminant plume from the closest facility to him. However, DOE recognizes that commingling of contaminant plumes from multiple disposal units may occur as distance from the units increases, but anticipates that, at 300 m, the highest concentration of contaminants is likely to result from the single closest plume. At greater distances from the disposal units, where overlap of the plumes is more likely, the concentrations in any given plume should be lower as a result of dispersion and dilution than those estimated at the 300-m well. The WM PEIS cannot address groundwater contaminant concentrations at distances greater than 300 m from disposal units. More detailed analyses, such as the performance assessments required under DOE Order 5820.2A, will address the issues of existing groundwater contamination and multiple disposal units. For example, in April 1996, DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help ensure that continuing disposal of low-level waste will not compromise the future radiological protection of the public. The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned low-level waste disposal facility and other sources of radioactive material in the ground that might interact with the LLW disposal facility.

6.4.1.9 Potential Collective Risk to Offsite Population From Waste Disposal

Risk assessments generally evaluate both collective and individual health risks, that is, risks for both populations of receptors and for MEIs. However, the WM PEIS disposal risk analysis quantitatively estimates risks only for the farm family MEI. Although the farm family scenario disposal risk analysis uses site-specific hydrogeologic and meteorologic data, use of "conceptual" disposal units was assumed. The analysis did not attempt to identify exact locations of these generic units on a site; rather, they were assumed to be placed either near existing disposal units where such units existed, or at a location on the site expected to be most sensitive to groundwater contamination. Since the analysis does not attempt to actually locate the disposal units on the site, DOE believes it is not possible to develop plausible quantitative estimates of the collective risks to current or future offsite populations resulting from exposure to contaminated groundwater. Both the concentrations of contaminants in the groundwater and the number of people potentially exposed will be strongly influenced by the locations of the disposal units and receptor wells. A hypothetical siting decision to support such an analysis is not favored because the choice of a site so strongly influences the results as to make them a direct reflection of the choice.

To address the relative potential of the proposed disposal sites and alternatives for collective risk to offsite populations, values for site parameters that influence potential groundwater contamination or that are

associated with the relative size of populations at risk were statistically analyzed. These variables included the size of the site (acres), depth to aquifer, the size of the offsite population living within 50 miles of the site, annual rainfall, annual groundwater recharge, and time of travel of groundwater from the surface to a downgradient well. Statistical analysis of these variables produced clusters or groupings of sites according to their relative potential risk vulnerability. These groupings are believed to be more appropriate metrics for decision making, given the lack of facility siting and other relevant information, than quantitative estimates of person-rem doses and latent cancer fatalities.

Section C.4.1 of Appendix C contains additional information about the methodology and results of the collective risk vulnerability analysis. This section also describes other DOE efforts to assess potential risks from waste disposal, including those of the Federal Facility Compliance Act Disposal Workgroup and the performance assessment process required by DOE Order 5820.2A.

Section 5.4.1 of Chapter 5 contains a discussion of the results of the collective risk vulnerability analysis. Candidate disposal sites are grouped into three population risk vulnerability (PRV) groups, with PRV Group 1 having the lowest potential vulnerability for offsite population risks from groundwater contamination following LLMW disposal, and PRV Group 3 having the highest potential. The results of this analysis generally agree with those of the Federal Facility Compliance Act Disposal Workgroup analysis of potential radionuclide exposure via the groundwater pathway, as presented in the report, *Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste* (DOE 1996d). It is important to note that this is a screening-level analysis that does not take into account any measures that would limit migration of disposed wastes into the groundwater, such as engineered disposal units or changes in waste acceptance criteria. The objective of the analysis is not to rule out any sites for disposal but to indicate where such disposal mitigation measures are more likely to be necessary and where the costs of disposal would likely increase as a result. In particular, though some sites may be listed in Group 3, this does not mean that disposal would be unacceptable there. Rather, it means that mitigation would be an important part of a disposal plan for these sites.

As previously described, the waste volume, curie load, chemical volume, and number of potential disposal units required at a given site vary by waste management alternative. Table 6.4–13 presents data on disposal volumes, number of disposal units, curies, and chemical inventories for each site as they vary over the proposed alternatives, in conjunction with the results of the risk vulnerability factor and cluster analyses. This information is summarized across the sites for each alternative and displayed in Table 6.4–14. The

Table 6.4–13. Disposal Variables (by Site and Alternative) and Population Risk Vulnerability Group for LLMW

Disposal Alternative Variables	ANL-E[b]	BNL	FEMP	Hanford[a]	INEL[a]	LANL	LLNL	NTS[b]	ORR[a]	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS[a]	WVDP
Risk Vulnerability Group	2	2	3	1	1	1	2	1	3	3	1	3	2	2	3	2
Decentralized Alternative																
Number of disposal units	1	1	1	2	1	1	1	1	2	1	1	1	2	1	1	1
Disposal waste volume (m^3)	30	84	1,080	12,500	6,550	670	1,870	2,980	20,400	220	200	5,910	13,900	14	5,520	0
Total radioactivity (Ci × 0.001)	0.039	0.085	0.013	52	126	1.1	17.9	26	24	0.98	0.17	3.5	0.29	0.08	24	0
Total chemical inventory (kg × 0.001))	0.20	1.2	8.2	88	103	9.1	7.8	5.8	189	1.4	0.95	98	75	0.15	51	0
Regionalized 1 Alternative																
Number of disposal units			1	2	1	1	1	1	2	1	1	1	2		1	
Disposal waste volume			1,080	12,500	8,630	690	1,870	900	20,040	220	200	6,020	13,900		5,520	
Total radioactivity (Ci × 0.001)			0.013	52	128	1.2	17.9	24	24	0.98	0.17	3.6	0.29		24	
Total chemical inventory (kg × 0.001)			8.2	88	106	9.2	7.8	2.9	189	1.4	0.95	99	75		51	
Regionalized 2 Alternative																
Number of disposal units				2	1	2			3						1	
Disposal waste volume				13,300	9,530	14,800			27,700						5,520	
Total radioactivity (Ci × 0.001)				70	152	1.7			28						24	
Total chemical inventory (kg × 0.001)				96	109	85			297						51	
Regionalized 3 Alternative																
Number of disposal units								9								
Disposal waste volume								70,850								
Total radioactivity (Ci × 0.001)								276								
Total chemical inventory (kg × 0.001)								638								

Table 6.4–13. Disposal Variables (by Site and Alternative) and Population Risk Vulnerability Group For LLMW—Continued

Disposal Alternative Variables	ANL-E[b]	BNL	FEMP	Hanford[a]	INEL[a]	LANL	LLNL	NTS[b]	ORR[a]	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS[a]	WVDP
Regionalized 4 Alternative																
Number of disposal units				2	3				3						1	
Disposal waste volume				13,300	24,320				27,700						5,520	
Total radioactivity (Ci × 0.001)				70	154				28						24	
Total chemical inventory (kg × 0.001)				96	197				297						51	
Centralized Alternative																
Number of disposal units				9												
Disposal waste volume				70,850												
Total radioactivity (Ci × 0.001)				276												
Total chemical inventory (kg × 0.001)				638												

[a] Total radioactivity (curies) for remote-handled (RH) LLMW associated with the waste at Hanford (9), INEL (220,000), ORR (324,000), and SRS (4,920) for all the action alternatives are not included within the table.

[b] NTS and ANL-E are sites that have been analyzed using newer information (see Appendix I). NTS also accepts waste for disposal from sites whose analysis is based on data from an earlier database. Thus, the information on disposal at NTS is a composite of data obtained from both sources. This affects the analysis (to a lesser extent) of any disposal site in any alternative that accepts waste for disposal from NTS and ANL-E.

Table 6.4-14. Disposal Variables by LLMW Alternative and Population Risk Vulnerability Group

Alternative	Group 3	Group 2	Group 1
Decentralized Alternative			
Number of disposal units	6	5	8
Disposal waste volume (m^3)	33,100	1,998	36,800
Total radioactivity (Ci × 0.001)	52.5	18.1	205.6
Total chemical inventory (kg × 0.001)	347.6	9.3	281.8
Regionalized 1 Alternative			
Number of disposal units	6	1	8
Disposal waste volume (m^3)	33,240	1,870	36,800
Total radioactivity (Ci × 0.001)	52.6	17.9	205.1
Total chemical inventory (kg × 0.001)	348.6	7.8	282.0
Regionalized 2 Alternative			
Number of disposal units	4	0	5
Disposal waste volume (m^3)	33,220	0	37,630
Total radioactivity (Ci × 0.001)	52.0	0	223.7
Total chemical inventory (kg × 0.001)	348.0	0	290.0
Regionalized 3 Alternative			
Number of disposal units	0	0	9
Disposal waste volume (m^3)	0	0	70,850
Total Radioactivity (Ci × 0.001)	0	0	276.0
Total chemical inventory (kg × 0.001)	0	0	638.0
Regionalized 4 Alternative			
Number of disposal units	4	0	5
Disposal waste volume (m^3)	33,220	0	37,620
Total radioactivity (Ci × 0.001)	52.0	0	224.0
Total chemical inventory (kg × 0.001)	348.0	0	293.0
Centralized Alternative			
Number of disposal units	0	0	9
Disposal waste volume (m^3)	0	0	70,850
Total radioactivity (Ci × 0.001)	0	0	276.0
Total chemical inventory (kg × 0.001)	0	0	638.0

Note: Total radioactivity (curies) for remote-handled (RH) LLMW associated with the waste at Hanford (9), INEL (220,000), ORR (324,000), and SRS (4,920) for all the action alternatives are not included within the table.

summary data in Table 6.4–14 suggest that the Regionalized 3 and Centralized Alternatives present lower potential collective risk to offsite populations from disposal than the Decentralized or other Regionalized Alternatives.

Note that the results of this screening-level risk vulnerability analysis are useful in discussing the relative potentials among the sites and the proposed waste management alternatives. However, more refined risk analyses will be included in the site-specific performance assessments that will be conducted for the design and siting of new disposal facilities. In addition, DOE will consider a number of other factors in the development of waste disposal decisions. These include the results of safety analyses for disposal facility operation, the extent of existing contamination or waste disposal at a site, the costs and benefits involved in transporting waste among sites, and other environmental and socioeconomic concerns.

6.4.1.10 Disposal Intruder Scenario Risks

Table 6.4–15 presents an overview, by alternative, of the greatest programwide risks to a hypothetical intruder 100 and 300 years after the disposal facility has closed. Because the focus is on an individual intruder, the risks are presented as the *probability* of that individual experiencing an adverse health impact

Table 6.4–15 LLMW Disposal: Summary Risks to Hypothetical Intruders at LLMW Sites

Alternative	T	D	Radionuclide				Chemical	
			Dose (rem)	Cancer Fatality Probability	Cancer Incidence Probability	Genetic Effects Probability	Cancer Incidence Probability	Hazard Index[a]
100 Years After Disposal Facility Closure								
Decentralized	37	16	34	2E–02	6E–02	3E–03	2E–13	1E–07
Regionalized 2	7	6	33	2E–02	6E–02	3E–03	2E–13	1E–07
Centralized	1	1	7	4E–03	1E–02	7E–04	5E–14	1E–07
RH–LLMW	4	4	68	3E–02	1E–01	7E–03	1E–14	9E–09
300 Years After Disposal Facility Closure								
Decentralized	37	16	0.7	4E–04	1E–03	7E–05	2E–13	1E–07
Regionalized 2	7	6	0.6	3E–04	1E–03	6E–05	2E–13	1E–07
Centralized	1	1	0.2	7E–05	3E–04	2E–05	5E–14	1E–07
RH–LLMW	4	4	2	1E–03	4E–03	2E–04	1E–14	9E–09

Notes: T = treatment; D = disposal.
[a] Maximum of values for each site evaluated under the alternative.

(assuming that the intrusion occurs) rather than a total number of impacts for a selected population. Note that the intruder scenario risks were not estimated for all alternatives. Regionalized Alternative 2 was selected to be representative of the Regionalized Alternatives with disposal at six sites.

For both the 100-year and 300-year scenarios, each of the evaluated alternatives is estimated to result in relatively high maximum probabilities of cancer fatality, cancer incidence, and genetic effects from radionuclide and direct radiation exposure. Chemical exposures are much lower, resulting in lower risks of cancer incidence or adverse noncancer health effects.

Table 6.4–16 presents the cancer fatality probabilities by site for each of the alternatives evaluated 100 years and 300 years after the disposal facility has closed. The data in Table 6.4–16 are graphically presented in Figure 6.4–4. Under the Decentralized Alternative, cancer fatality probability values span a range of about four orders of magnitude. Cancer fatality probabilities generally are lower for the 300-year scenario by one to two orders of magnitude (i.e., 10–100 times) under all alternatives, which suggests that risks decrease as radionuclides decay. Strontium-90 (half-life 29 years) was the main radionuclide risk driver at 100 years, under each of the alternatives evaluated, whereas thorium-232 (half-life 1E+10 years), nickel-63 (half-life 96 years), and americium-241 (half-life 432 years) were the main risk drivers at 300 years. There is no general trend in intruder risk among the disposal alternatives evaluated.

The estimated doses presented in Tables 6.4–16 exceed the DOE Order 5820.2A performance assessment objective limits for intruders of 100 millirem per year for continuous exposure at the Hanford Site and INEL under the Decentralized and Regionalized 2 Alternatives and 500 millirem per year for acute exposure at ORR for RH-LLMW. Similar to the discussion in Section 6.4.1.8, site-specific considerations during design, construction, and operation would be expected to mitigate these exceedances. These mitigation measures are also described in Chapter 12.

6.4.2 TRANSPORTATION-RELATED IMPACTS

Transporting LLMW for treatment and disposal may affect the health of the truck or rail crew and the public along the transportation route. These impacts are the result of radiation exposure during normal operations, accidents in which the waste containers are assumed to be opened, exposure to vehicle exhaust during transport, and physical injury from vehicle accidents. In the No Action Alternative, no wastes are

Table 6.4–16 LLMW Disposal: Hypothetical Intruder Cancer Fatality Probabilities 100 and 300 Years After Facility Closure[a]

Sites	Decentralized Alternative				Regionalized Alternative 2				Centralized Alternative			
	100 Years		300 Years		100 Years		300 Years		100 Years		300 Years	
	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)
ANL-E	3E-04	6.6E-01	1E-05	2.3E-02	--	--	--	--	--	--	--	--
BNL	7E-06	1.5E-02	3E-07	5E-04	--	--	--	--	--	--	--	--
FEMP	7E-07	1E-03	7E-07	1.4E-03	--	--	--	--	--	--	--	--
Hanford	9E-03	1.9E+01	8E-05	1.5E-01	9E-03	1.9E+01	7E-05	1.4E-01	4E-03	7.1E+00	7E-05	1.5E-01
INEL	4E-03	7.5E+00	1E-04	2.5E-01	4E-03	7.9E+00	1E-04	2.6E-01	--	--	--	--
LANL	3E-05	5.2E-02	9E-07	1.9E-03	2E-05	4.6E-02	7E-06	1.4E-02	--	--	--	--
LLNL	2E-04	3.2E-01	5E-06	9.3E-03	--	--	--	--	--	--	--	--
NTS	2E-05	4.9E-02	2E-06	3.1E-03	7E-08	1E-04	2E-08	3E-04	--	--	--	--
ORR	1E-03	2.6E+00	4E-05	8.5E-02	1E-03	2.5E+00	7E-05	1.5E-01	--	--	--	--
PGDP	6E-05	1.3E-01	6E-05	1.3E-01	--	--	--	--	--	--	--	--
Pantex	9E-06	1.9E-02	9E-08	2E-04	--	--	--	--	--	--	--	--
PORTS	2E-04	4.8E-01	3E-06	6E-03	--	--	--	--	--	--	--	--
RFETS	8E-06	1.6E-02	6E-06	1.1E-02	--	--	--	--	--	--	--	--
SNL-NM	6E-06	1.1E-02	8E-08	2E-04	--	--	--	--	--	--	--	--
SRS	2E-03	3.1E+00	2E-05	4.6E-02	2E-03	3.1E+00	2E-05	4.6E-02	--	--	--	--

Notes: -- = action not applicable for alternative.

[a] Results are provided for contact-handled wastes. Remote-handled LLMW results (all alternatives) are shown in the table below.

Sites	100 Years		300 Years	
	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)
Hanford	3E-06	6E-03	2E-08	5E-05
INEL	6E-03	1.3E+01	1E-04	3E-01
ORR	3E-02	6E+01	1E-03	2E+00
SRS	4E-05	7E-02	5E-07	1E-03

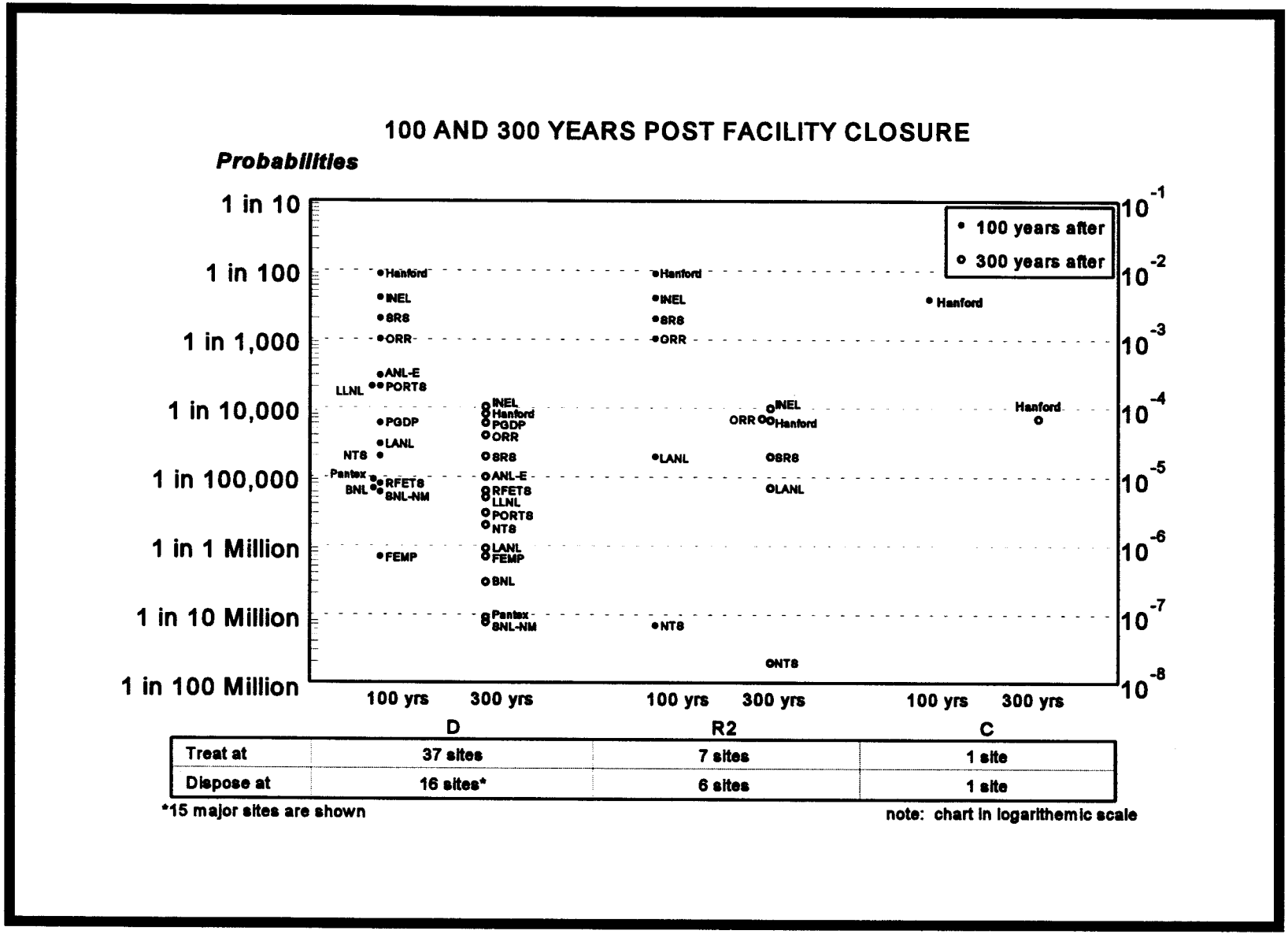


Figure 6.4–4. LLMW Disposal—Hypothetical Intruder Cancer Fatality Probabilities

shipped between sites. For all other alternatives, shipments were assumed to occur uniformly over a 10-year period.

The methods used to estimate transportation risk and the risks to the public along the transportation routes are described in Appendix E. Tables 6.4–17 and 6.4–18 present the total number of estimated fatalities associated with truck and rail transportation of LLMW, respectively. The total number of estimated fatalities resulting from radiation exposure and from nonradiological causes (i.e., vehicle exhaust-induced cancers and physical injury resulting from accidents) is less than one when LLMW is transported by rail (Table 6.4–18). The total number of radiological fatalities for truck transportation is also estimated to be less than one (Table 6.4–17). However, the number of fatalities for truck transportation is estimated to be approximately one for Regionalized Alternative 3 and the Centralized Alternative as a result of physical injuries received during traffic accidents.

The health impacts associated with exposure to the hazardous chemical components of LLMW that are released during transportation accidents are presented in Appendix E.

6.4.3 Facility Accident Impacts

6.4.3.1 Storage Facility Accidents

Accidents and source terms for current storage of LLMW were not analyzed explicitly. Unlike treatment, which will predominantly use new facilities that will have common characteristics, current (pretreatment) storage will use a variety of predominantly preexisting facilities that vary greatly in the amounts and types of waste inventories stored, the configurations in which they are stored, and the containment or confinement characteristics of the storage buildings or enclosures. However, recent DOE safety analysis reports (SARS) and NEPA information provide guidance on the potential risk impacts applicable to LLMW and TRUW storage facility accidents.

Information in these current SARs and DOE site EISs can be used as valid indicators of the predicted consequences for a range of waste storage facility accidents of varying frequency. A brief summary of some of the key accidents and assumptions used by the sites in preparing these analyses, and the related health

Table 6.4–17. LLMW Truck Transportation—Estimated Fatalities From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Number of Shipments	Shipment Miles (in Millions)	Estimated Number of Radiological Fatalities[a]		Estimated Number of Nonradiological Fatalities	
	T	D			Normal Operations Public	Normal Operations Crew	Fuel Emission	Injury From Traffic Accidents
No Action	3	NA	0	0	0	0	0	0
Decentralized	37	16	480	0.3	*	*	*	*
Regionalized 1	11	12	1,820	0.6	*	*	*	*
Regionalized 2	7	6	5,560	3	*	*	*	*
Regionalized 3	7	1	10,990	15	*	*	*	1
Regionalized 4	4	6	4,250	3	*	*	*	*
Centralized	1	1	7,520	14	*	*	*	1

Notes: T = treatment; D= disposal; * = greater than 0 but less than 0.5; NA = not applicable.
[a] Fatalities are from radiation-induced cancer.

Table 6.4–18. LLMW Rail Transportation—Estimated Fatalities From Rail Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Number of Shipments	Shipment Miles (in Millions)	Estimated Number of Radiological Fatalities[a]		Estimated Number of Nonradiological Fatalities	
	T	D			Normal Operations Public	Normal Operations Crew	Fuel Emission	Injury From Traffic Accidents
No Action	3	NA	0	0	0	0	0	0
Decentralized	37	16	350	0.2	*	*	*	*
Regionalized 1	11	12	1,030	0.5	*	*	*	*
Regionalized 2	7	6	2,490	1.4	*	*	*	*
Regionalized 3	7	1	4,540	6.8	*	*	*	*
Regionalized 4	4	6	2,050	1.6	*	*	*	*
Centralized	1	1	3,340	6.5	*	*	*	*

Notes: T = treatment; D= disposal; * = greater than 0 but less than 0.5; NA = not applicable.
[a] Fatalities are from radiation-induced cancer.

effects results, are shown in Appendix F. Examples of results applicable to LLMW storage facilities include accidents ranging from violent single drum breaches to large fires in Centralized facilities. The recent SARs and EISs that are relevant focus on TRUW accidents more than LLMW due to TRUW's higher radioactivity. However, the accident scenarios, estimates of airborne material releases due to the accidents, and atmospheric dispersion and health effects calculations are analogous. As a result, LLMW storage facility accident results can be directly related to TRUW facility analyses.

The most relevant recent analyses dealing with postulated accidents for LLMW and TRUW storage facilities were reviewed. Numerous accident scenarios were analyzed (e.g., fires, earthquakes, explosions, etc.). Predicted radiological doses to the MEI ranged from about 10 millirem per accident to about 3 rem for a severe TRUW facility accident (the effects of the latter accident exceeded those from all LLMW facility accidents). When multiplied by the risk conversion factor of 0.0005 latent cancer fatalities per person-rem of exposure (ICRP, 1990), the resultant estimated incremental cancer fatality risk to the MEI would range from about 5E-06 to 2E-03 if the accident were to occur. However, note that the accident frequencies in the reviewed documents ranged from greater than 1E-02 per year for the lower consequence accidents to less than 1E-06 per year for the high consequence accidents. Although there is considerable variation in the assumptions used by the various DOE sites in these recent studies to develop accident scenarios and predicted impacts, public risk from LLMW storage accidents should be very low.

It should be noted that explicitly analyzing risks from storage would not help to discriminate among alternatives because of the assumption used in the WM PEIS for estimating the treatment throughputs that dictate the inventories to be stored before treatment. This assumption is that all sites will accumulate or at least not reduce these inventories for roughly 10 years, at which time the complexwide treatment will begin. Thus, all sites will achieve their maximum inventories (leading to maximum potential releases during a storage facility accident) independent of alternative.

6.4.3.2 Treatment Facility Accidents

Although there are many processes used for treating LLMW, to date, thermal treatment technologies have been most effective in destroying the combustible hazardous constituents contained in LLMW. Since significant incineration data are available, public interest is heightened, and results achieved through incineration are representative and bounding of other thermal treatment processes, this risk analysis focused on incineration. Like other LLMW treatment processes, incineration operations/accidents can result in

airborne releases of radionuclides. Potential treatment facility accidents identified for all LLMW alternatives include: (1) incineration facility fires or explosions initiated from internal causes; (2) an earthquake or tornado that causes damage and possible fires in the facility; and (3) the crash of a large or small aircraft into the facility, resulting in fire and possible explosion. All of these accidents can involve release of the radioactive contents of the kiln, the stored ash byproduct of the incineration process, or the trapped contents of the filtration systems in the facility. The accident with the highest potential consequence at each site was evaluated.

The radiological risk and chemical health effects calculations were based upon conservative assumptions. Table 6.4–19 summarizes the estimated doses and cancer fatalities resulting from radiation exposures associated with potential treatment facility accidents. This table contains cancer fatality estimates for the maximum reasonably foreseeable accidents with the highest potential consequences at each site and the estimated frequency of those accidents occurring in any one year. The doses indicated are a function of the severity of the accident and the size and distribution of the population affected. The indicated probabilities of an excess cancer are based on the assumption that the accident occurs. Consistent with standard practice in radiological safety analysis, the fatalities are derived only from the cancers associated with radiation. In general, local worker fatalities in severe accidents from trauma would primarily result from the initiation of the accident, e.g., the initial impact and fire of an airplane crash. These trauma fatalities would tend to be independent of the inventory or process characteristics of a particular site for a given consolidation alternative, and therefore would not tend to be a significant discriminator among the alternatives. Trauma fatalities to the offsite populations from severe accidents would be almost totally independent of the site consolidation and process characteristics that are driven by alternative selection and also would not discriminate among alternatives.

Assuming that the accident occurs, none of the alternatives is estimated to result in a cancer fatality at any site to members of offsite populations or workers. Each of the alternatives poses a cancer fatality probability of greater than one in one million for the offsite MEI. Under the No Action Alternative, the cancer fatality probability is estimated to be greater than one in one million for the indicated accident affecting the offsite MEI at ORR. Under Regionalized Alternatives 2, 3 and 4, an offsite MEI cancer fatality probability of greater than one in one million is estimated for accidents at the Hanford Site and ORR. Under the Decentralized Alternative, 4 sites (the Hanford Site, LLNL, ORR and PGDP) are estimated to have offsite MEI cancer fatality risks greater than one in one million. The Regionalized Alternative 1 is expected to have an offsite MEI cancer fatality probability of greater than one in one million for the assumed accident at

Table 6.4–19. LLMW Facility Accidents—Radiation-Induced Cancer Fatalities From Maximum Reasonably Foreseeable Potential Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Radiation Dose (rem)	Offsite MEI Cancer Fatality Probability	Population Radiation Dose (person-rem)	Offsite Population Number of Cancer Fatalities	Worker Radiation Dose (person-rem)	WM Workers Number of Cancer Fatalities
No Action								
INEL	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-04	1E-07	1E+00	*	2E-01	*
ORR	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	5E-06	2E+02	*	1E+01	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	5E-04	3E-07	2E+01	*	4E+00	*
Decentralized Alternative								
ANL-E	Nonalpha, natural phenomena	1E-06 to 1E-04	6E-05	3E-08	2E+00	*	7E-03	*
BNL	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-03	9E-07	2E+01	*	2E-02	*
FEMP	Nonalpha, natural phenomena	1E-06 to 1E-04	8E-06	4E-09	4E-02	*	2E-04	*
Hanford	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	6E-06	6E+02	*	2E+01	*
INEL	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	4E+00	*	8E+00	*
LANL	Alpha, natural phenomena	1E-06 to 1E-04	8E-04	4E-07	2E+00	*	5E-01	*
LLNL	Nonalpha, natural phenomena	1E-06 to 1E-04	4E-03	2E-06	2E+01	*	3E-01	*
NTS	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-04	9E-08	5E-01	*	3E+00	*
ORR	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-02	1E-05	4E+02	*	3E+01	*
Pantex	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-04	6E-08	1E+00	*	1E-02	*
PGDP	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-02	9E-06	6E+01	*	5E+00	*
RFETS	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	1E+01	*	1E+00	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-03	6E-07	4E+01	*	8E+00	*
Regionalized Alternative 1								
INEL	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	4E+00	*	8E+00	*
LANL	Alpha, natural phenomena	1E-06 to 1E-04	8E-04	4E-07	2E+00	*	5E-01	*
LLNL	Nonalpha, natural phenomena	1E-06 to 1E-04	4E-03	2E-06	2E+01	*	3E-01	*
RFETS	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	1E+01	*	1E+00	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	5E-08	4E+00	*	3E-01	*
Regionalized Alternatives 2 & 3								
Hanford	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	6E-06	6E+02	*	3E+01	*
INEL	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	4E+00	*	8E+00	*
LANL	Alpha, natural phenomena	1E-06 to 1E-04	8E-04	4E-07	2E+00	*	5E-01	*
ORR	Nonalpha, natural phenomena	1E-06 to 1E-04	4E-02	2E-05	4E+02	*	5E+01	*
RFETS	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	1E+01	*	1E+00	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-03	6E-07	4E+01	*	8E+00	*
Regionalized Alternative 4								
Hanford	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	6E-06	6E+02	*	3E+01	*
INEL	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	4E+00	*	1E+01	*
ORR	Nonalpha, natural phenomena	1E-06 to 1E-04	4E-02	2E-05	4E+02	*	3E+01	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-03	6E-07	4E+01	*	8E+00	*
Centralized Alternative								
Hanford	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-02	9E-06	8E+02	*	3E+02	*

Notes: * = greater than 0 but less than 0.5. Natural phenomena refer to accidents initiated either by earthquake or by high wind or tornado, depending on the site and the associated recurrence frequencies. Incineration was the thermal treatment analyzed. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

LLNL. The Hanford Site and ORR have the highest offsite MEI cancer fatality risk under each of the alternatives, with the exception of the Regionalized Alternative 1. However, when the frequencies of the accidents are considered, none of the alternatives pose an offsite MEI cancer risk of greater than one in one million.

Table 6.4–20 summarizes the estimated cancer incidences and noncancer risks resulting from chemical exposures associated with potential treatment facility accidents. This table contains cancer incidence and noncancer risk estimates for a maximum reasonably foreseeable accident at each site and the estimated annual accident frequency. As with the previous tables, only the cancer incidence and noncancer risks from chemical exposures are presented; fatalities resulting from physical hazards directly associated with the accident are not included. The overall risk from these potential chemical exposures, when the frequency of the assumed accidents is considered, is very small.

None of the alternatives is estimated to result in cancer incidence equal to or greater than one within the offsite population as a result of chemical exposures. For the offsite MEI, cancer incidence probability is not estimated to exceed one in one million for any site. None of the alternatives is estimated to result in cancer incidence equal to or greater than one within the waste management worker population as a result of chemical exposure. Each of the alternatives has noncancer risks above acceptable levels for the most exposed waste management worker with IDLH (Immediately Dangerous to Life and Health) Index values equal to or greater than one for all sites. Accidents at ORR and Portsmouth also result in noncancer risks to the offsite MEI.

It is also important to note that use of the latest safety analysis documentation (described in the preceding section on storage facility accidents) would reduce all predicted impacts. In addition, the consequences and risks provided here assume no mitigation of the accident and take no credit for emergency response actions. The reduction in impacts due to these mitigation actions would be significant.

6.4.3.3 Disposal Facility Accidents

As discussed in Appendix F, disposal facility accidents were not evaluated because of the lack of details of ultimate disposal. However, except for dedicated centralized disposal facilities (e.g., Yucca Mountain and WIPP for HLW and TRUW, respectively), disposal sites would generally lack a concentrated volume of material at risk being stored in a configuration susceptible to phenomena such as fires and explosions

Table 6.4-20. LLMW Facility Accidents—Chemical-Related Health Risks From Maximum Reasonably Foreseeable Potential Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite Population Number of Cancer Incidences	Offsite MEI Probability of Cancer Incidence	WM Workers Number of Cancer Incidences	Offsite MEI Hazard Index	Maximally Exposed WM Worker IDLH[a] Index
No Action							
INEL	Nonalpha, facility fire	>1E-02	*	1E-10	*	0.002	1
ORR	Nonalpha, facility fire	>1E-02	*	3E-07	*	4	2
SRS	Nonalpha, facility fire	>1E-02	*	3E-09	*	0.04	7
Decentralized Alternative							
ANL-E	Nonalpha, facility fire	>1E-02	*	2E-11	*	0.0003	1
BNL	Nonalpha, facility fire	>1E-02	*	6E-10	*	0.01	1
FEMP	Nonalpha, facility fire	>1E-02	*	1E-08	*	0.2	2
Hanford	Nonalpha, facility fire	>1E-02	*	2E-09	*	0.03	5
INEL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	5
LANL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	3
LLNL	Nonalpha, facility fire	>1E-02	*	2E-08	*	0.4	3
NTS	Nonalpha, facility fire	>1E-02	*	7E-14	*	0.000001	1
ORR	Nonalpha, facility fire	>1E-02	*	6E-07	*	9	36
Pantex	Nonalpha, facility fire	>1E-02	*	5E-10	*	0.007	2
PGDP	Nonalpha, facility fire	>1E-02	*	2E-08	*	0.3	2
PORTS	Nonalpha, facility fire	>1E-02	*	8E-08	*	1	10
RFETS	Alpha, facility fire	>1E-02	*	1E-08	*	0.2	2
SNL-NM	Nonalpha, facility fire	>1E-02	*	1E-09	*	0.02	1
SRS	Nonalpha, facility fire	>1E-02	*	5E-09	*	0.09	14
Regionalized Alternative 1							
FEMP	Nonalpha, facility fire	>1E-02	*	1E-08	*	0.2	2
Hanford	Nonalpha, facility fire	>1E-02	*	2E-09	*	0.03	5
INEL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	5
LANL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	3
LLNL	Nonalpha, facility fire	>1E-02	*	3E-08	*	0.4	3
ORR	Nonalpha, facility fire	>1E-02	*	6E-07	*	9	36
Pantex	Nonalpha, facility fire	>1E-02	*	5E-10	*	0.007	2
PGDP	Nonalpha, facility fire	>1E-02	*	2E-08	*	0.3	2
PORTS	Nonalpha, facility fire	>1E-02	*	8E-08	*	1	10
RFETS	Alpha, facility fire	>1E-02	*	1E-08	*	0.2	2
SRS	Nonalpha, facility fire	>1E-02	*	5E-09	*	0.09	14
Regionalized Alternatives 2 & 3							
Hanford	Nonalpha, facility fire	>1E-02	*	3E-09	*	0.04	8
INEL	Alpha, facility fire	>1E-02	*	1E-08	*	0.2	6
LANL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	3
ORR	Nonalpha, facility fire	>1E-02	*	6E-07	*	9	36
PORTS	Nonalpha, facility fire	>1E-02	*	9E-08	*	2	11
RFETS	Alpha, facility fire	>1E-02	*	1E-08	*	0.2	2
SRS	Nonalpha, facility fire	>1E-02	*	5E-09	*	0.09	14
Regionalized Alternative 4							
Hanford	Nonalpha, facility fire	>1E-02	*	3E-09	*	0.04	8
INEL	Alpha, facility fire	>1E-02	*	2E-08	*	0.3	9
ORR	Nonalpha, facility fire	>1E-02	*	7E-07	*	0.1	46
SRS	Nonalpha, facility fire	>1E-02	*	5E-09	*	0.09	14
Centralized Alternative							
Hanford	Nonalpha, facility fire	>1E-02	*	3E-08	*	0.4	68

Notes: * = greater than 0 but less than 0.5. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] Immediately dangerous to life and health.

capable of causing significant releases. These repositories have accident analyses performed as part of their site-specific EISs. Although seismic events could breach in-ground containers, leading to airborne releases, such events would be bounded by accidents breaching the concentrated volumes of waste being held in a treatment or storage facility. The available safety literature does not indicate any credible accident sequence in which the risk from airborne releases in a low-level mixed waste disposal facility would be sufficiently significant to rule out a site from consideration and thereby serve as a discriminator among disposal alternatives.

6.5 Air Quality Impacts

The management of LLMW would not appreciably affect the air quality at most sites. However, centralization of treatment at the Hanford site could cause adverse air quality impacts requiring special emission control measures for criteria air pollutants. Emissions at RFETS could result in adverse air quality impacts if the waste at this site is treated or disposed of onsite. Emissions of hazardous air pollutants, including radionuclides, were estimated to be below the applicable standards at any site.

As illustrated in Table 6.5-1, DOE evaluated air quality impacts at each proposed LLMW treatment and disposal site based on estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (which include radionuclides), and toxic air pollutants. Pollutant emission estimates were made for the construction, and operations and maintenance (O&M) activities of LLMW facilities.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new sources of emissions from both "stationary" (e.g., treatment and storage facilities) and mobile (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria air pollutant for nonattainment areas. An entity which seeks to engage in an activity that will result in emissions equal to or greater than those limits in a nonattainment area must first obtain a permit.

In "attainment areas" (where air pollution standards are met), only new sources of emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit

Table 6.5-1. Air Quality Impacts Evaluated for LLMW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Table 6.5-2
	Operations	Estimated for thermal treatment units, for fuel use by all other LLMW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 6.5-3
Radionuclide emissions	Operations	For all LLMW treatment and disposal facilities	Percent of standard	Text discussion only
Hazardous and toxic air pollutant emissions	Operations	For all LLMW treatment and disposal facilities	Percent of standard	Text discussion only

is required for a new stationary source that equals or exceeds the allowable increase. However, a permit is not required for criteria pollutant emissions from mobile sources.

Subsequent to December 6, 1995, hazardous waste and LLMW facilities are subject to the requirements of the Resource Conservation Recovery Act regulations found at 40 CFR Part 264, subpart AA regarding air emission standards from process vents and subpart BB regarding air emission standards for process leaks. Compliance with the requirements of 40 CFR Part 264, subpart CC, regarding air emissions of volatile organic compounds from tanks, surface impoundments, and containers began June 6, 1996 (60 FR 56952).

6.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site. Both are considered to be "mobile sources."

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities

Major Types of Air Pollutants

Criteria Air Pollutants: *carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*

Hazardous Air Pollutants: *189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

Toxic Air Pollutants: *Other toxic compounds regulated by EPA and state or local governments*

under all the LLMW alternatives would result in emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. Table 6.5–2 lists those sites. DOE chose the 10% threshold to highlight those sites where criteria air pollutant emissions could result in adverse air quality impacts.

As indicated in Table 6.5–2, five of the 16 major proposed LLMW sites are located in nonattainment areas and, as a result of LLMW construction activities, would have emissions that equal or exceed 10% of the allowable limit for a particular criteria air pollutant. All five sites would exceed the 10% threshold in the Decentralized Alternative. Under the Regionalized 2, Regionalized 3, Regionalized 4, and Centralized Alternatives, ANL-E, NTS, and RFETS would exceed the 10% threshold.

DOE estimates that emissions from construction activities at RFETS could exceed the allowable level; thus, RFETS needs to obtain a Clean Air Act permit. In addition, construction activities at NTS would result in emissions at approximately 94% of the allowable limit for carbon monoxide. This percentage may overestimate potential impacts because it assumes that NTS is in a nonattainment region since it is adjacent to the Clark County nonattainment region for CO and PM_{10}. The NTS EIS (DOE, 1996b) does not show any exceedances for criteria pollutants.

6.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operations and maintenance of LLMW facilities (stationary sources) and by vehicles that are driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

Eight of the 16 major proposed LLMW sites would equal or exceed 10% of applicable air pollutant emission standards (Table 6.5–3). Of these, two sites are located in nonattainment areas; six sites are in attainment areas. As many as seven sites would have pollutant standards that equal or exceed 10% of the levels under an alternative. Only the Hanford Site is estimated to exceed the standard: particulates would be approximately 50% above the standard in the Centralized Alternative, primarily from thermal destruction

Table 6.5–2. Percent of Sites' Allowable Air Emissions Discharged During Construction—LLMW Sites Equaling or Exceeding 10% of Standard in Nonattainment Regions[a]

Alternative	Number of Sites		Criteria Pollutants—Construction[b]					
			ANL-E	BNL	FEMP		NTS	
	T	D	NO_2	NO_2	VOC	NO_2	CO	PM_{10}
No Action[c]	3	NA	10 (9/1)			22 (20/2)	25(18/7)	
Decentralized	37	16	44 (39/5)	14 (5/9)	11 (3/8)	22 (16/6)	94 (64/30)	13(13/0)
Regionalized 1	11	12	27 (20/7)		16 (4/12)	30 (20/10)	26 (12/14)	
Regionalized 2	7	6	27 (20/7)				25 (12/13)	
Regionalized 3	7	1	27 (20/7)				73 (41/32)	
Regionalized 4	4	6	27 (20/7)				25(12/13)	
Centralized	1	1	27 (20/7)				25 (12/13)	

Alternative	Number of Sites		Criteria Pollutants—Construction[b]		
			RFETS		
	T	D	CO	NO_2	VOC
No Action	3	NA	95 (31/64)	94 (81/13)	31 (16/15)
Decentralized	37	16	169 (33/136)	114 (87/27)	50 (17/33)
Regionalized 1	11	12	169 (33/136)	114 (87/27)	50 (17/33)
Regionalized 2	7	6	107 (5/102)	32 (12/20)	27 (2/25)
Regionalized 3	7	1	107 (5/102)	32 (12/20)	27 (2/25)
Regionalized 4	4	6	48 (3/45)	16 (7/9)	12 (1/11)
Centralized	1	1	48 (3/45)	16 (7/9)	12 (1/11)

Notes: T = treatment; D = disposal; NA = not applicable; blanks indicate that a site does not exceed 10% of the standard under the specified alternative.
[a] Pollutants: CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter less than or equal to 10 micrometers in diameter; NO_2 = nitrogen dioxide; VOC = volatile organic compounds.
[b] Sites which exceed 10% of the limit specified by the General Conformity Rule; total % of limit (% equipment/% worker vehicles).
[c] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

Table 6.5-3. Percent of Sites' Allowable Air Emissions Discharged During Operations—LLMW Sites Equaling or Exceeding 10% of Standard[a]

Alternative	Number of Sites		Criteria Pollutants—Operation and Maintenance PSD or General Conformity						
			FEMP	Hanford		INEL		NTS	
	T	D	PM_{10}[c]	NO_2[c]	PM_{10}[c]	NO_2[c]	PM_{10}[c]	CO[d]	PM_{10}[d]
No Action[e]	3	NA				10			
Decentralized	37	16		12	22	15	13	21 (1/20)	10 (10/0)
Regionalized 1	11	12	12	13	23	15	13		
Regionalized 2	7	6		14	25		14		
Regionalized 3	7	1		14	25		14	39 (0/39)	
Regionalized 4	4	6		14	25	25	45		
Centralized	1	1		82	147				

Alternative	Number of Sites		Criteria Pollutants—Operation and Maintenance PSD or General Conformity								
			ORR		PORTS		RFETS			SRS	
	T	D	NO_2[c]	PM_{10}[c]	NO_2[c]	PM_{10}[c]	CO[d]	NO_2[b]	VOC[b]	NO_2[c]	PM_{10}[c]
No Action	3	NA	19	26			23 (1/22)			13	10
Decentralized	37	16	33	50		13	81 (1/80)	25 (9/16)	20 (1/19)		10
Regionalized 1	11	12	33	50	11	15	81 (1/80)	25 (9/16)	20 (1/19)		10
Regionalized 2	7	6	33	50	13	25	53 (1/52)	17 (6/11)	13 (0/13)		10
Regionalized 3	7	1	26	46	13	25	53 (1/52)	17 (6/11)	13 (0/13)		
Regionalized 4	4	6	51	77			24 (0/24)				10
Centralized	1	1					24 (0/24)				

Notes: T = treatment; D = disposal; NA = not applicable; blanks indicate that a site does not exceed 10% of the standard under the specified alternative.

[a] Pollutants: CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter equal to or less than 10 micrometers in diameter; NO_2 = nitrogen dioxide; VOC = volatile organic compounds.

[b] Nonattainment area for the pollutant ozone. NO_2 and VOC are ozone precursor pollutants; total % (% stationary-source/% mobile-source).

[c] Attainment area for this pollutant. PSD regulations applied; total % represents stationary source emissions only.

[d] Nonattainment area for this pollutant. General Conformity regulations applied; total % (% stationary-source/% mobile-source).

[e] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

emissions. Therefore, additional control measures may be needed at this site to reduce emissions of particulates to acceptable levels.

The most stringent PSD requirements are for Class I areas (40 CFR 52.21). Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 kilometers (62 miles) of a PSD Class I area. Nine sites proposed for LLMW activities under the alternatives are located within 100 kilometers of a PSD area: BNL, FEMP, INEL, LANL, LLNL, NTS, ORR, RFETS, and SNL-NM. None of these would have sufficient quantities of emissions to affect a PSD Class I area.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

6.5.3 HAZARDOUS AND TOXIC AIR POLLUTANT EMISSIONS

Thermal treatment of LLMW will result in emission of small quantities of hazardous and toxic air pollutants. Hazardous air pollutants, other than radionuclides, and toxic air pollutants were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits (AALs). Radionuclides from air emissions were evaluated by comparing the annual radiation dose to the MEI to the National Emissions Standard for Hazardous Air Pollutants (NESHAP)—10 millirem per year (40 CFR 61).

Doses from airborne radionuclides were estimated not to equal or exceed 10% of the dose standard at any site. In addition, nonradiological hazardous or toxic air pollutant concentrations at the treatment sites were estimated to be below 10% of the applicable guidelines or standards.

6.6 Water Resources Impacts

Impacts to water availability tend to decrease as the LLMW management facilities are Centralized. Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL–Site 300. Modeling indicates that groundwater concentration reduction measures may be needed for radionuclides when disposal occurs at FEMP, the Hanford Site, ORR, SNL-NM, and SRS. Concentration reduction measures for radionuclides would not be needed when disposal occurs at NTS, even under the Regionalized 3 (one disposal site) Alternative.

As illustrated in Table 6.6–1, DOE analyzed the impacts on water resources of treatment and disposal activities. DOE evaluated the effects on water availability from building and operating treatment, storage and disposal facilities. DOE examined the effects of migration of radionuclides and chemicals from disposal facilities on groundwater quality.

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation

Table 6.6–1. Water Resources Impacts Evaluated for LLMW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Table 6.6–2
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by treatment and disposal processes	Percent increase in current water use	Table 6.6–2
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only
Groundwater quality	Post-closure	Disposal of LLMW	Percent of drinking water quality standard	Table 6.6–3

- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

6.6.1 WATER AVAILABILITY

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of LLMW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 6.6-2 identifies sites where projected water usage under any alternative would increase by more than 1%. This 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Table 6.6-2. Maximum Percent of Current Water Use for Construction or Operations—LLMW Sites Predicted to Exceed 1%

Alternative	Number of Sites		FEMP	INEL	LANL	LLNL	NTS	RFETS	SRS	WVDP
	T	D								
No Action[a]	3	NA	4.4	1.3	1.7	81	1.3	28	4.7	
Decentralized	37	16	4.4	1.9		20	3.9	33	2.2	2.8
Regionalized 1	11	12	5.9	1.9		22		33	2.2	
Regionalized 2	7	6				1.5		7.6	2.2	
Regionalized 3	7	1				1.5	2.4	7.6		
Regionalized 4	4	6				1.5		2.7	2.2	
Centralized	1	1				1.5		2.7		

Notes: T = treatment; D = disposal; NA = not applicable; blank cells are less than or equal to 1%. Water sources assumed as follows: Groundwater for FEMP, INEL, LANL, LLNL, NTS, and SRS; municipal water for RFETS; surface water for WVDP.
[a] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

Eight of the 16 major sites are predicted to exceed the 1% threshold. Most exceedances shown are due largely to water used during the 2–3 year period for construction of treatment facilities; however, under the No Action Alternative, large quantities of water for concrete would be needed to build storage facilities. Although projected water requirements exceed current water use by 1% or more at FEMP, INEL, LANL, NTS, SRS, and WVDP, these six sites are not likely to experience adverse impacts because of sufficient capacities and the relatively small amount of additional water needed (DOE, 1995a). Adverse impacts could be experienced at two sites, LLNL and RFETS, which are discussed further below.

Water use at LLNL would exceed 1% of current use for all alternatives and approach 81% under the No Action Alternative. This is based on the conservative assumption that water at Site 300, the assumed location for proposed WM facilities at LLNL, would be supplied by groundwater. However, most of the water would probably be supplied by a new municipal hookup for Site 300, or the Livermore Valley municipal system that serves LLNL. If the water were supplied by the new 500,000-gallons-per-day municipal hookup at Site 300, the maximum water use would be 14% of the capacity of the system. If the water were supplied by the municipal system in Livermore Valley, it would be less than 10% of the current water use rate of 717,000 gallons per day. If water for LLNL is supplied by an offsite municipal system, onsite water resources would not be affected. Therefore, adverse impacts to onsite water resources, though possible, are unlikely. Impacts on the source of the municipal supply are not within the scope of this PEIS.

Water use at RFETS would exceed 1% of current use for all alternatives. RFETS does not withdraw water from any onsite surface water or groundwater body. Instead, water is supplied by Denver Water from the South Boulder Creek and Ralston Reservoir via the South Boulder Diversion Canal. Under the Decentralized and Regionalized 1 Alternatives, construction of treatment and disposal facilities would require an additional 9.4% of the 1,000,000 gallon-per-day capacity of the water supply distribution system. The increases in water use result from adding new alpha LLMW treatment and disposal facilities. However, because water for RFETS is supplied by an offsite municipal system, onsite water resources would not be affected. Impacts on the source of the municipal supply are not within the scope of this PEIS, but would be expected to be very small, since the maximum usage for WM activities would be less than 0.05% of the 178.8 mgd of water supplied by Denver Water (Denver Water, 1996) to its customers in 1995.

As shown in the Volume II tables, for DOE sites that withdraw water directly from a surface water source (Hanford, ORR, PGDP, and WVDP), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during

operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, BNL, FEMP, ORR, Paducah, Portsmouth, RFETS, SRS, and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

6.6.2 WATER QUALITY

DOE evaluated the impacts to groundwater quality caused by the migration of radionuclides and chemicals that leach from disposal facilities over time. DOE calculated concentrations of radionuclides and hazardous components at a hypothetical well located 300 meters from the center of the disposal facility, and compared these to EPA's drinking water standards (which have been adopted in DOE's internal orders). For radionuclides, the allowable drinking water concentrations equate to a 4 millirem-per-year effective dose equivalent.

The drinking water standards are used as comparison criteria for groundwater quality. Although they are not enforceable standards, they are often used as goals for contaminated site cleanup actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC 9601 *et seq.*). Because EPA established the drinking water standards to protect human health, groundwater concentrations of radionuclides and chemicals at or below these levels present a low risk.

Concentrations in the groundwater that equal or exceed 25% of the drinking water standard are presented, although the discussion of impacts concentrates on contaminants that are near or exceed drinking water standards. (See Appendix C for discussion on the methodology used in this analysis.)

6.6.2.1 Radionuclides

Table 6.6–3 and Table 6.6–4 identify sites where CH- and RH-LLMW would be disposed and where, under any alternative, the calculated value for any pollutant would exceed 25% of the drinking water standards for radionuclides.

Table 6.6–3. Percent of Drinking Water Standards for Radionuclides in Groundwater From Disposal of CH LLMW—Sites Exceeding 25% of Standard [a]

Alternative	Number of Sites		FEMP	Hanford			ORR			SNL-NM	SRS
	T	D	U-238	Tc-99	U-234	U-238	Pu-239	Pu-240	Tc-99	Pu-240	U-238
No Action	3	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	100*			100*	50	30	40	100*	100*
Regionalized 1	11	12	100*			100*	40		30	--	100*
Regionalized 2	7	6	--			100*	40	30	100*	--	100*
Regionalized 3	7	1	--	--	--	--	--	--	--	--	--
Regionalized 4	4	6	--			100*	50	30	100*	--	100*
Centralized	1	1	--	40	40	100*	--	--	--	--	--

Notes: T = treatment; D= disposal; -- = no disposal at this site under this alternative; * = WM PEIS modeling indicates that a reduction in the estimated concentration in the groundwater would be necessary to meet drinking water standards. See Volume II tables for the value of the exceedance. Blanks indicate that a site does not exceed 25% of the standard under the specified alternative.
[a] Only radionuclides equal to or above 25% of drinking water standards are listed. Blanks indicate concentrations less than 25% of standards. See Appendix C for a list of the drinking water standards.

Table 6.6–4. Percent of Drinking Water Standards for Radionuclides in Groundwater From Disposal of RH LLMW—Sites Exceeding 25% of Standard [a]

Alternative	Number of Sites		ORR				
	T	D [b]	Np-237	Pu-239	Pu-240	Tc-99	U-238
No Action	3	--	--	--	--	--	--
Decentralized	37	16	30	100*	100*	100*	100
Regionalized 1	11	12	30	100*	100*	100*	100
Regionalized 2	7	6	30	100*	100*	100*	100
Regionalized 3	7	1	30	100*	100*	100*	100
Regionalized 4	4	6	30	100*	100*	100*	100
Centralized	1	1	30	100*	100*	100*	100

Notes: T = treatment; D = disposal; -- = no disposal at this site under this alternative; * = WM PEIS modeling indicates that a reduction in the estimated concentration in the groundwater would be necessary to meet drinking water standards. See Volume II tables for the value of the exceedance.
[a] Only radionuclides equal to or above 25% of drinking water standards are listed. See Appendix C for a list of the drinking water standards.
[b] Number of disposal sites includes those disposing of CH-LLMW; disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR, and SRS) for all alternatives (except No Action, for which there is no disposal).

Disposal of CH-LLMW at FEMP, Hanford, ORR, SNL-NM, and SRS is predicted to cause 25% of drinking water standards for radionuclides to be exceeded in the groundwater. Of these sites, only FEMP is located above an EPA-designated sole-source aquifer. Twenty-five percent of standards would not be exceeded when CH-LLMW is disposed at ANL-E, BNL, INEL, LANL, LLNL, NTS, the Pantex Plant, Paducah, Portsmouth, or RFETS. A maximum of five sites would exceed 25% of drinking water standards under the Decentralized Alternative. Only under the Regionalized 3 Alternative (disposal of all CH-LLMW at NTS) are 25% of drinking water standards not exceeded.

Radionuclides that would exceed 25% of the drinking water standards are plutonium-239, plutonium-240, technetium-99, uranium-234, and uranium-238. These are all long half-life radionuclides, with the minimum half-life being 6,537 years for plutonium-240. Shorter half-life radionuclides (e.g., cesium-137, strontium-90) tend to decay to acceptable levels before reaching the 300-meter well.

For radionuclides with long half-lives, disposal inventory, infiltration rate, depth to groundwater, and the character of the media through which the water flows, are some of the primary factors that determine the concentration in the groundwater. The infiltration rate is related to rainfall, such that sites in arid regions generally perform better than sites in humid regions because of their smaller infiltration rate. Sites with a large depth to groundwater are generally better due to longer travel times. Sites located over areas with large percentages of materials that retard the movement of radionuclides (e.g., clays and organic materials) generally perform better than sites located over areas devoid of these materials.

For CH-LLMW, uranium-238 is the most problematic radionuclide, exceeding 100% of the standard at three sites (FEMP, the Hanford site, and SRS). In all of these cases, concentrations in the groundwater would have to be reduced to meet drinking water standards. Technetium-99 (ORR) and plutonium-240 (SNL-NM) would also have to be reduced to meet drinking water standards.

More recent estimates for the release of radionuclides to the groundwater based on updated waste loads project increases in the expected groundwater exceedances for particular radionuclides at these sites: FEMP (U-238), Hanford (U-238), SRS (U-238), and SNL-NM (Pu-240). See Appendix I of the Final WM PEIS.

Disposal of RH-LLMW at ORR is predicted to cause 25% of the drinking water standards to be exceeded for neptunium-237, plutonium-239, plutonium-240, technetium-99 and uranium-238. Drinking water standards would be exceeded for all alternatives except No Action, when all LLMW would be stored.

Concentrations of plutonium-239, plutonium-240, and technetium-99 would have to be reduced to meet drinking water standards. Disposal of RH-LLMW at Hanford, INEL, or SRS would not exceed 25% of standards.

Measures that could be used to reduce the estimated concentration of radionuclides in the groundwater include:

- Modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration)
- Modifying the form of the waste to be disposed to reduce the release rate (e.g., changing to a vitrified waste form)
- Changing the specific location of the disposal facility so it is sited over an area with more favorable hydrologic conditions
- Imposing waste acceptance criteria (i.e., restricting the amount of the radionuclide allowed in the disposal facility)

The performance of disposal facilities at a specific site would be evaluated in greater detail in DOE's Performance Assessment process under DOE Order 5820.2A (DOE, 1988). This process would help to ensure that all regulatory requirements are met and significant contamination of groundwater would not occur.

6.6.2.2 Hazardous Constituents

The concentrations of hazardous constituents in the groundwater from disposal of LLMW are largely due to assumptions on the routing of wastes through the treatment system. As shown in the LLMW flow diagram (Figure 6.2-1), some wastes containing solvents were assumed to bypass the thermal treatment processes. The solvents in these wastes were not destroyed, but instead, ended up in the disposal facility. Some of these wastes contain solvents in large enough concentrations to cause standards to be exceeded when the wastes are disposed. In practice, LLMW to be disposed would meet EPA standards for treatment and disposal, and therefore should not produce major impacts to groundwater quality. Therefore, although the absolute values of the results for hazardous constituent contamination in groundwater are higher than would result from wastes treated to EPA standards, the results are still useful in showing the relative suitability of the sites. Even with the conservative assumptions used in the WM PEIS, drinking water

standards were not exceeded at some sites. This may indicate that these sites are better for LLMW disposal than other sites.

As shown in Table 6.6–5, the WM PEIS analysis indicates that disposal of CH-LLMW at ANL-E, the Hanford Site, LANL, NTS, ORR, Portsmouth, RFETS, and SRS would cause 25% of drinking water standards for hazardous constituents to be exceeded in the groundwater.

A maximum of 8 sites would exceed 25% of drinking water standards under the Decentralized Alternative. Disposal of CH-LLMW at BNL, FEMP, INEL, LLNL, Paducah, Pantex, and SNL-NM would not exceed 25% of drinking water standards for hazardous constituents. Therefore, disposal at these latter sites is likely to pose less risk of groundwater contamination.

Hazardous constituents that exceed 25% of drinking water standards in the WM PEIS analysis include benzene, carbon tetrachloride, chromium, 1,2-dichloroethane, methylene chloride, selenium, and silver. Only chromium, selenium, and silver would not require reduction of concentrations to meet standards. Of these constituents, the solvents appear to be the most problematic, with methylene chloride requiring reductions at seven sites and with 1,2-dichloroethane requiring reductions at six sites.

Measures that could be used to reduce the concentration of hazardous constituents in the groundwater include those described for radionuclides. In addition, more rigorous treatment could be used to provide a greater removal/destruction efficiency than that assumed in the WM PEIS analysis.

Disposal of RH-LLMW at the Hanford Site, INEL, ORR, and SRS would not exceed 25% of drinking water standards. Reductions of groundwater concentrations of hazardous constituents would not be required for disposal of RH-LLMW.

As illustrated by Table 6.7–1, DOE analyzed the effects of construction site clearing to build LLMW treatment and disposal facilities, and the operation of treatment facilities on ecological resources at representative sites. DOE also considered the effects of accidental spills of LLMW in transportation, extrapolating the results from an assessment conducted for LLW.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for

Table 6.6–5. Percent of Drinking Water Standards for Hazardous Constituents in Groundwater From Disposal of CH LLMW— Sites Exceeding 25% of Standard [a]

Alternative	Number of Sites		ANL-E	Hanford					LANL		NTS[b]		
	T	D	B	B	CT	DCA	MC	Ag	DCA	MC	B	DCA	MC
No Action	3	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	30	100*	60	80	90		50	100*	50		40
Regionalized 1	11	12	--	100*	60	70	90		50	100*			40
Regionalized 2	7	6	--	100*	60	80	90	30	30	70			
Regionalized 3	7	1	--	--	--	--	--	--	--	--	100*	100*	100*
Regionalized 4	4	6	--	100*	70	80	100	30	--	--			
Centralized	1	1	--	100*	100*	100*	100*	40	--	--	--	--	--

Alternative	Number of Sites		ORR			PORTS		
	T	D	B	DCA	MC	B	DCA	MC
No Action	3	--	--	--	--	--	--	--
Decentralized	37	16	50	100*	100*		80	100*
Regionalized 1	11	12	50	100*	100*	30	100*	100*
Regionalized 2	7	6	70	100*	100*	--	--	--
Regionalized 3	7	1	--	--	--	--	--	--
Regionalized 4	4	6	70	100*	100*	--	--	--
Centralized	1	1	--	--	--	--	--	--

Alternative	Number of Sites		RFETS			SRS					
	T	D	CT	DCA	MC	B	Cr	CT	DCA	MC	Se
No Action	3	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	100*	100*	100*	100*	40	100*	100*	100*	30
Regionalized 1	11	12	100*	100*	100*	100*	40	100*	100*	100*	30
Regionalized 2	7	6	--	--	--	100*	40	100*	100*	100*	30
Regionalized 3	7	1	--	--	--	--	--	--	--	--	--
Regionalized 4	4	6	--	--	--	100*	40	100*	100*	100*	30
Centralized	1	1	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; -- = no disposal at this site under this alternative; * = WM PEIS modeling indicates that a reduction in the estimated concentration in the groundwater would be necessary to meet drinking water standards. See Volume II tables for the value of the exceedance. Blanks indicate that a site does not exceed 25% of the standard under the specified alternative.

[a] Only hazardous constituents equal to or above 25% of drinking water standards are listed. See Appendix C for a list of the drinking water standards. Blanks indicate concentrations less than 25% of the standards. Ag = silver; B = benzene; Cr = chromium; CT = carbon tetrachloride; DCA = 1,2-dichloroethane; MC = methylene chloride; Se = selenium.

[b] Note that the NTS EIS (DOE, 1996b) shows no exceedances of groundwater quality comparison criteria from disposal. The values presented here for NTS overestimate potential risks at that site since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over two million years (Sully et al., 1995).

6.7 Ecological Resources Impacts

Loss of limited acreages of habitat at some sites during construction of LLMW facilities would not significantly affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. DOE should be able to locate new LLMW facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction site acreages are small compared to the total acreage at each site suitable for waste operations. A screening level risk assessment of facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. Transportation accidents leading to spills of LLMW into aquatic environments would have serious short and long term consequences; however, the probability of such accidents is low but would increase with increased waste shipping.

Table 6.7-1. Ecological Resources Impacts Analyzed for LLMW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at LLMW construction sites to general habitat range	Text discussion only
Terrestrial species exposures	Terrestrial animal species	Comparison of estimated radiation dose of representative species with toxicity standard	Text discussion only
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats based on comparing construction acreage to available acreage of nonsensitive habitats	Text discussion only
Sensitive species concerns	Federally and State-listed endangered and threatened species	Numbers of Federally and State-listed species displayed by site/alternative	Table 6.7-2
Effects of transportation accidents	Aquatic species in streams crossing transportation corridors	Results of scenario-based modeling analysis of accidental spill; effects on fish in various size streams	Text discussion only

facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

6.7.1 General Impacts of Site Clearing

None of the alternatives would require extensive site clearing for construction of LLMW facilities. No more than 55 acres would be disturbed at any site, for any alternative. These acreage requirements are small

compared to the available habitat for nonsensitive species represented at the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small mammals and songbirds with limited home ranges), no significant effects to populations of these species are expected from implementation of any proposed LLMW alternatives because nonsensitive species habitats are well established regionally.

6.7.2 Site Clearing Effects on Sensitive Habitats

For those sites that contain sensitive habitats, the degree to which these habitats may be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby LLMW construction activities depends on DOE's ability to avoid siting near those habitats. A measure of this ability is the percentage of available land required at a site for facility construction under any LLMW alternative. Available acreage was estimated from site development plans either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percentage of available acreage required for the LLMW facilities ranged from 0.0009% at NTS under the Regionalized 1, 2, and 4 and the Centralized Alternatives to 4.4% at FEMP under the Regionalized 1 Alternative. Considering these small fractions of land required for LLMW facilities, DOE would have a great degree of flexibility in its siting and can employ a range of mitigative measures, so that site clearing to implement any of the LLMW alternatives would not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices would minimize these effects. Direct discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

6.7.3 Effects of LLMW Treatment Facility Emissions

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of radionuclides and hazardous chemicals from treatment facilities. This analysis used

the same atmospheric emissions estimates as the human health risk assessment and provided estimates of radionuclides and hazardous chemicals deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Six radionuclides were evaluated: tritium, Ni-63, Cs-137, Pu-241, Th-234, and U-238. Potential toxicity to terrestrial wildlife was analyzed for selected sites for these radionuclides, which comprise 80% of the total activity expected to be emitted. The remaining activity was contributed by smaller emissions of a large number of radionuclides. The conservative assumptions used to characterize the scenario (e.g., accumulation of contaminants for 10-year period with no loss due to decay or transport) might compensate for limiting the analyses to 80% of the released activity.

The concentrations of these radionuclides were used in calculating Hazard Indexes for each selected site/alternative combination as composite ratios between the estimated species exposures to each of the contaminants and known, contaminant-specific toxic levels. A Hazard Index greater than one would indicate a potential for the combined exposures to adversely affect the health of terrestrial species. Nine hazardous chemicals were evaluated—arsenic, barium, cadmium, chromium VI, cyanide, lead, mercury, selenium, and silver. The resulting maximum estimated Hazard Index values for the radionuclides and for the chemicals were less than 0.01. Therefore, no impacts to terrestrial animal populations are expected from LLMW facility airborne emissions.

6.7.4 CONSIDERATION OF SENSITIVE SPECIES

For comparison of the LLMW management program's potential to affect sensitive species, Table 6.7–2 lists the numbers of Federally and State-listed endangered and threatened species occurring or potentially occurring at each LLMW site under each alternative. Site-specific analysis would be required for an assessment of sensitive species impacts. That analysis would take into account specific locations for the LLMW facilities in relation to the location of sensitive habitats and sensitive species at each site, including species listed by the U.S. Fish and Wildlife Service as endangered or threatened.

Table 6.7-2. Numbers of Federally Listed and State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the LLMW Sites by Alternative (Federal/State)

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	3	NA	2/5	2/6	2/10	3/11	2/2	2/4	6/5	2/2	1/11	9/12	5/8	1/9	2/2	1/8	8/8	1/8
Decentralized	37	16	2/5	2/6	2/10	3/11	2/2	2/4	6/5	2/2	1/11	9/12	5/8	1/9	2/2	1/8	8/8	1/8
Regionalized 1	11	12	--	--	2/10	3/11	2/2	2/4	6/5	2/2	1/11	9/12	5/8	1/9	2/2	--	8/8	--
Regionalized 2	7	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	1/9	2/2	--	8/8	--
Regionalized 3	7	1	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	1/9	2/2	--	8/8	--
Regionalized 4	4	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	--	--	--	8/8	--
Centralized	1	1	--	--	--	3/11	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; NA = not applicable; -- = no major actions are proposed for the site under the alternative.

6.7.5 EFFECTS OF LLMW TRANSPORTATION ACCIDENTS

DOE believes that the radiologic effects on aquatic resources from transportation accidents involving LLMW would be similar to those estimated for LLW (See Chapter 7, Section 7.7.5). However, because LLMW also contains hazardous chemical components, transportation accidents could result in greater adverse effects to aquatic resources depending upon the specific chemical constituents contained in the waste. The number of expected accidents is related to the total number of miles traveled during LLMW shipment. Thus, as fewer shipments of LLMW occur, as in the Decentralized Alternative, the number of accidents is expected to decrease. The greatest potential for such accidents is under the Centralized Alternative. The toxic effects on aquatic resources from hazardous constituents in LLMW may be severe immediately following a spill, depending upon the chemicals involved, but are unlikely to have long-term effects due to emergency spill response efforts.

6.8 Economic Impacts

Nationwide, the largest economic effects resulting from LLMW management would be for the Decentralized Alternative and generally decrease as the alternatives become more Centralized. The greatest benefit at any site occurs when LLMW is treated, stored and disposed of at that site. The greatest percentage increases in the number of jobs would occur at the Hanford Site and INEL. The national economy would not be affected by total project expenditures for the construction, operation, or transportation to LLMW facilities under any alternative (DOE, 1995a).

DOE estimated the effects of expenditures for LLMW management on the local and national economies (Table 6.8–1). Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of treatment and disposal facilities. The socioeconomic region of influence (ROI), where local effects were evaluated, consists essentially of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data for the ROI counties. Local jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at a national level only.

Table 6.8-1. Economic Impacts Analyzed for LLMW Alternatives

Economic Impact Analyzed	Affected Aspect of the Economy	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures for LLMW management multiplied by regional employment multiplier at each LLMW site	Text discussion only
Increased regional incomes	Regional personal income	Proposed site expenditures for LLMW management multiplied by regional income multiplier at each site	Text discussion only
National economic effects	National employment and personal income	Proposed site expenditures at all LLMW sites and total transportation expenditures multiplied by national employment and income multipliers	Text discussion only

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined to estimate total project effects at each site. For all alternatives, except No Action, construction was assumed to take 4 years of the 10-year construction period; the operations phase was assumed to take 15 years (a 10-year operations and maintenance period and a 5-year decontamination period undertaken after the conclusion of operations). Under the No Action Alternative, in place of distinct construction and operational phases, all costs were assumed to occur in a 20-year work off of all existing waste (plus 5 years for decontamination and decommissioning). Five years were added to the decontamination and decommissioning phase to account for the continued effects on employment and income after each project phase ended. Job and personal income increases are shown for each site in the Volume II site tables.

Across the LLMW alternatives, only the Hanford site, INEL, and Portsmouth regions would experience greater than a 1% change in the number of new direct, indirect, and induced jobs as a result of expenditures to implement the alternatives. The Hanford region would experience an increase in the number of direct, indirect, and induced jobs of 1.7% under the Centralized Alternative. Regionalized Alternative 4 would result in the greatest increase in the number of regional jobs at INEL which is 2%. In the Decentralized and Regionalized 1, 2 and 3 Alternatives, the INEL region would experience a change ranging from 1.4% to 1.6% in the number of jobs in its ROI. The Portsmouth region would experience an increase in the number of new jobs of about 1% in the Decentralized Alternative and Regionalized Alternatives 1, 2 and 3. No ROIs would experience a 1% or greater increase in personal income under any of the alternatives.

The sum of the new direct, indirect, and induced jobs from the combined weighted construction and O&M activities across site ROIs for all the alternatives ranges from approximately 3,840 (under the No Action Alternative) to 11,250 (under the Decentralized Alternative).

In addition to analyzing the impacts on the regional economy, a comparison of these impacts was made on the national economy. None of the LLMW alternatives would substantially affect the national economy. The total number of jobs generated in the national economy from combined weighted construction and operations phase activities ranges from 5,650 under the No Action Alternative, due to long-term storage requirements, to 16,500 jobs under the Decentralized Alternative. Although the number of jobs appears large in absolute terms, 16,500 jobs represent only 0.01% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. It is likely that any changes would represent a shift in the source of income from previous employment to employment in LLMW projects rather than a net change in national personal income.

6.9 Population Impacts

No major population increases are expected at any site under any alternative, and thus community characteristics and the provision of services would not be affected.

Potential population changes in the ROI at each LLMW site were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that population changes would cause effects, such as changes in community size and diversity, and effects on the provision of necessary services.

No site would experience 1% or greater increases in the ROI population. Regions containing two sites—INEL under Regionalized Alternative 4 and the Hanford site under the Centralized Alternative—would experience an estimated population increase of more than one-half of 1%, which may marginally affect community characteristics and services.

6.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of LLMW indicated that minority and low-income populations at the LLMW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the LLMW alternatives.

Analysis of environmental justice impacts from management of LLMW was based on a review of the impacts reported in this chapter regarding the LLMW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the 16 major LLMW sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done and includes maps illustrating the distribution of minority and low-income populations residing within 50 miles of each LLMW site.

6.10.1 Results

The potential for adverse human health effects from exposures to radionuclide emissions from LLMW treatment facility operations is low for all LLMW management alternatives for all LLMW sites. Incident-free LLMW treatment facility operations were analyzed (see Section 6.4.1) in terms of risk to workers and the public. The analysis indicated that incident-free operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the population surrounding any site. No disproportionately high and adverse health effects would be expected for any particular segment of the population, minority populations and low-income populations included. The number of potential fatalities due to both radiological and nonradiological exposures to truck or rail transportation of LLMW is small. A more detailed analysis of environmental justice impacts would be presented in NEPA reviews that deal with site-specific activities.

6.10.1.1 Transportation

Because incident-free LLMW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income populations, no environmental justice impacts are expected. As Section 6.4.2 indicates, the estimated total

cancer fatalities resulting from incident-free transportation are less than 0.5 under all LLMW alternatives. The expected number of cancer fatalities due to radiation exposure from transportation accident releases, taking into account both the consequences of such a release and the probability that such a release will occur, is less than 0.5 under all alternatives. The expected number of transportation accident fatalities from trauma is no higher than 1 under any LLMW alternative. Therefore, disproportionately high and adverse health effects to minority or low-income populations from LLMW transportation are not expected to occur.

6.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 6.10 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources. Air quality impacts are possible at three sites, but no disproportionately high and adverse impacts are expected for any segment of the population.

None of the alternatives would have an adverse impact on land use, ecology, or cultural resources because of the limited amount of previously undisturbed land which would be needed for use onsite (no offsite lands are involved) and the mitigation programs already in place. These programs include working closely under agreements with State Historical Preservation Officers and Tribal governments regarding preservation of historic and cultural resources. Consultations with Tribal governments have expanded the DOE's awareness of Tribal interests and values with respect to nature, religion, and the land, and are designed to avoid or relocate these resources if possible. If avoidance were not possible, data recovery (such as archiving artifacts) or other mitigation measures may be developed in consultation with affected Tribes and the respective State Historical Preservation Officer, as appropriate. Similarly, the DOE is aware of sensitive ecological resources, and avoids wetlands and endangered plant or animal species habitats. Disturbance of certain ecological resources (which are not federally listed as threatened or endangered) is possible, but not likely. The reasonably foreseen environmental impacts, if any, to land use, ecological resources, or cultural resources are expected to be small under any of the alternatives, and DOE expects no disproportionately high and adverse environmental impacts to minority and low-income populations at the LLMW sites.

6.11 Land Use Impacts

Only at FEMP, under the No Action, Decentralized, and Regionalized Alternative 1, did the land requirement for facility construction exceed the 1% threshold of the acreage designated or suitable for waste operations. Further evaluation indicates the land requirements at FEMP are not expected to impact current onsite or offsite land uses. Site development plans indicated no conflict between proposed treatment or disposal facilities and other plans for the LLMW sites.

DOE examined the impacts of the LLMW alternatives on land use by comparing the acreage required for new treatment and disposal facilities to the acreage either designated for waste operations or suitable for development (see Table 6.11-1). Suitable land is the total site acreage, minus the acreage required for known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts among the proposed facilities required under each alternative and plans for future site uses.

Under all alternatives, only the land requirements at FEMP exceeded the 1% threshold. In addition, proposed treatment or disposal facilities were not in conflict with the development plans for any site.

For FEMP, the 1% threshold was exceeded when facilities were built or expanded: the No Action Alternative would require 2.3% (6 acres) of the designated waste management area, the Decentralized Alternative would require 3.1% (9 acres), and Regionalized Alternative 1 would require 4.5% (12 acres). However, because only a small fraction of the 275 acres of designated waste operations land at FEMP is

Table 6.11-1. Land Use Impacts Analyzed for LLMW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each LLMW site	Land use shown in site development plans	Comparison of required acreage with amount designated (or estimated) for LLMW in site development plan—all instances where requirements are 1% or higher are noted	Text discussion only
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed LLMW uses and nearby land uses	Text discussion only

required under these alternatives, no significant onsite land use impacts are expected to occur. For the same reason, no conflicts with adjacent land uses are expected.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations within a site.

6.12 Infrastructure Impacts

Although no offsite infrastructure impacts are expected to occur, proposed LLMW activities would affect the onsite infrastructure at 14 sites. Nine sites experience increased requirements for water, wastewater treatment, or electrical power of 5% or greater of current system capacity. However, only the wastewater requirement at the Hanford Site (under the Centralized Alternative) is estimated to exceed the existing treatment capacity. Onsite transportation infrastructure would be affected at 12 sites because of site employment increases of 5% or more above current levels.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and power (see Table 6.12–1). Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on the community infrastructure.

Table 6.12–2 shows the increase in onsite demand for water, wastewater treatment, and power at sites where the increase exceeds 5%. The potential for a major impact is assumed to exist where an increase of 5% or greater causes total demand to exceed 90% of capacity. A moderate impact is assumed where total demand remains below 90% of capacity. Impacts to offsite infrastructure are not expected because population increases do not exceed 5% at any site under any alternative.

Table 6.12-1. Infrastructure Impacts Analyzed for LLMW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support LLMW facilities	Onsite water, power, and wastewater systems	Add increased LLMW facility use to current use—compare to current capacities	Table 6.12-2
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Table 6.12-3
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

Table 6.12-2. Increase in Demand for Water, Wastewater Treatment, or Power as a Percent of Current Capacity—LLMW Sites With Increases Exceeding 5%

Alternative	Number of Sites T	Number of Sites D	ANL-E	FEMP	Hanford	INEL	LANL	LLNL	NTS	RFETS	SRS
No Action[a]	3	NA	**P (19)**	P (8)		P (25)	P (8)	P (10)	**P (9)**	P (31) W (8)	P (6)
Decentralized	37	16		P (7)		P (13)			P (15) Ww (6)	P (33) W (9)	
Regionalized 1	11	12	--			P (13)				P (33) W (9)	
Regionalized 2	7	6	--	--	Ww (5)			--		P (5)	
Regionalized 3	7	1	--	--				--	P (8)	P (5)	
Regionalized 4	4	6	--	--	Ww (5)	P (6)		--			
Centralized	1	1	--	--	**Ww (22)**	--	--	--			--

Notes: T = treatment; D = disposal; NA = not applicable; W = water; Ww = wastewater; P = power; -- = no major actions are proposed for the site under the alternative. Bold indicates major impact, all others moderate. Blank cells indicate less than 5% of current capacities. Numbers in parentheses represent percentage increases.

[a] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW. Beyond 20 years, waste storage infrastructure requirements would be expected to be the same or greater; however, site infrastructure capacity changes could change the percentages in the table. See Section 6.16 for additional information on longer term impacts.

As shown in Table 6.12–2, most of the infrastructure impacts relate to demand for power. Major wastewater treatment impacts would occur only at the Hanford Site under the Centralized Alternative, increasing the current demand by 22%. A further evaluation found that this increase also could cause the current system capacity to be exceeded by 1%. If new construction were needed to increase system capacity, additional environmental impacts and costs would result.

Table 6.12–3 identifies sites at which the increase in site employment from construction activities exceeds 5%. These sites could experience impacts to the onsite transportation infrastructure from increased worker traffic (DOE, 1995a).

6.13 Cultural Resources Impacts

Construction of LLMW facilities could adversely affect cultural resources. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007) may be affected at sites where LLMW treatment and disposal facilities are proposed to be built. Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys at the 16 major proposed LLMW sites and lists the reported cultural resources at those sites. However, the impacts of the construction of LLMW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site (DOE, 1995a).

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Table 6.12-3. Percent Increase in Site Employment From Construction—LLMW Sites With Employment Increases Equal to or Greater Than 5%

Alternative	Number of Sites		FEMP	Hanford	INEL	LANL	LLNL	ORR	Pantex	PGDP	PORTS	RFETS	SRS	WVDP
	T	D												
No Action[a]	3	--			5							7		5
Decentralized	37	16	13		7	6		5	5	11	20	14		
Regionalized 1	11	12	20		7	6	6	5	5	8	20	14		
Regionalized 2	7	6	--		6	8	--	5		--	19	11		
Regionalized 3	7	1	--		5	6	--			--	19	11		
Regionalized 4	4	6	--		9		--	6		--	5	5	5	
Centralized	1	1	--	14		--	--			--	5	5		

Notes: T = treatment; D = disposal; NA = not applicable; -- = no major actions are proposed at the site under the alternative. Blank cells indicate site employment increases of less than 5%.

[a] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW. Beyond 20 years, requirements to rehabilitate or replace aging facilities could result in equal or greater impacts from construction. See Section 6.16 for additional information on longer term impacts.

Land requirements for the construction of LLMW waste management facilities are sufficiently small under all alternatives so that DOE would probably have enough flexibility in siting LLMW facilities to avoid impacts on cultural resources. If not, measures would be taken to mitigate negative effects on these resources.

6.14 Costs Impacts

Costs decrease as the number of treatment and disposal sites decrease, ranging from $12.3 billion for the Decentralized Alternative to $7.7 billion for the Centralized Alternative. Transportation costs are much lower than facility costs, making shipment to available facilities at another site generally less expensive than building a new facility on site.

As indicated in Table 6.14–1, DOE estimated costs for building and operating treatment and disposal facilities, and for transportation (INEL, 1995a,b). DOE evaluated costs associated with LLMW management from both a life-cycle and process perspective, using 1994 dollars.

Table 6.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts Are Assessed	Location of Impacts Assessment
Process Costs	Treatment	Life-cycle costs for treatment including support facilities	Table 6.14–2
	Storage[a]	Life-cycle costs for storage facilities	Table 6.14–2
	Disposal[b]	Life-cycle costs for disposal facilities	Table 6.14–2
Transportation Costs	Truck	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 6.14–2
	Rail	See above	Table 6.14–2

[a] No Action Alternative includes 20 years of storage and limited operations and maintenance.
[b] Disposal includes closure and 300 years of post-closure custodial support.

6.14.1 Life-Cycle Costs

DOE evaluated facility costs for four phases representing the life cycle of the facilities and their operations: pre-operations, construction, operations and maintenance, and decontamination and decommissioning. Life-cycle costs do not include speculative factors, such as the impacts on long-term value of land.

Costs for pre-operation activities consist of technology and site adaptation, including bench-scale tests and demonstrations; permitting; plant startup and cold run costs; and related reference design, safety analysis, project management, and contingencies.

Facility construction costs consist of building construction, equipment purchase and installation, contractor overhead, and related design, construction management, project management, and contingencies. Mobilization and demobilization costs are included for portable treatment units.

Operations and maintenance costs consist of annual operations labor and material, maintenance labor and equipment, utilities, contractor supervision and overhead, and related project management and contingencies.

Decontamination and decommissioning costs consist of facility decontamination and demolition, closure, post-closure, and environmental monitoring activities.

6.14.2 Process Costs

DOE also analyzed costs based on treatment, storage, and disposal activities. Treatment costs include costs to build and operate treatment facilities (such as grout solidification or thermal destruction) and common support facilities (such as maintenance and certification/shipping facilities).

For the purpose of the WM PEIS analysis, LLMW storage capacity is assumed to be sufficient, except for the No Action Alternative. DOE estimated the costs to build and operate sufficient storage capacity to contain all LLMW managed in the No Action Alternative.

Disposal costs include costs to build and operate front-end administration and receiving facilities for disposal as well as the actual disposal units.

Transportation costs include the costs associated with the physical movement of the waste from one site to another, for either treatment or disposal. Transportation costs are evaluated for both truck transportation and rail shipments (INEL, 1995a).

The summary of costs is shown in Table 6.14–2 (INEL, 1996). Construction accounts for 27% to 32% of the total costs and O&M accounts for 56% to 55% of those costs. As waste is consolidated at fewer sites, costs for treatment and disposal facilities decrease, reflecting the economy of scale of using larger and fewer facilities. The difference between the Decentralized Alternative and Centralized Alternative is $4.6 billion—of which $3.0 billion (65%) would be for treatment.

Under the No Action Alternative, DOE would treat LLMW at existing or planned facilities, and would then store the waste for the period of analysis. Although the costs for this alternative are the lowest of any LLMW alternative, the No Action Alternative does not comply with RCRA. The No Action Alternative costs provide a baseline for comparison with the other alternatives that would be in compliance.

Table 6.14–2. Life-Cycle Costs (Billions of 1994 Dollars)

Alternative	Number of Sites		Total Costs[a] (Including Truck Transportation)	Life-Cycle Costs				Process Costs			Transportation Costs	
	T	D		Pre-ops	Const	O&M	D&D	T	S[b]	D	Truck	Rail
No Action[c]	3	NA	5.2	0.4	1.4	2.7	0.7	2.5	2.7	0	0	0
Decentralized	37	16	12.3	1.4	3.9	6.1	0.9	9.8	0	2.5	0.001	0.0007
Regionalized 1	11	12	11.0	1.1	3.3	5.7	0.9	8.6	0	2.4	0.004	0.002
Regionalized 2	7	6	9.5	0.9	2.8	5.1	0.7	7.6	0	1.9	0.02	0.005
Regionalized 3	7	1	8.4	0.8	2.5	4.6	0.5	7.6	0	0.7	0.06	0.02
Regionalized 4	4	6	8.4	0.8	2.4	4.7	0.5	7.0	0	1.4	0.006	0.005
Centralized	1	1	7.7	0.7	2.2	4.3	0.5	6.8	0	0.9	0.03	0.01

Notes: T = treatment; S = storage; D = disposal; NA = not applicable; Pre-ops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning.

[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. Total Costs, also in the table, add truck costs to the facility costs. Therefore, Total Costs equals the sum of life-cycle costs and truck costs and also equals the sum of process costs and truck costs.

[b] RCRA-compliant storage facilities are constructed under the No Action Alternative; for the other alternatives, the existing onsite storage was assumed to be adequate since treatment or packaging for transportation to regional treatment sites would reduce the amount of waste currently being stored on the site. The cost of current storage is included in the site infrastructure accounts which are not included in this PEIS.

[c] Costs under the No Action Alternative include those from only the first 20 years of indefinite storage; see Section 6.16 for additional information on longer term impacts.

Although the quantity of waste requiring transport is at its maximum in the alternatives that centralize functions at NTS or the Hanford Site, the relative proportion of transportation costs remains small, less than approximately 0.7% of total costs.

6.15 Environmental-Restoration-Transferred Waste

The volume of LLMW generated by environmental restoration activities that would be transferred to the waste management program is currently estimated to be about 90% of the volume of waste management LLMW. Because the radiological profiles and physical characteristics of the environmental restoration (ER) transferred LLMW have not yet been determined to the extent necessary to allow a meaningful evaluation of the potential environmental and human health impacts, the ER transferred LLMW volumes are discussed separately in the WM PEIS. When the radiological profiles and physical characteristics of the ER transferred waste are better known, DOE may be required to assess the impacts of managing the ER transferred LLMW on a site-specific basis.

DOE is responsible for the management of wastes currently in inventory and those generated by future operations (referred to as "waste management" wastes). As discussed in Chapter 1, DOE is also responsible for the management and remediation of contaminated media, including soils, groundwater, and buildings. DOE expects that most of the contaminated media at its sites will be remediated under the Environmental Restoration Program. The extent to which media are "cleaned up" is site specific and will depend largely on regulatory requirements and decisions regarding future land use. For analyses purposes, a standard "base case" scenario has been developed that estimates remediation costs across the DOE complex (DOE 1996c). Although most waste generated by cleanup activities will be managed within the Environmental Restoration Program, a certain subset of the waste generated by these activities will be transferred to waste management facilities. In this PEIS, these wastes are referred to as "environmental restoration (ER) transferred wastes." At present, only estimates of the volumes of ER transferred waste are available. These estimates were used to provide a qualitative assessment about how the addition of ER transferred waste may affect LLMW alternatives.

Appendix B provides more detail on how certain wastes generated during environmental restoration will be transferred to the waste management program for final disposition, and provides estimates of the volumes of ER transferred LLMW. Appendix B also discusses the assumptions and uncertainties involved in assessing how ER transferred LLMW may affect waste management alternatives.

To conduct a health risk impact analysis for the additional ER transferred LLMW similar to that conducted for waste management LLMW, additional information is needed on the ER transferred waste streams. In addition to the volume of ER transferred waste, information is needed on the treatability of the individual transferred LLMW streams that would include data about the radiological profile, chemical constituents, and physical form of the ER transferred waste. The wastes would also have to be categorized according to alpha and non-alpha radionuclide composition. Physical characterization of the ER transferred wastes into one of the treatment categories identified for LLMW is needed to estimate management costs. Information about the timing for the transfer of ER wastes to the waste management program is needed to determine the capacities of treatment and disposal facilities. This information is also crucial to conduct transportation and socioeconomic analyses. However, in many cases, this information will not be available until site-specific cleanup is conducted.

To identify how the addition of ER transferred LLMW could affect the comparison among waste management alternatives in the WM PEIS, DOE compared the volumes of waste management LLMW with the expected volumes of ER transferred LLMW. This analysis reveals the potential for overloading treatment facilities for those sites and alternatives where the volumes of ER transferred LLMW are projected to equal or exceed the volumes of waste management LLMW. Strategies to manage the additional loading of ER transferred LLMW in order to avoid overloading facilities include increasing operational capacity and operating a facility longer to "work off" the increased waste load. The WM PEIS treatment facilities are assumed to have an operational life of at least 30 years, which allows for an additional 20 years of operational capacity beyond the 10 years needed to work off the waste management wastes.

Increased radiation and chemical exposure risks to site workers, offsite populations, and the environment are related to the chemical constituents and radiological activity in the ER transferred wastes which, at present, cannot be reliably predicted. However, because radiological activities and chemical concentrations in ER transferred waste are, in general, expected to be lower than those for comparable waste management waste, risks from the addition of ER transferred wastes are expected to be lower than the risks resulting from the treatment of equivalent volumes of waste management wastes. Site-specific performance assessments would be conducted and appropriate restrictions would be imposed to manage any potential increased risks. The risks from physical hazards associated with operating facilities to manage the ER transferred waste are related to the volume relationship between the ER transferred and waste management wastes. Transportation risks and costs are also dependent upon waste volumes rather than the composition of the waste.

Overall, the volume of ER transferred LLMW is expected to be about 90% of the waste management LLMW load (200,000 cubic meters compared with 219,000 cubic meters, respectively). See Table B.6–1. The additional ER transferred waste would affect waste treatment at two sites, RFETS and SRS under the Decentralized and Regionalized Alternatives (see Table B.7–2). The ER transferred LLMW load at RFETS is expected to be up to 200% of the waste management LLMW load while at SRS the ER transferred LLMW is expected to be 750% of the waste management LLMW. The additional ER transferred LLMW would have little effect on the Centralized Alternative.

6.16 Comparison of Alternatives Summary

The LLMW impacts were evaluated across all the LLMW alternatives to identify trends and ultimately the preferred alternative. Although some impact areas, including cost, illustrated clear trends across the alternatives, most did not. Rather, the analysis of the impacts illustrated sensitivities at particular sites, regardless of the alternative.

The following discussion focuses on each impact area, identifying alternative trends when appropriate, and highlighting noteworthy findings at particular sites.

Health Risks. Risks at sites treating or disposing of LLMW are principally to workers, rather than for other receptor groups, driven by physical injury hazards. As the number of sites decreases, facilities become larger and programwide physical injuries decrease, reflecting an economy of scale and fewer total workers.

The most important influence on offsite population risk is treatment of tritium in the Decentralized and Regionalized 1 Alternatives. There are no other notable trends for offsite population risks.

For disposal, concentrations of radionuclides and chemicals in the groundwater near disposal facilities could exceed applicable standards at several sites, demonstrating the need for performance-based waste acceptance criteria and other site-specific considerations. More extensive pretreatment of chemicals and management of radionuclide concentrations and waste forms could be required to assure acceptable water quality and human health risks. One of the most prevalent causes of the exceedances was unconstrained disposal of uranium-238 at the Hanford Site and SRS, which was evaluated under most of the alternatives. Disposal

of LLMW containing this radionuclide must be carefully managed at these sites. Exceedances were also recorded for all disposal alternatives at FEMP (uranium-driven), SNL-NM (plutonium-driven), and ORR (disposal of contact-handled and remote-handled waste with high concentrations of uranium-238, technetium-99, and plutonium-239 and plutonium-240). Up to four chemicals could exceed standards at seven sites, demonstrating the need for more rigorous pretreatment and primary treatment to meet LDRs than was evaluated in the WM PEIS.

Intruder risks are generally higher at sites that combine high radioactivity and long-lived radionuclides. These risks decrease with time, with the lowest risks after 300 years experienced at three sites with new disposal facilities in the Decentralized Alternative (BNL, the Pantex Plant, and SNL-NM). Transportation risks are low in all alternatives, reflecting low vehicle miles.

Air Quality Impacts. The management of LLMW does not affect the air quality at most sites. However, centralization of treatment at Hanford could cause adverse air quality impacts requiring special emission control measures for criteria air pollutants. Emissions from equipment and vehicles during construction at RFETS could result in adverse air quality impacts if the waste at this site is managed onsite as proposed in the Decentralized and Regionalized 1, 2, and 3 Alternatives. Emissions of hazardous air pollutants, including radionuclides, were estimated to be below the applicable standards at any site.

Water Resources Impacts. Impacts to water availability tend to decrease as the LLMW management facilities are Centralized. Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL–Site 300.

Impacts to water quality were discussed under health risks. Careful management of waste through performance-based acceptance criteria would be required, as well as careful selection of technology, to avoid exceedance of drinking water standards at a number of sites.

Ecological Resources, Cultural Resources, Environmental Justice Concerns, and Land Use. The WM PEIS did not provide discriminators among the alternatives in these four impact areas. The programmatic analysis that was conducted did not reveal any major impacts in any alternative. However, impacts to ecological and cultural resources are dependent to some degree on specific technologies and their location at each site. These were not determined at the programmatic level of the WM PEIS, and consequently these impact areas would be evaluated in more detail when such site-level details are evaluated. Assessment of

potential environmental justice impacts indicated that minority and low-income populations at the LLMW sites would not experience disproportionately high and adverse impacts under any LLMW alternative. Land use is not a discriminator because the LLMW alternatives do not use much land compared to the amount available at every site.

Economic Impacts. Nationwide, the largest economic effects resulting from LLMW management would be for the Decentralized Alternative and generally decrease as the alternatives become more Centralized. The greatest benefit at any site occurs when LLMW is managed at that site. The greatest percentage increases in the number of jobs would occur at the Hanford Site in the Centralized Alternative and INEL in Regionalized Alternative 4. The national economy would not be affected by total project expenditures for the construction, operation, or transportation to LLMW facilities under any alternative.

Population Impacts. No major population increases are expected at any site under any alternative, and thus community characteristics and the provision of services would not be affected.

Infrastructure Impacts. Although no offsite infrastructure impacts are expected to occur, proposed LLMW activities would affect the onsite infrastructure at 14 sites. Nine sites experience increased requirements for water, wastewater treatment, or electrical power of 5% or greater of current system capacity. Greatest increases are at RFETS in the Decentralized and Regionalized Alternative 1, and the Hanford Site in the Centralized Alternative, when waste is consolidated for treatment and disposal at these sites. However, only the wastewater requirement at the Hanford Site (under the Centralized Alternative) is estimated to exceed the existing treatment capacity. Onsite transportation infrastructure would be affected at 12 sites because of site employment increases of 5% or more above current levels.

Costs. Costs decrease as the number of treatment and disposal sites decrease, ranging from $12.3 billion for the Decentralized Alternative to $7.7 billion for the Centralized Alternative. Transportation costs are much lower than facility costs, making shipment to available facilities at another site generally less expensive than building a new facility onsite. Actual cost differences have not been calculated for this document for the privatization or commercialization of DOE waste management activities. The reason for pursuing both privatization and commercialization is the belief that private vendors could be able to perform the same tasks faster and at a lower cost than DOE, through innovative technology, efficient oversight, and application of other streamlined business practices. In the experience of other institutions that have

attempted privatization, savings are more common than increased costs. The details of cost estimating are covered in Section 5.3.3 of Chapter 5.

Summary of Impacts by Alternative. Tables 6.16–1 and 6.16–2 summarize key impacts for each alternative.

Long-Term (Beyond 20 Years) Effects of Indefinite Storage Under the No Action Alternative. The risks, environmental impacts, and costs identified in the WM PEIS from storage of LLMW under the No Action Alternative are based on a 20-year period of analysis. As shown in Tables 6.16–1 and 6.16–2, these impacts and costs are less than for the action alternatives in some impact categories. Impacts are expected beyond this 20-year time frame, however, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. These impacts are likely to be greater than those for the first 20 years. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of LLMW, where risks to workers and to the offsite population and other impacts and costs are greatly reduced following disposal. (Potential migration of contaminants into the environment and potential intrusions, which could result in long-term risks for all alternatives, are discussed further below.)

For the period beyond 20 years, risks and other impacts associated with monitoring and maintaining the LLMW storage facilities are likely to increase as waste containers and storage facilities deteriorate. Added to the 20-year risks presented in the No Action Alternative would be those to the public from increased package and facility emissions and to workers from increased inspections and corrective actions around degrading facilities. At some point beyond 20 years, increasing maintenance would require replacement of the facilities and repackaging of the waste. The risks and costs of such actions would be greater than for the earlier new construction and packaging because of the deteriorated condition of materials.

Over time, the potential for chronic leakage and accidents increases. The waste under the No Action Alternative is largely untreated waste, so it contains both hazardous chemicals and unstabilized radioactive waste. The corrosion of the containers may interact with these chemicals, leading to pressure buildup within the containers and a corresponding greater likelihood of leakage. Once released, the untreated wastes would pose a greater risk to human health than the treated, stabilized waste produced in the action alternatives.

Risks from emissions during routine operations or from accidents and leakage could be further increased for the offsite public if the population near storage sites continues to grow. The population density near sites

Table 6.16-1. Comparison of LLMW Alternatives—Projected Risk Results

Alternative	Number of Sites		Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Disposal Worker Physical Hazard Fatalities	Disposal Worker Cancer Fatalities	Groundwater Impacts from Disposal			Truck Radiation Fatalities	Truck Non-Radiation Fatalities
	T	D						Number of Sites That Meet Groundwater Standards for Radionuclides Without Additional Constraints	Number of Sites That Require Additional Constraints to Meet Standards	Radionuclides[a] Which Must Be Constrained for Sites to Meet Standards		
No Action[b]	3	--	2	1	*	NA	NA	--	--	--	--	--
Decentralized	37	16	4	1	*	*	1	11	4	U-238, Pu-240	*	*
Regionalized 1	11	12	4	1	*	*	1	9	3	U-238	*	*
Regionalized 2	7	6	3	1	*	*	1	3	3	U-238, Tc-99	*	*
Regionalized 3	7	1	3	1	*	*	*	1	0	--	*	1
Regionalized 4	4	6	3	1	*	*	1	3	3	U-238, Tc-99	*	*
Centralized	1	1	3	1	*	*	*	0	1	U-238	*	1

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.5; -- = action not applicable for this alternative.

[a] Additional reductions to chemical concentrations may also be required to meet chemical groundwater standards at each site (see Section 6.6). This requires treatment options not evaluated in the WM PEIS. RH-LLMW, disposed of in every alternative except No Action at ORR, would also require additional constraints to assumed concentrations of Pu-239, Pu-240, and Tc-99 in order to meet groundwater standards.

[b] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

Table 6.16–2. Comparison of LLMW Alternatives—Selected Impacts

Alternative	Number of Sites		Number of Sites With Air Pollutants That Exceed Standards	Highest Air Pollutant Percentages at Any Site	Cost ($ Billions)	Truck Shipments	Comment
	T	D					
No Action[a]	3	NA	0	95 (CO-RFETS)	5.2	NA	Extended storage at every site—does not comply with RCRA
Decentralized	37	16	1	169(CO-RFETS)	12.3	500	Maximum number of sites treat and dispose
Regionalized 1	11	12	1	169(CO-RFETS)	11.0	1,800	LDRs treatment at 6 western, 5 eastern sites; disposal at 12
Regionalized 2	7	6	1	107(CO-RFETS)	9.5	5,600	LDRs treatment at 4 western, 3 eastern sites; disposal at current LLW disposal sites
Regionalized 3	7	1	1	107(CO-RFETS)	8.4	11,000	LDRs treatment at 4 western, 3 eastern sites; Centralized disposal at NTS
Regionalized 4	4	6	0	77(PM_{10}-ORR)	8.4	4,300	LDRs treatment and disposal at 2 western, 2 eastern large generators; disposal at current LLW disposal sites
Centralized	1	1	1	147 (PM_{10}-HS)	7.7	7,500	Centralized treatment and disposal at the Hanford site

Notes: T = treatment; D= disposal; NA = not applicable.
[a] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

could be expected to increase over time, and the possibility of encroachment into current buffer areas would also increase.

Although it is DOE's intent to maintain control as long as necessary to assure public health and safety, at some date in the future, loss of institutional control of the storage facility must be assumed for a conservative analysis. With loss of control, the potential for intrusion into the facility and movement of contaminants into the environment sharply increases. The risks predicted for a human intruder into a storage facility containing untreated wastes are likely to be as high or higher than those presented in Section 6.4.1.10 for intrusion into a disposal facility. In particular, the presence of untreated chemicals in the stored wastes would increase the risk from chemical exposures. Migration of the waste into the groundwater from a storage facility, which could also be expected at some time after maintenance and control of the facility has ended, could pose risks as high or higher than those presented for the hypothetical farm family and population in Sections 6.4.1.8 and 6.4.1.9. The untreated condition of the waste could result in faster movement of contaminants through the groundwater, which could contain both a greater concentration of short-lived radionuclides and a higher concentration of chemicals. These conditions would add to the risks predicted for migration from a disposal facility.

Should the No Action Alternative be selected in the near term, it would be reasonable to expect a decision to treat and dispose of the waste at some point in the future, both because of the continued accumulation of effects already noted and because indefinite storage of untreated waste does not fulfill obligations under existing laws or agreements. Should such a decision be made, it is likely that the impacts and risks for treating and disposing would be greater than those shown for the action alternatives; the further deterioration of the waste containers over time would present a more difficult management situation. Consequently, for a course of action that continues storage of untreated LLMW for 20 years or more and then accomplishes treatment and disposal at some future date, the total impacts and costs would be likely to exceed the sum of the No Action Alternative impacts over 20 years plus those presented in Chapter 6 under any action alternative pursued for treatment and disposal.

The Preferred Alternative for Treatment. A number of the Department's sites (generally sites with small amounts of LLMW) would send their LLMW to other sites for treatment. The sites that would receive these wastes and treat them under the Department's preferred alternative are Hanford, INEL, ORR, and SRS. ANL-E, FEMP, LLNL, LANL, Pantex, PORTS, RFETS, and SNL would treat LLMW onsite.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several Regionalized Alternatives as shown in Table 3.7-1 in Chapter 3. The potential environmental impacts of all alternatives for treatment of LLMW evaluated in the WM PEIS are small. DOE's preferred alternative is generally consistent with the Site Treatment Plans prepared under the FFCAct; these plans include the use of commercial facilities to treat some LLMW. DOE realizes that the compliance orders issued by State and Federal regulators on the basis of these Site Treatments Plans establish the requirements for treatment of DOE's LLMW.

The Preferred Alternative for Disposal. The Department's preferred alternative at this time is to send its LLMW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW or LLMW disposal operations and, except for NTS and LANL, each has relatively large LLMW volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLMW the Department will need to dispose of, there is no need for additional candidate sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLMW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLMW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Table 6.16–3 provides potential impacts for the preferred alternative by combining the impacts evaluated in the WM PEIS for the preferred alternative at each site. Although it is not possible to estimate disposal impacts with precision until the disposal sites have been selected, the table provides approximate values and ranges expected for the preferred LLMW alternatives. Treatment and disposal impacts are taken from Volume II site data tables for the preferred alternatives specified in the second and third rows of Table 6.16–3. Values presented in the table for regionalized disposal are the high and low values at each site when impacts are estimated for Hanford, INEL, LANL, NTS, ORR, and SRS under Regionalized Alternative 2 (six disposal sites), Regionalized Alternative 3 (one disposal site—NTS), and the Centralized Alternative (one disposal site—Hanford). These values provide a range for potential impacts. Impact estimates under Regionalized Alternative 3 at NTS and the Centralized Alternative at Hanford provide an upper limit for the range of impacts at these sites, using impacts that result when all LLMW is disposed of at one site—NTS or Hanford. The preferred disposal alternative would distribute disposal impacts over two to three sites, lowering values shown for NTS or Hanford.

Table 6.16–3. The Preferred LLMW Alternative — Selected Impacts

Impact Area	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Total
Preferred alternative	T	D	R1[a]	D	R1	R4	D	D	R1[a]	R2	R2	D	D	D	D	R1	R1[a]	
	D[b]	—	—	—	R	R	—	R	R	R	—	—	—	—	—	R	—	—
Worker physical hazard fatalities	T	6.4E-03	4.0E-03	1.6E-01	4.8E-01	8.8E-01	2.7E-01	2.0E-01	4.6E-02	4.8E-01	1.3E-02	3.8E-02	4.8E-01	6.2E-01	5.1E-03	3.3E-01	3.2E-03	4.0E+00
	D	—	—	—	0.0E+00–<1.5E-01	0.0E+00–5.5E-02	—	0.0E+00–1.3E-01	0.0E-00–<8.4E-02	0.0E+00–5.6E-02	—	—	—	—	—	0.0E+00–1.0E-01	—	8.4E-02–4.2E-01
	Total	6.4E-03	4.0E-03	1.6E-01	4.8E-01–<6.3E-01	8.8E-01–9.4E-01	2.7E-01	2.0E-01–3.3E-01	4.6E-02–<1.3E-01	4.8E-01–5.4E-01	1.3E-02	3.8E-02	4.8E-01	6.2E-01	5.1E-03	3.3E-01–4.3E-01	3.2E-03	4.1E+00–4.4E+00
Worker cancer fatalities	T	6.7E-05	5.7E-05	2.9E-04	1.2E-01	1.2E-01	7.8E-03	1.6E-03	2.9E-03	1.2E-01	1.5E-04	3.4E-04	1.4E-03	1.0E-03	3.3E-04	1.1E-01	2.8E-05	4.9E-01
	D	—	—	—	0.0E+00–<3.6E-01	0.0E+00–1.7E-01	—	0.0E+00–1.2E-02	0.0E-00–<3.9E-01	0.0E+00–9.3E-02	—	—	—	—	—	0.0E+00–3.9E-02	—	3.6E-01–5.2E-01
	Total	6.7E-05	5.7E-05	2.9E-04	1.2E-01–<4.8E-01	1.2E-01–2.9E-01	7.8E-03	1.6E-03–1.4E-02	2.9E-03–<3.9E-01	1.2E-01–2.1E-01	1.5E-04	3.4E-04	1.4E-03	1.0E-03	3.3E-04	1.1E-01–1.5E-01	2.8E-05	8.5E-01–1.0E+00
Offsite population cancer fatalities	T	1.7E-05	5.2E-08	2.6E-05	1.4E-03	6.7E-04	1.5E-01	5.9E-04	6.4E-09	1.2E-03	8.1E-07	3.5E-05	2.7E-06	8.8E-05	1.4E-04	1.8E-03	1.7E-07	1.6E-01
Radionuclides requiring constraints to meet groundwater standards	D	—	—	—	None or U-238	None	—	None	None	None or PU-239 PU-240 TC-99 U-238	—	—	—	—	—	None or U-238	—	0-3 sites exceed

Table 6.16–3. The Preferred LLMW Alternative — Selected Impacts—Continued

Impact Area	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Total
Preferred alternative	T	D	R1[a]	D	R1	R4	D	D	R1[a]	R2	R2	D	D	D	D	R1	R1[a]	
	D[b]	—	—	—	R	R	—	R	R	R	—	—	—	—	—	R	—	
Truck radiation fatalities		These numbers reflect intersite transportation results and are not attributable to individual sites																<0.5
Truck nonradiation fatalities																		≤1.0
Highest air pollutant percentage	T	44% NO_2	1% NO_2	22% NO_2	23% PM_{10}	45% PM_{10}	5% PM_{10}	2% NO_2/PM_{10}	25% CO	50% PM_{10}	1% VOC	1% NO_2	13% PM_{10}	107% CO	9% CO	10% PM_{10}	0%	1 site exceeds (RFETS)
	D	—	—	—	—	—	—	—	0-73% CO	—	—	—	—	—	—	—	—	No sites exceed
Cost $ billions	T	0.06	0.01	0.34	0.70	1.87	0.33	0.40	0.18	1.46	0.06	0.15	0.69	1.23	0.07	0.96	0.01	8.5
	D	0	0	0	0-<1.04	0-0.33	0	0-0.42	0-<0.52	0-0.32	0	0	0	0	0	0-0.29	0	0.7-1.6
	Total[c]	0.06	0.01	0.34	0.70-<1.74	1.87-2.20	0.33	0.40-0.82	0.18-<0.70	1.46-1.78	0.06	0.15	0.69	1.23	0.07	0.96-1.25	0.01	9.2-10.1
Truck shipments[d]		20	20	110	40-7,520	1,740-5,840	210	130-2,610	160-9,640	1,660-2,100	50	40	650	2,520	30	110-710	30	10,000-23,770

[a] Wastes from these sites (BNL, NTS, and WVDP) undergo shipment offsite to regional treatment centers.
[b] DOE prefers to further narrow its configuration of disposing sites to two or three sites from these six sites. DOE has no site preferences pending further deliberations with regulators and stakeholders. For the preferred disposal alternative, disposal volumes would range between zero and quantities disposed of in the Regionalized Alternative 2 at INEL, LANL, ORR, and SRS. At NTS, disposal volumes would range between zero and a quantity less than those evaluated for Regionalized Alternative 3. At Hanford, disposal volumes would range between zero and a quantity less than those evaluated in the Centralized Alternative.
[c] Costs for truck transportation (≤ $.06 billion) were added to these site totals for the total alternative cost as presented in Table 6.16-2.
[d] Total one-way shipments between two sites, as defined for shipment totals in Table 6.16–2, are (10,000 - 23,770) ÷ 2 = 5,000 - 11,885 shipments.

Chapter 6
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Proposed Waste Management Actions at Each Site Under the Low-Level Mixed Waste Alternatives[a]

Alternatives	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	3	0	S	S	S	S	TS	S	S	S	TS	S	S	S	S	S	TS	S
Decentralized	37[b]	16	TD	TD	TD	TD	TD$^{\alpha}$[c]	TD$^{\alpha}$	TD$^{\alpha}$	TD$^{\alpha}$	TD	TD	TD	TD	TD$^{\alpha}$	TD	TD$^{\alpha}$	TD
Regionalized 1	11	12			TD	TD	TD$^{\alpha}$	TD$^{\alpha}$	TD$^{\alpha}$	D$^{\alpha}$	TD	TD	TD	TD	TD$^{\alpha}$		TD$^{\alpha}$	
Regionalized 2	7	6				TD	TD$^{\alpha}$	TD$^{\alpha}$		D$^{\alpha}$	TD			T	T$^{\alpha}$		TD$^{\alpha}$	
Regionalized 3	7	1				T	T$^{\alpha}$	T		D$^{\alpha}$	T			T	T$^{\alpha}$		T$^{\alpha}$	
Regionalized 4	4	6				TD	TD$^{\alpha}$	D$^{\alpha}$		D$^{\alpha}$	TD						TD$^{\alpha}$	
Centralized	1	1				TD$^{\alpha}$												

Notes: T = treatment to meet land disposal restrictions; D = disposal; S = indefinite storage. A blank indicates that no treatment or disposal takes place at a site. All sites have wastewater treatment capability as needed.

[a] The actions shown are for contact-handled (CH) wastes. Remote-handled (RH) wastes would be treated and disposed of onsite at the Hanford Site, INEL, ORR, and SRS in all alternatives except No Action. RH waste is stored under No Action. Facilities with the α symbol treat or dispose of contact-handled alpha and nonalpha waste.

[b] Although 37 sites generate LLMW, only 17 have been designated major sites in the WM PEIS (see Section 1.6.1 for details).

[c] Treatment and disposal facilities identified for one site with the α symbol can manage both alpha and nonalpha waste.

CHAPTER 7
Impacts of the Management of Low-Level Waste

Chapter 7 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for low-level waste (LLW). This chapter provides information on existing and anticipated LLW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to LLW characteristics and the treatment and disposal technologies considered, as well as the rationale for selecting the specific sites analyzed under each alternative. This chapter discusses the human health risks, environmental impacts, and costs of the alternatives, and provides a comparison of them.

The methods used to evaluate impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the LLW analysis are contained in a technical report entitled "Low-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the appendices in Volumes III and IV and the technical reports provided in Chapter 15.

7.1 Background

- *LLW includes all radioactive waste not classified as High-Level Waste, Transuranic Waste, Spent Nuclear Fuel, or byproduct tailings.*
- *LLW is currently generated, projected to be generated, or stored at 27 DOE sites as a result of nuclear weapons technology production and dismantlement, nuclear reactor operations, environmental restoration activities, and research.*
- *DOE will need to manage an estimated 1.5 million cubic meters of LLW over the next 20 years.*
- *DOE must select treatment and disposal sites for LLW.*

7.1.1 DEFINITION AND ORIGIN

Low-level waste (LLW) is defined as all radioactive waste not classified as either HLW, TRUW, spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section 11 (e) (2) of the Atomic Energy Act of 1954 [42 USC 2011 *et seq.*]) and not containing hazardous or toxic wastes under RCRA or TSCA. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW provided that the concentration of transuranics is less than 100 nanocuries per gram. Since the Manhattan Project during World War II, LLW has been generated by DOE and its predecessor agencies from a variety of activities including weapons production, nuclear reactor operations, environmental restoration activities, and research.

DOE also has the responsibility for two other classes of waste frequently categorized as LLW: special case waste, which is waste generated by DOE that does not fit into any typical LLW management activity (i.e., treatment, storage, and disposal), and commercially generated Greater-Than-Class-C (GTCC) LLW. However, because special case waste has unique site-specific considerations and the GTCC LLW program has not been fully defined, these LLW groups are excluded from the WM PEIS analysis (see discussion in Chapter 1, Section 1.5.6).

7.1.2 VOLUMES AND LOCATIONS

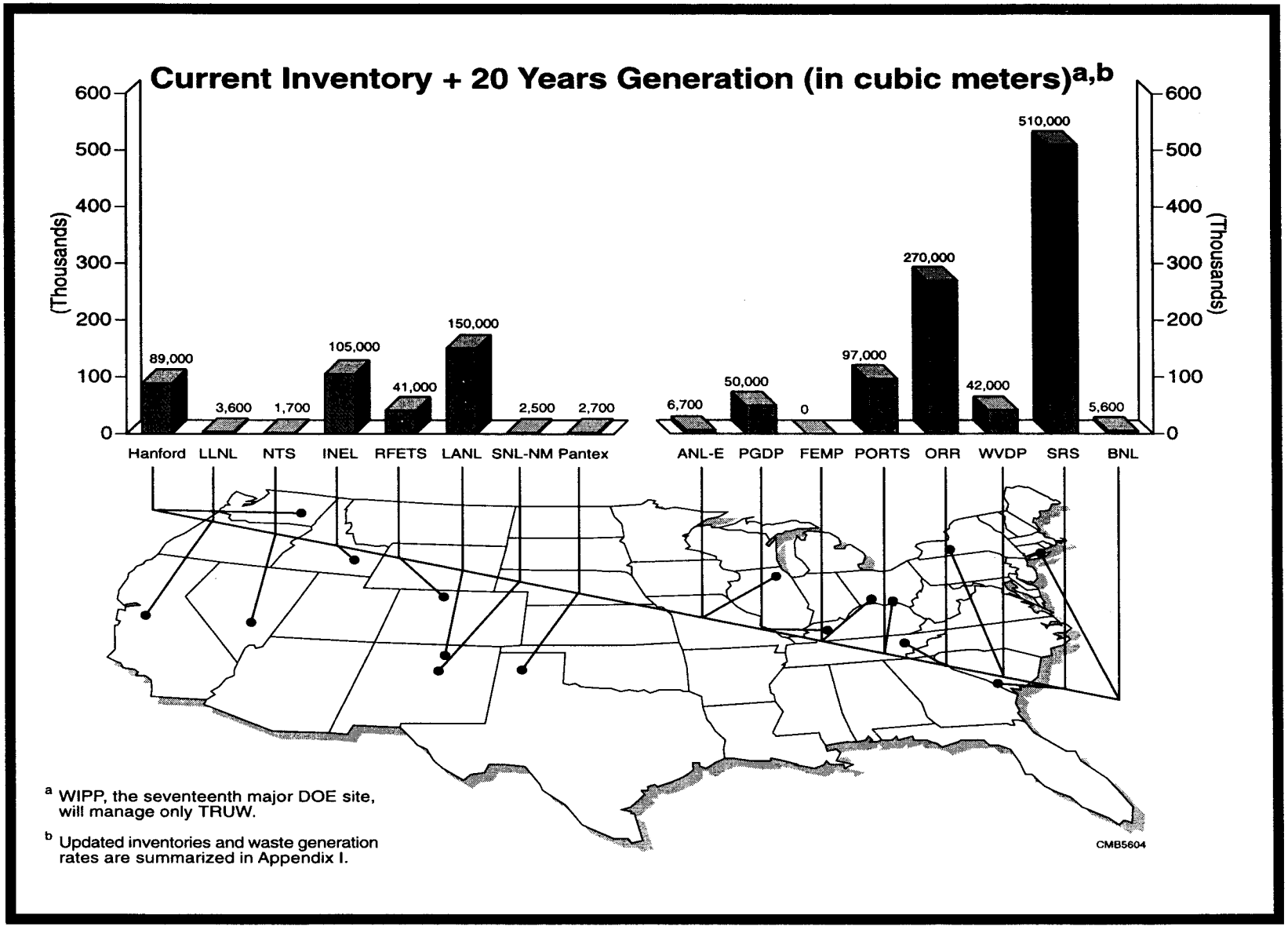
Approximately 1.5 million cubic meters of LLW is generated, projected to be generated, or stored at 27 DOE sites. Table 7.1-1 presents the total estimated LLW volumes at those sites. LLW volume data are derived primarily from data in the 1992 Integrated Data Base (IDB) (DOE, 1992) and the Waste Management Information System (WMIS) (ORNL, 1992). (Details of the amounts and characteristics of LLW are provided in ANL [1996].) Although 27 DOE sites manage LLW, 7 sites generate more than 80% of the LLW load: the Hanford Site, INEL, LANL, ORR, Paducah, Portsmouth, and SRS. Figure 7.1-1 presents the total LLW volumes at the 16 major sites considered under the LLW alternatives and illustrates LLW distribution across the country. The naval shipyards (i.e., Norfolk, Pearl Harbor, Puget Sound, and Portsmouth) generate small quantities of LLW not included here. Impacts from the minor amounts of naval shipyard LLW are not expected to affect the overall conclusions reached in the WM PEIS.

Owing primarily to improvements in waste characterization, projected waste volumes and inventories of LLW have changed since the analysis of these wastes was carried out for the WM PEIS. Updated LLW volumes for all sites were derived from information in the IBD Report–1994 (DOE, 1995c) and are given in Appendix I. The appendix also identifies criteria for reanalyzing site wastes using more recent data, compares the waste load data used in the Draft WM PEIS with the more recent data and describes DOE's conclusions about the need to analyze the more recent data for specified sites. For five sites—BNL, NTS, ORR, Pantex, and WVDP—updated LLW data are used in the alternatives analyses only when these sites treat their own waste.

Table 7.1-1. Low-Level Waste Volumes [a,b]
(cubic meters)

DOE Site	Inventory	20-Year Projected Generation	Estimated Inventory Plus 20-Years Generation
1. Ames Laboratory	26	80	110
2. Argonne National Laboratory-East	880	5,800	6,700
3. Bettis Atomic Power Laboratory	0	12,000	12,000
4. Brookhaven National Laboratory	560[c]	5,080[c]	5,600[c]
5. Fermi National Accelerator Laboratory	45	1,400	1,500
6. Fernald Environmental Management Project	d	d	d
7. Hanford Site[e]	0	89,000	89,000
8. Idaho National Engineering Laboratory[f]	3,500	101,000	105,000
9. Kansas City Plant	4	20	24
10. Knolls Atomic Power Laboratory	0	19,000	19,000
11. Lawrence Berkeley Laboratory	53	1,200	1,300
12. Lawrence Livermore National Laboratory[g]	780	2,800	3,600
13. Los Alamos National Laboratory	0	150,000	150,000
14. Mound Plant	1,600	37,000	38,000
15. Nevada Test Site	270[c]	1,400[c]	1,700[c]
16. Oak Ridge Reservation	20,000[c]	250,000[c]	270,000[c]
17. Paducah Gaseous Diffusion Plant	5,300	45,000	50,000
18. Pantex Plant	210[c]	2,440[c]	2,700[c]
19. Pinellas Plant	16	1,300	1,300
20. Portsmouth Gaseous Diffusion Plant	1,500	96,000	97,000
21. Princeton Plasma Physics Laboratory	2	220	220
22. RMI Titanium Company	2,500	48,000	51,000
23. Rocky Flats Environmental Technology Site	2,400	39,000	41,000
24. Sandia National Laboratories-New Mexico[h]	680	1,800	2,500
25. Savannah River Site[i]	11,000	500,000	510,000
26. Stanford Linear Accelerator Center	2,200	280	2,500
27. West Valley Demonstration Project	14,000[c]	28,000[c]	42,000[c]
Total	**67,500**	**1,440,000**	**1,500,000**

[a] Volume data are rounded from field estimates and columns may not add. Updated inventories and waste generation rates are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW."
[b] Potential waste to be generated by environmental restoration activities are not included in the totals in this table. See Section 7.15 for a discussion of environmental-restoration-generated LLW.
[c] Data from the IDB Report-1994 were used in the analysis (DOE, 1995c).
[d] Waste is ER waste only; no WM waste is generated at Fernald.
[e] Excludes LLW fraction of the Hanford Site tank wastes.
[f] Includes Argonne National Laboratory-West and Naval Reactor Facility.
[g] Includes Sandia National Laboratories, California.
[h] Includes Inhalation Toxicology Research Institute.
[i] Excludes SRS saltstone—29,600 m^3/yr.
Sources: DOE (1992) and ORNL (1992), except where noted.



[a] WIPP, the seventeenth major DOE site, will manage only TRUW.

[b] Updated inventories and waste generation rates are summarized in Appendix I.

Figure 7.1–1. Low Level Waste—Total Inventory and Generation

7.1.3 EXISTING AND PLANNED FACILITIES AVAILABLE AT DOE SITES

DOE used the existing and planned LLW facilities and capacities listed in Table 7.1-2 to establish the baseline capacities for treatment and disposal and to determine the need for new or expanded facilities. Planned facilities include only the facilities for which a Title II design has been initiated.

Analysis in the WM PEIS assumes use of existing and planned facilities until their capacities are met. If additional capacity is needed, use of new generic facilities is assumed. These conceptual facilities provide the difference in TSD capacity between the baseline reported in Table 7.1-2 and what is necessary to manage the particular LLW stream which a given site would receive under any given alternative.

Table 7.1-2. Capacities of Existing and Planned LLW Facilities[a]

Site	Treatment (m^3/yr)				Disposal (m^3/yr)	
	Incineration	Size Reduction	Compaction	Solidification	Engineered Disposal	Shallow Land
Hanford			4,040			8,500
INEL	2,300	5,000	5,700	27,770		3,900
LANL						1,300
NTS						44,900
ORR			1,400		600	
SRS	8,200*		4,000	210*	5,370	
LBL			Sufficient for LBL Needs	105		
LLNL		115	1,500			
PGDP				Sufficient for PGDP Needs		
Mound				252		
Pantex			1,083			
RFETS			5,600			
RMI	102					

Note: * = planned capacity; blanks indicate that the treatment or disposal operation does not take place at the specified site.
[a] The capacities of these existing and planned units may be used for several waste types in accordance with site plans.
Source: DOE (1996a).

Conceptual facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). Where necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of generic facilities.

Eleven sites conduct different degrees of LLW treatment using existing facilities. Size reduction and compaction facilities typically used to reduce the total volume of waste requiring disposal are the most prevalent existing facilities for LLW treatment. Seven DOE sites have operating LLW disposal facilities. Of these, three (INEL, LANL, and ORR) accept only onsite wastes, one (SRS) accepts small amounts of waste from several small generators, and two (the Hanford Site and NTS) accept large quantities of offsite waste from other DOE sites.

7.2 Analytical Methods and Assumptions

The character of the waste is as important as waste volume in determining the potential impacts resulting from LLW management. LLW can contain many different radionuclides in many combinations and can be present in many physical forms ranging from dilute liquids to activated metal equipment. For the purposes of analysis, DOE categorized LLW by radiological and physical properties, and assigned the waste into an appropriate treatability category to calculate risk, costs, and other impacts. This process is further described below.

7.2.1 CHARACTERISTICS

7.2.1.1 Physical

DOE defined the treatment requirements for LLW based on physical characteristics of the waste. Using site data and information contained in the Waste Management Information System database (ORNL, 1992), LLW at each site was characterized into the following 10 treatability categories: solid LLW classified as (1) combustible, (2) noncombustible-noncompactible, (3) noncombustible-compactible, (4) surface-contaminated bulk metal/equipment, (5) activated bulk metal/equipment, (6) sludge/resin, (7) other (wastes that do not fit into the previous categories); liquid LLW classified as either (8) small-volume dilute/aqueous or (9) liquids containing organic materials; and (10) remote-handled (RH) LLW, which requires special

shielding during waste handling. These categories determined the treatment and processing techniques required for LLW to produce a final waste form suitable for disposal.

7.2.1.2 Radiological Profiles

After categorizing the waste into the 10 treatability categories, DOE further categorized LLW by its radiological characteristics. Six radiological categories, or radiological profiles, defined in the 1992 Integrated Data Base (DOE, 1992) were assigned to LLW streams at the 16 major sites. These categories, described in Table 7.2–1, identify the radionuclides likely to be encountered based on the origin of the waste. A detailed listing of the radionuclides that compose each radiological category is available in ANL (1996).

7.2.2 Technologies and Treatment Processes

DOE analyzed two treatment strategies for LLW: minimum treatment, defined as the least amount of treatment required to meet applicable requirements for either onsite disposal or transport to another site for disposal; and volume reduction, which reduces the overall disposal volume of LLW using a variety of treatment techniques. Minimum treatment includes solidification of liquids and fines, and packaging.

Table 7.2–1. LLW Radiological Profiles

Category	Description
Uranium/thorium	Waste material primarily containing the naturally occurring radioactive elements of uranium or thorium.
Fission products	Waste containing radionuclides (e.g., cesium-137 and strontium-90) that result when a heavy nucleus is split.
Induced activity	Waste that contains elements that were initially not radioactive but became radioactive as a result of absorbing neutrons (e.g., cobalt-60).
Tritium	Waste material containing trace amounts of tritium (a synthetically produced radioactive isotope of hydrogen).
Alpha	Waste materials contaminated with alpha-emitting (helium nuclei) radionuclides not listed under uranium/thorium or low levels (less than 100 nCi/g) of transuranic isotopes.
Other	Waste material that is combined or undefined.

Volume reduction uses several different available technologies, including thermal treatment, compaction/supercompaction, and size reduction to decrease the volume of combustible and/or compactible LLW. Minimal treatment is used for wastes that are not amenable to the volume reduction technologies.

LLW is treated by one or more treatment processes (or "modules"). Individual modules were linked together to form a complete treatment flow process. Figure 7.2–1 illustrates the treatment flow diagrams which include thermal treatment, solidification, compaction/supercompaction, and size reduction.

Figure 7.2–2 illustrates the percentage of waste that could be treated by each technology under the policies of minimum treatment and volume reduction. Because treatment is based primarily on physical waste characteristics, not all the wastes are eligible for all the treatment technologies.

For LLW disposal, DOE evaluated the impacts associated with both shallow land burial and engineered disposal facilities.

7.2.3 WM PEIS Assumptions: Facilities, Treatment, and Disposal

In addition to the assumptions regarding the physical and radiological characteristics of LLW, DOE made other assumptions to conduct the LLW analysis. These assumptions are summarized below.

Facilities

- The WM PEIS uses a 20-year period for the analysis of waste management operations. Within this 20-year period, new facilities will be constructed within the first 10 years, and inventory waste and annually generated waste will be treated within the following 10-year period.
- In the LLW analysis, each site is assumed to build and operate facilities with capacities sufficient to handle only LLW. This avoids linking results of one waste type to decisions not yet made in another and results in conservative estimates of risk, cost, and impacts. However, the alternatives were structured to accommodate locating LLMW and LLW facilities at the same sites to more accurately reflect the reality of coordinated treatment and disposal. Chapter 11 discusses cumulative effects for sites hosting more than one waste type facility.

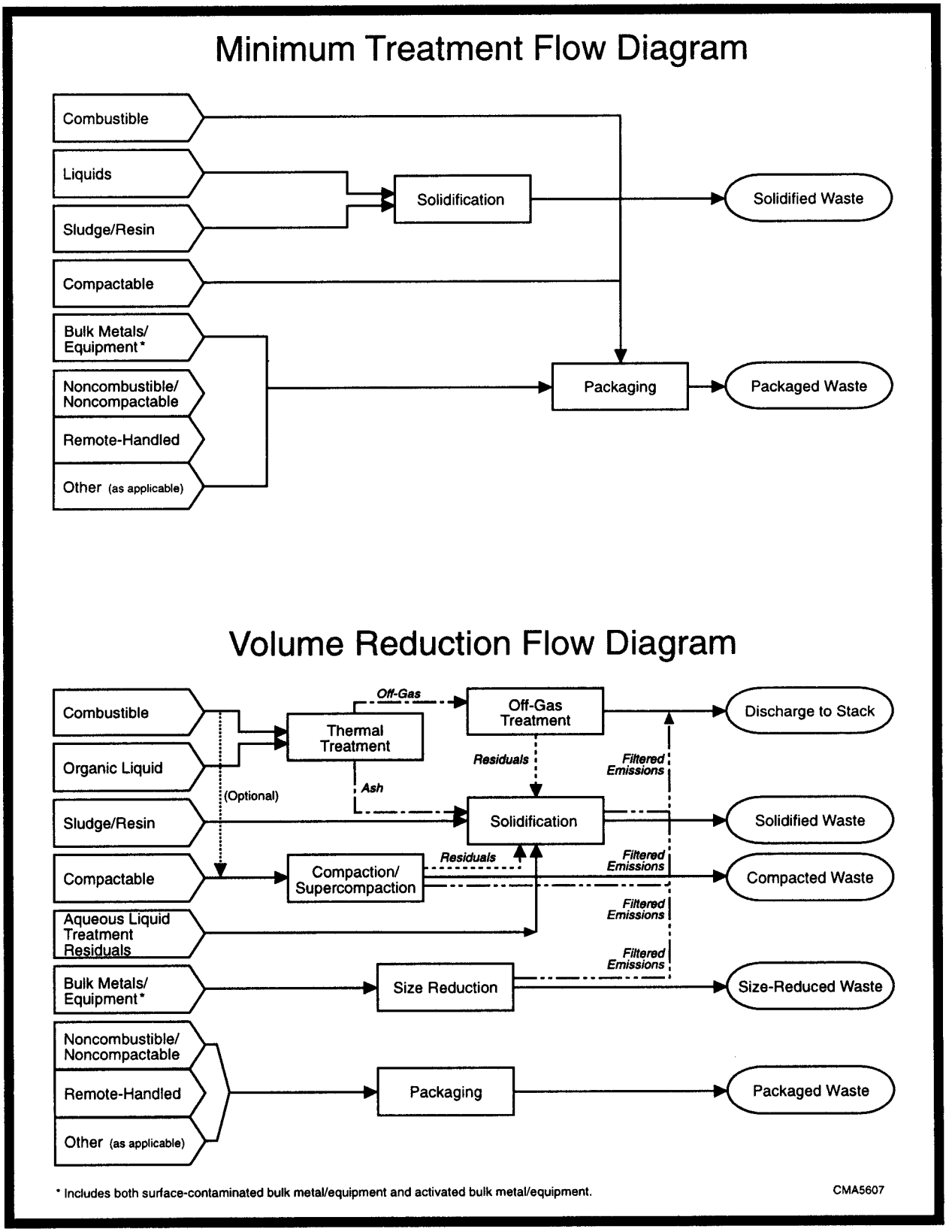


Figure 7.2–1. Low-Level Waste Flow Diagram

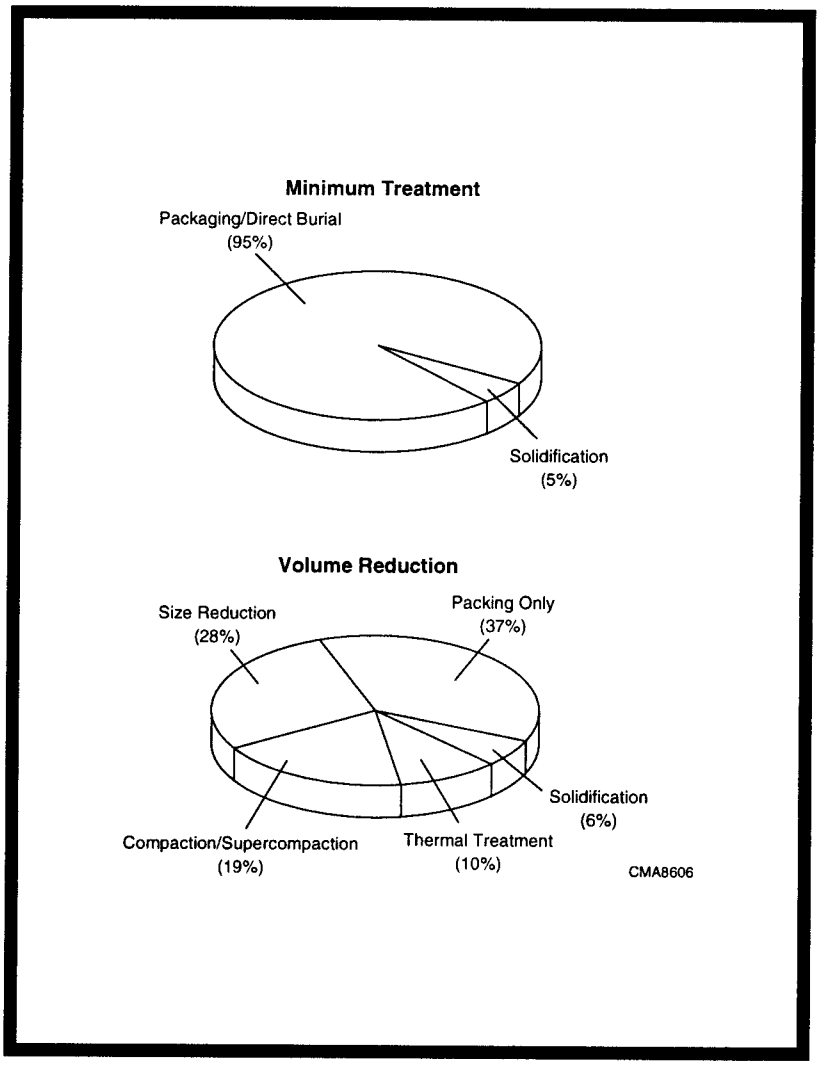


Figure 7.2-2. LLW Treatment Processes

Treatment

- Aqueous liquid LLW treatment facilities are assumed to exist in sufficient capacities at all facilities with wastewater. The sludges (fine material and residuals) from aqueous treatment are to be solidified at the site of generation; therefore, aqueous liquid LLW is not shipped for treatment or disposal in any of the alternatives. LLW sludges resulting from treatment are transported primarily to move the waste to a final disposal location.
- For all alternatives, some treatment is considered practical and will occur at every site in both the minimum treatment and volume reduction approaches.

- LLW storage capacities are sufficient at individual sites or can be expanded to meet future requirements.
- For analytical purposes, incineration was modeled as the representative thermal treatment for LLW.

Disposal

- Two types of disposal were analyzed in the WM PEIS: shallow land burial and engineered disposal. Shallow land disposal is generally used where the groundwater table is far below the surface and therefore was the primary disposal method assumed at western sites, except at RFETS which used aboveground facilities because of shallow groundwater conditions. Engineered concrete structures are typically used for disposal at sites with shallow groundwater and high precipitation rates to reduce potential radionuclide migration. In addition to RFETS, DOE assumed the use of aboveground engineered concrete structures for sites located in the eastern United States, except at SRS which currently uses belowground vaults.

7.2.4 TRANSPORTATION ANALYSIS AND ASSUMPTIONS

DOE analyzed transportation impacts associated with each alternative. Both truck and rail transportation were analyzed using routing models following the general principle of minimizing distance and transportation time. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines; however, because the routes were determined for the purposes of risk assessment, they do not necessarily represent actual routes that would be used to transport waste in the future. Actual routes would be determined during the transportation planning process described in Section 4.3.10.

In general, the impacts resulting from transportation of radioactive materials are directly proportional to the external dose rate, which is a measure of the external radiation (principally gamma radiation) emitted from the shipment. For analytical purposes, DOE assumed the average dose rate of each shipment would not exceed 1 millirem per hour at 1 meter from the shipping container (consistent with DOE's historical practices), although DOT regulations allow a dose rate of 10 millirem per hour at 2 meters from the container.

7.3 Low-Level Waste Alternatives

The WM PEIS LLW alternatives cover two approaches for solid LLW treatment. As considered in this section, the minimal treatment approach simply includes procedures (e.g., packaging, solidification) that can be employed to enable the waste to meet applicable criteria for LLW transport and/or disposal. All LLW will undergo only minimal treatment at each waste generation site under the Decentralized Alternative, Regionalized Alternatives 1, 3, 6, and 7, and the Centralized Alternatives 1 and 2. The volume reduction approach includes procedures and technologies (e.g., incineration, supercompaction) that would reduce the waste volume prior to undergoing final treatment to meet applicable LLW acceptance criteria. Only certain waste types, such as compactible and combustible LLW, would be amenable to volume reduction technologies. Under the LLW No Action Alternative, Regionalized Alternatives 2, 4, and 5, and the Centralized Alternatives 3, 4, and 5, all generating sites would conduct minimal treatment for their own noncombustible, noncompactible waste streams, while the remaining wastes would undergo volume reduction at designated regional treatment sites prior to final disposition.

The WM PEIS LLW analysis considers 14 alternatives for treatment and disposal facilities within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. Treatment and disposal activities vary by alternative and by site. Each of the 14 alternatives was developed in order to capture and quantify the human health risks, environmental impacts, and costs associated with the range of LLW treatment and disposal options available to DOE, and to provide input for decisions about where to locate LLW treatment and disposal facilities. The foldout table at the end of this chapter shows the sites at which LLW would be treated and disposed of under each alternative. This table is designed to be used as a quick reference when reading the LLW impact sections.

In the table at the end of this chapter, the sites identified with a "T" or "D" for treatment or disposal are candidate sites. The evaluation of impacts for treatment or disposal at a candidate site is based on waste that either exists at the site or is routed there from off site. In some alternatives, a candidate site does not receive waste or have waste on site for waste management. In these alternatives, the site is listed as a candidate with a "T" or "D," but there was no impact evaluation.[1]

[1]FEMP is shown as a candidate site for disposal in the Decentralized, Regionalized 1, and Regionalized 2 Alternatives; however, this disposal would be for onsite waste only, if FEMP is determined to have waste management LLW. At present, FEMP does not report waste management LLW (see Section 7.15 and Appendix B).

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, U.S. Nuclear Regulatory Commission (NRC), and U.S. Environmental Protection Agency (EPA) regulations and by the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

In Tables 7.3–1 through 7.3–14, the percentages represent the relative proportion of the waste managed at the respective regional treatment or disposal site that originates from offsite locations. The percentages are developed based on the shipped volumes of LLW. In the Decentralized Alternative, Regionalized Alternatives 1, 3, 6, and 7, and Centralized Alternatives 1 and 2, where all LLW undergoes only minimal treatment at the waste generating site, the percentages are derived from the generating site waste totals and include the small volume increases due to waste solidification or packaging prior to shipment. In the Regionalized Alternatives 2, 4, and 5 and Centralized Alternatives 3, 4, and 5, where volume reduction treatment is conducted on certain wastes, the percentages reflect a more complex set of waste shipping parameters. Under these alternatives, the volume of waste sent to regional treatment sites includes only the LLW streams that are amenable to volume reduction as described in Section 7.2.2. These volumes are then compared with the total volume of waste that is to be treated at the designated regional treatment site. The volume of waste sent from the treatment site to the regional disposal site is calculated based on the reduced waste volume after treatment. Waste from generating sites that is not amenable to volume reduction treatment undergoes only minimal treatment and is then sent directly to the regional disposal site. More detail on the breakdown of LLW by site and waste treatment category and shipment volumes is given in the report by Argonne National Laboratory (ANL, 1996).

7.3.1 No Action Alternative

The No Action Alternative provides a baseline for the analysis that approximates the current DOE program. Under the No Action Alternative, LLW would be treated using existing facilities and shipped to one of six authorized DOE disposal sites. Today, most offsite LLW disposal occurs at NTS and the Hanford Site. The six sites currently operating have sufficient unused designated disposal area onsite for the proposed LLW disposal operations, or the disposal area could be expanded as required. Figure 7.3–1 and Table 7.3–1 illustrate the No Action Alternative.

LLW No Action Alternative—(Disposal at 6 Sites)

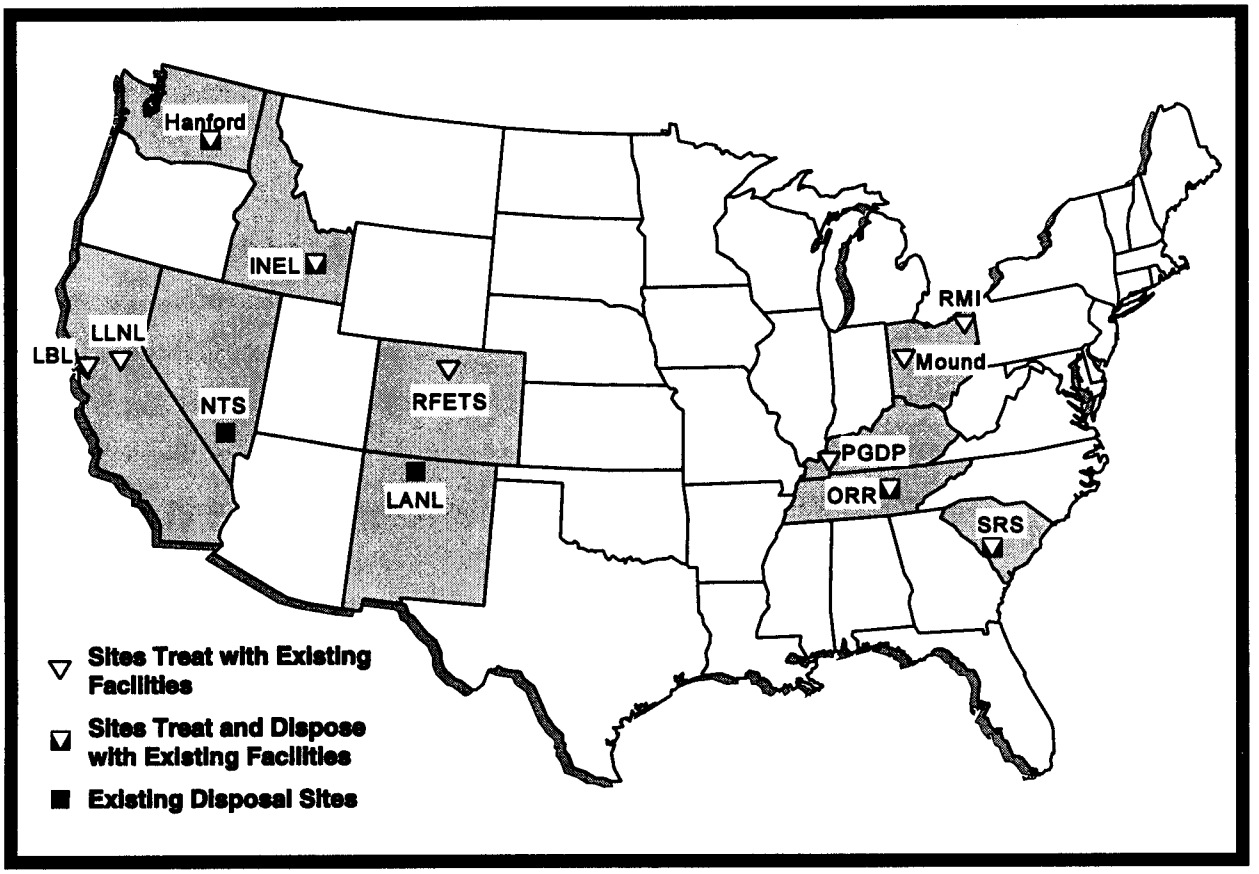


Figure 7.3–1. LLW No Action Alternative

	Generating Sites					
	ORR	Ames, Hanford, ANL-E, BNL, Fermi, LBL, KAPL, PGDP, PORTS, PPPL, SLAC, WVDP, Bettis	INEL	LANL	LLNL, NTS, FEMP, SNL-NM, Pantex, RFETS, RMI, KCP, Mound	Pinellas, SRS
Treat	ALL SITES MINIMUM TREAT AND SOME SITES VOLUME REDUCE USING EXISTING FACILITIES, AS APPLICABLE					
Dispose (% Rec'd From Offsite)	ORR (0)	Hanford (73)	INEL (0)	LANL (0)	NTS (97)	SRS (<1)

Note: Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–1. LLW No Action Alternative

7.3.2 DECENTRALIZED ALTERNATIVE

The Decentralized Alternative considers disposal at 16 DOE sites following minimum treatment at all 27 LLW sites. Figure 7.3–2 and Table 7.3–2 illustrate the Decentralized Alternative.

7.3.3 REGIONALIZED ALTERNATIVES

The Regionalized Alternatives consider minimum treatment at all sites; volume reduction treatment at 11, 7, and 4 sites; and disposal at 12, 6, and 2 sites. Regionalized Alternative 1 considers disposal at 12 sites after minimum treatment at all sites. Regionalized Alternative 2 analyzes the impacts resulting from disposal at the same 12 sites after volume reduction at 11 of these sites. In addition to the Decentralized Alternative, Regionalized Alternatives 1 and 2 are the only alternatives that propose disposal activities at FEMP, LLNL, the Pantex Plant, and Paducah.

The remainder of the LLW Regionalized Alternatives (Regionalized Alternatives 3 through 7) focus most LLW treatment and disposal activities at eight sites: the Hanford Site, INEL, LANL, NTS, ORR, Portsmouth, RFETS, and SRS. Although the sites are the same for most of the Regionalized Alternatives, impacts at the sites vary because of the use of different treatment technologies and incoming waste volumes. For example, Regionalized Alternatives 3 and 4 would dispose of waste at the same six sites. However, Regionalized Alternative 3 would conduct only minimum treatment before disposal, whereas Regionalized Alternative 4 would use volume reduction techniques on the waste that can be reduced, in addition to conducting minimum treatment prior to disposal. Because Portsmouth and RFETS become waste consolidation sites for volume reduction before disposal in Regionalized Alternative 4, they would have a greater potential to experience impacts than under the minimum treatment scenario in Regionalized Alternative 3, although both configurations use the same six sites for disposal. Regionalized Alternative 5 considers volume reduction at four sites and disposal at six, compared to volume reduction at seven sites under Regionalized Alternative 4. Regionalized Alternatives 6 and 7 each consider disposal at two sites after minimum treatment: the Hanford Site and SRS under Regionalized Alternative 6, and NTS and SRS under Regionalized Alternative 7.

Figures 7.3–3 through 7.3–9 and Tables 7.3–3 through 7.3–9 illustrate Regionalized Alternatives 1 through 7.

LLW Decentralized Alternative—(Disposal at 16 Sites)

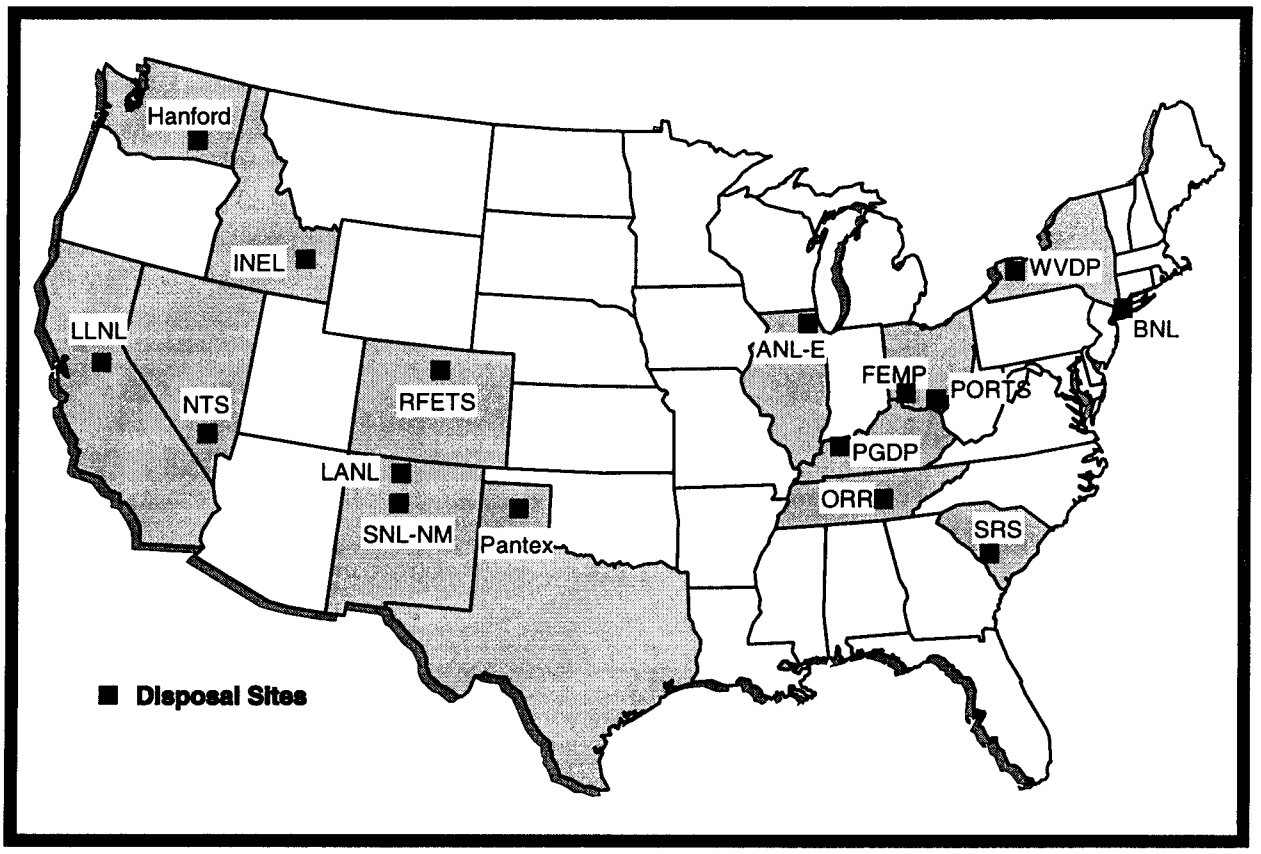


Figure 7.3-2. LLW Decentralized Alternative

	Generating Sites															
	Bettis KAPL PPPL Mound PORTS RMI	ANL-E Ames Fermi	WVDP	BNL	FEMP	Hanford	INEL	KCP PGDP	LANL	LBL LLNL SLAC	NTS	ORR	Pantex	Pinellas SRS	RFETS	SNL-NM[a]
Treat	MINIMUM TREAT AT ALL GENERATING SITES															
Dispose (% Rec'd From Offsite)	PORTS (55)	ANL-E (19)	WVDP (0)	BNL (0)	FEMP (0)	Hanford (0)	INEL (0)	PGDP (<1)	LANL (0)	LLNL (55)	NTS (0)	ORR (0)	Pantex (0)	SRS (<1)	RFETS (0)	SNL-NM (0)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

[a] Includes ITRI in all alternatives.

Table 7.3-2. LLW Decentralized Alternative

LLW Regionalized Alternative 1—(Disposal at 12 Sites)

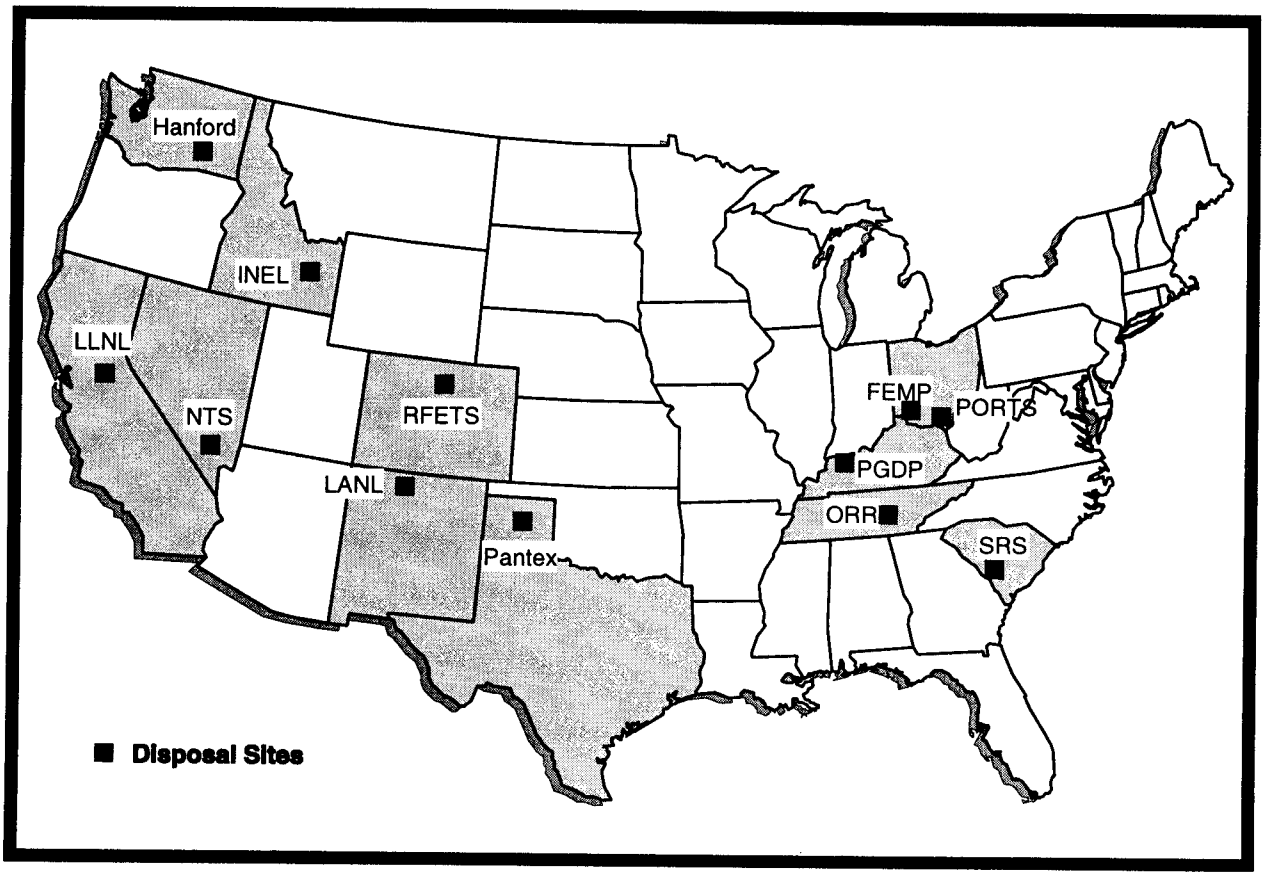


Figure 7.3–3. LLW Regionalized Alternative 1

	Generating Sites											
	Ames, ANL-E, Bettis, BNL, Fermi, KAPL, Mound, PORTS, PPPL, RMI, WVDP	FEMP	Hanford	INEL	KCP, PGDP	LANL, SNL-NM	LBL, LLNL, SLAC	NTS	ORR	Pantex	Pinellas, SRS	RFETS
Treat	MINIMUM TREAT AT ALL GENERATING SITES											
Dispose (% Rec'd From Offsite)	PORTS (61)	FEMP (0)	Hanford (0)	INEL (0)	PGDP (<1)	LANL (2)	LLNL (55)	NTS (0)	ORR (0)	Pantex (0)	SRS (<1)	RFETS (0)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–3. LLW Regionalized Alternative 1

LLW Regionalized Alternative 2—(Treatment at 11 Sites; Disposal at 12)

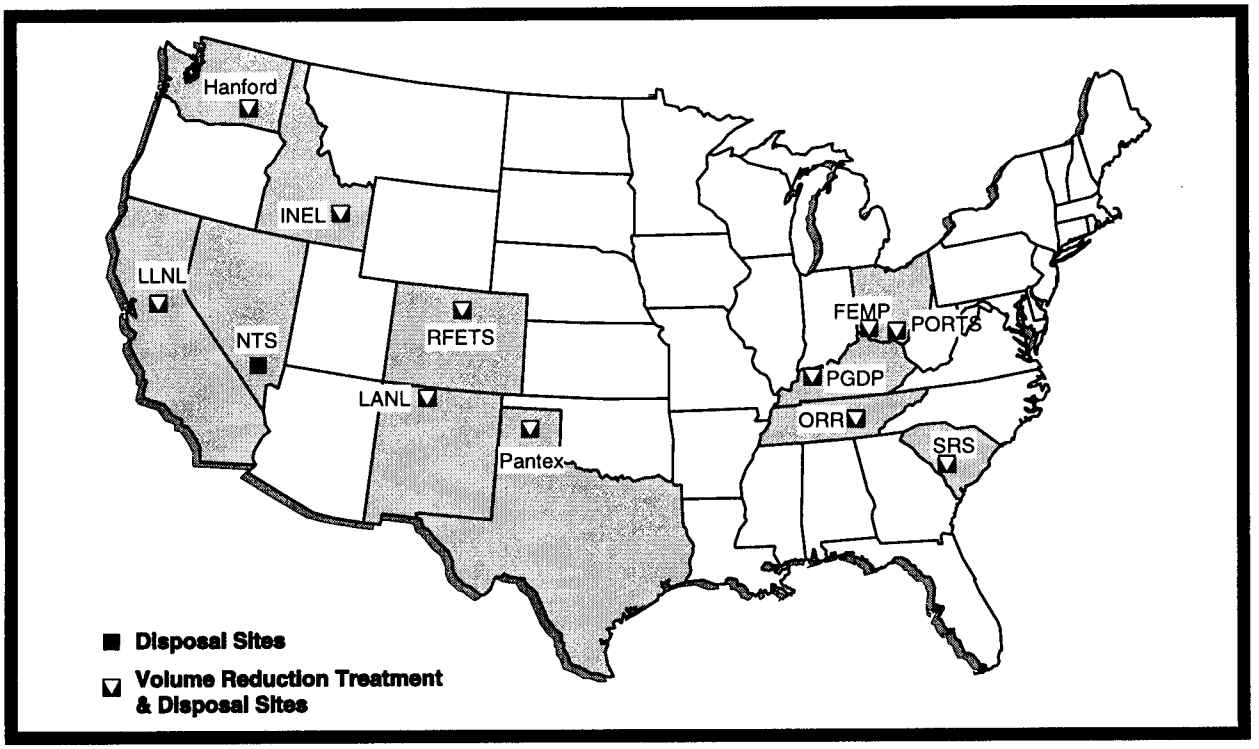


Figure 7.3–4. LLW Regionalized Alternative 2

	Generating Sites												
	Bettis, BNL, KAPL, PORTS, PPPL, RMI, WVDP	Ames, ANL-E, Fermi, Mound	FEMP	Hanford	INEL, NTS	KCP, PGDP	LBL, LLNL, SLAC	LANL, SNL-NM	NTS[a]	ORR	Pantex	Pinellas, SRS	RFETS
Treat (% Rec'd From Offsite)	PORTS (27)	FEMP (100)		Hanford (0)	INEL (0)	PGDP (<1)	LLNL (55)	LANL (2)		ORR (0)	Pantex (0)	SRS (<1)	RFETS (0)
Dispose (% Rec'd From Offsite)	PORTS (90)		FEMP[b] (ND)	Hanford (0)	INEL (0)	PGDP (<1)	LLNL (55)	LANL (2)	NTS (0)	ORR (0)	Pantex (0)	SRS (<1)	RFETS (0)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. All sites minimum treat those waste streams that cannot be volume reduced, and send that waste to disposal at the volume reduction site, if applicable, or to another disposal site. Percentage of waste a site would receive from offsite is indicated in parentheses.

[a] LLW requiring minimum treatment only.

[b] FEMP should be viewed as a candidate disposal site for this alternative; whether waste will be disposed of there is contingent on whether there is WM waste onsite. ND = not determined.

Table 7.3–4. LLW Regionalized Alternative 2

LLW Regionalized Alternative 3—(Disposal at 6 Sites)

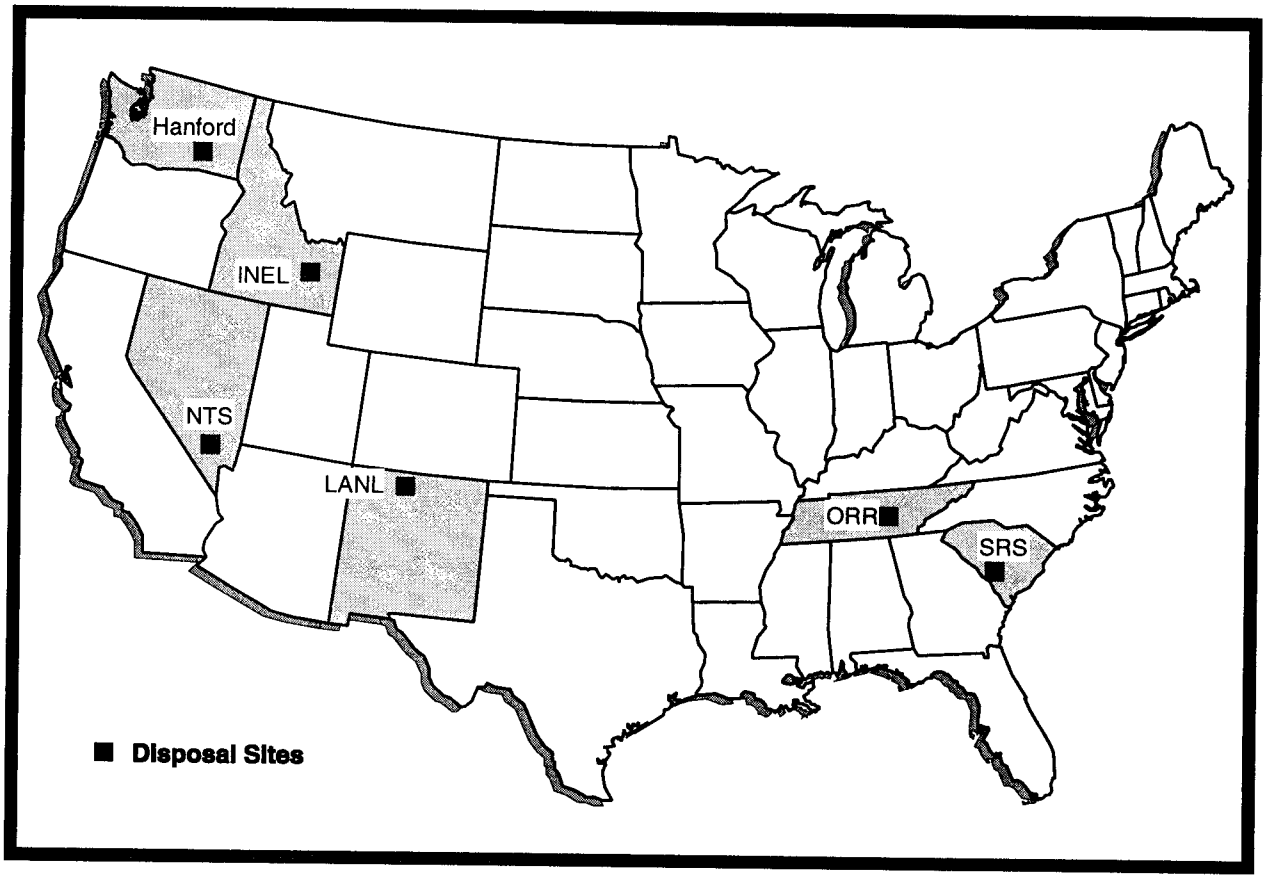


Figure 7.3–5. LLW Regionalized Alternative 3

	Generating Sites					
	Ames, ANL-E, Bettis, BNL, FEMP, Fermi, RMI, KAPL, PGDP, PORTS, PPPL, KCP, Mound, ORR, WVDP	Hanford	INEL	LANL, Pantex, RFETS, SNL-NM	LBL, LLNL, NTS, SLAC	Pinellas, SRS
Treat	MINIMUM TREAT AT ALL GENERATING SITES					
Dispose (% Rec'd From Offsite)	ORR (45)	Hanford (0)	INEL (0)	LANL (24)	NTS (80)	SRS (<1)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–5. LLW Regionalized Alternative 3

LLW Regionalized Alternative 4—(Treatment at 7 Sites; Disposal at 6)

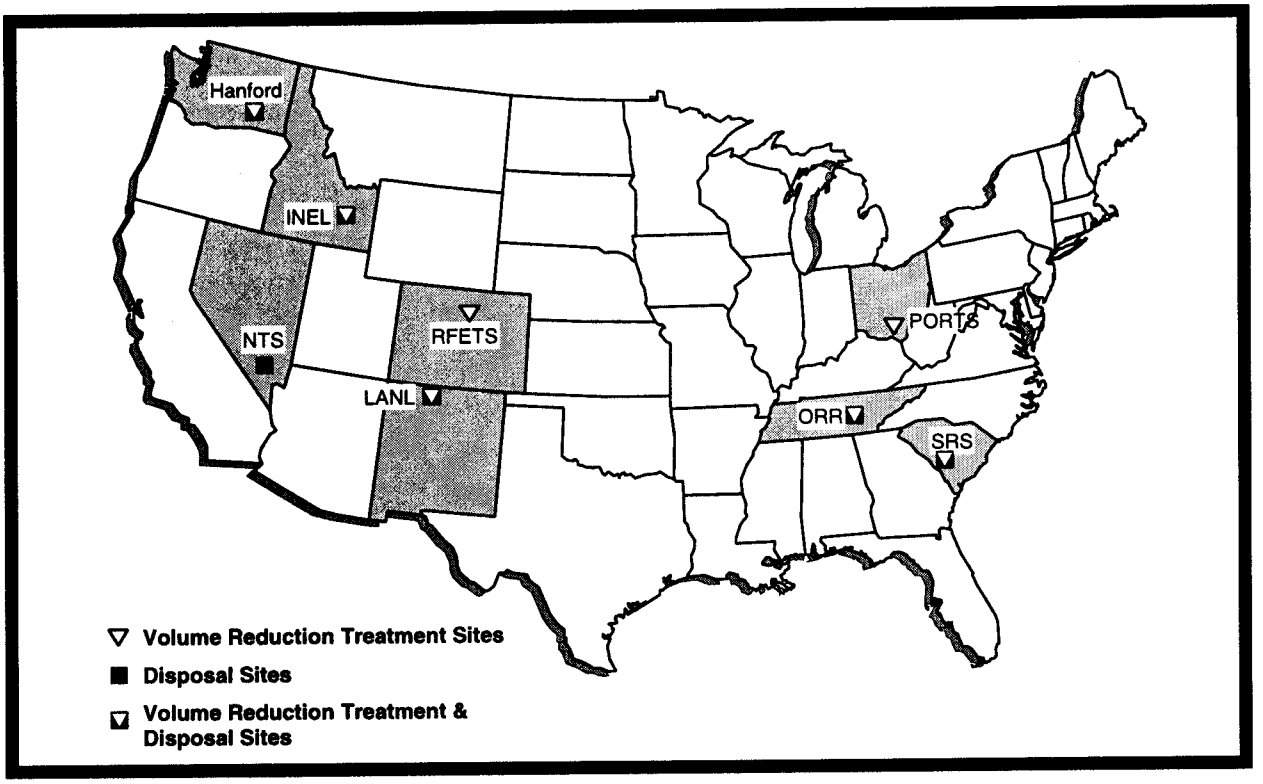


Figure 7.3–6. LLW Regionalized Alternative 4

	Generating Sites							
	Ames, ANL-E, Bettis, BNL, Fermi, FEMP, KAPL, KCP[a], Mound, PORTS, PPPL, RMI, WVDP	ORR, PGDP	Hanford, LBL, LLNL, SLAC	NTS[a], LLNL[a], LBL[a], SLAC[a]	INEL NTS	KCP, RFETS	LANL, Pantex, SNL-NM	Pinellas, SRS
Treat (% Rec'd From Offsite)	PORTS (30)	ORR (4)	Hanford (3)		INEL (1)	RFETS (<1)	LANL (<1)	SRS (<1)
Dispose (% Rec'd From Offsite)	ORR (60)		Hanford (12)	NTS (80)	INEL (1)	LANL (6)		SRS (<1)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. All sites minimum treat those waste streams that cannot be volume reduced, and send that waste to disposal at the volume reduction site, if applicable, or to another disposal site. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] LLW requiring minimum treatment only.

Table 7.3–6. LLW Regionalized Alternative 4

LLW Regionalized Alternative 5—(Treatment at 4 Sites; Disposal at 6)

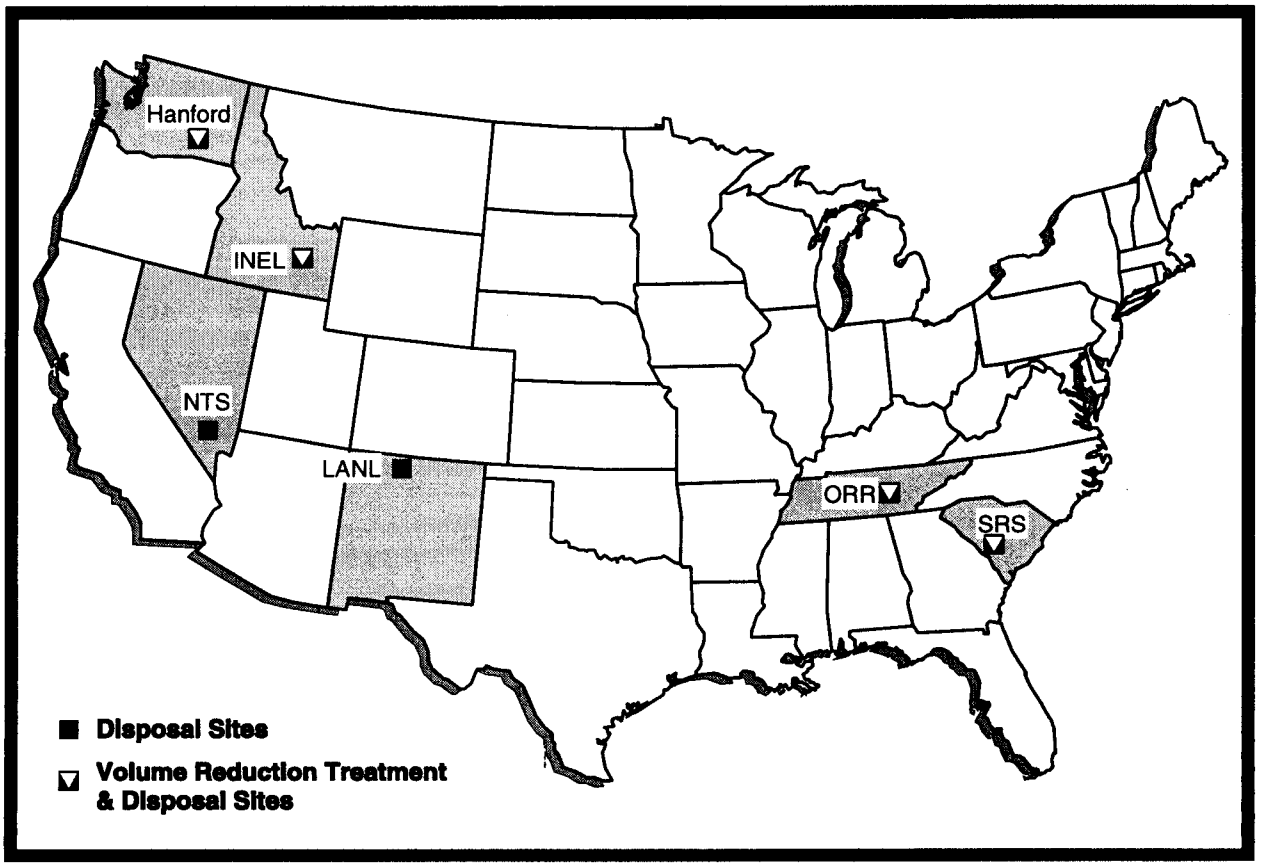


Figure 7.3–7. LLW Regionalized Alternative 5

	Generating Sites					
	Ames, ANL-E, Bettis, BNL, Fermi, FEMP, KCP, KAPL, Mound, ORR, PGDP, PORTS, PPPL, RMI, WVDP	Hanford, LBL, LLNL, SLAC	INEL, LANL, NTS, Pantex, RFETS, SNL-NM	Pinellas, SRS	LLNL[a], LBL[a], SLAC[a], NTS[a]	SNL-NM[a], LANL[a], Pantex[a], RFETS[a]
Treat (% Rec'd From Offsite)	ORR (36)	Hanford (3)	INEL (60)	SRS (<1)		
Dispose (% Rec'd From Offsite)	ORR (60)	Hanford (12)	INEL (80)	SRS (<1)	NTS (80)	LANL (24)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. All sites minimum treat those waste streams that cannot be volume reduced, and send that waste to disposal at the volume reduction site, if applicable, or to another disposal site. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] LLW requiring minimum treatment only.

Table 7.3–7. LLW Regionalized Alternative 5

LLW Regionalized Alternative 6—(Disposal at 2 Sites)

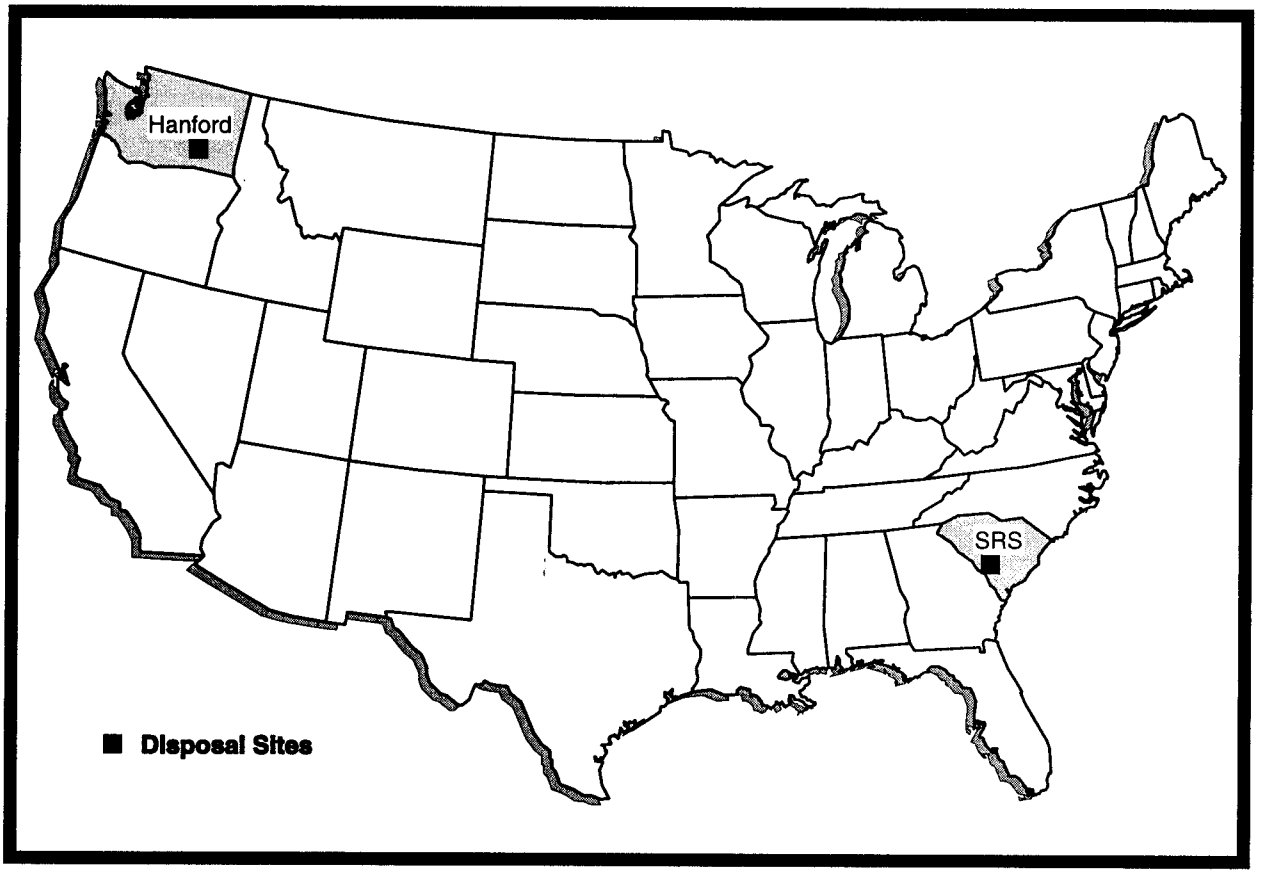


Figure 7.3–8. LLW Regionalized Alternative 6

	Generating Sites	
	Hanford, INEL, LANL, LBL, LLNL, NTS, Pantex, RFETS, SLAC, SNL-NM	Ames, ANL-E, Bettis, BNL, FEMP, Fermi, KAPL, KCP, Mound, ORR, PGDP, Pinellas, PORTS, PPPL, RMI, SRS, WVDP
Treat	MINIMUM TREAT AT ALL GENERATING SITES	
Dispose (% Rec'd From Offsite)	**Hanford** (75)	SRS (53)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–8. LLW Regionalized Alternative 6

LLW Regionalized Alternative 7—(Disposal at 2 Sites)

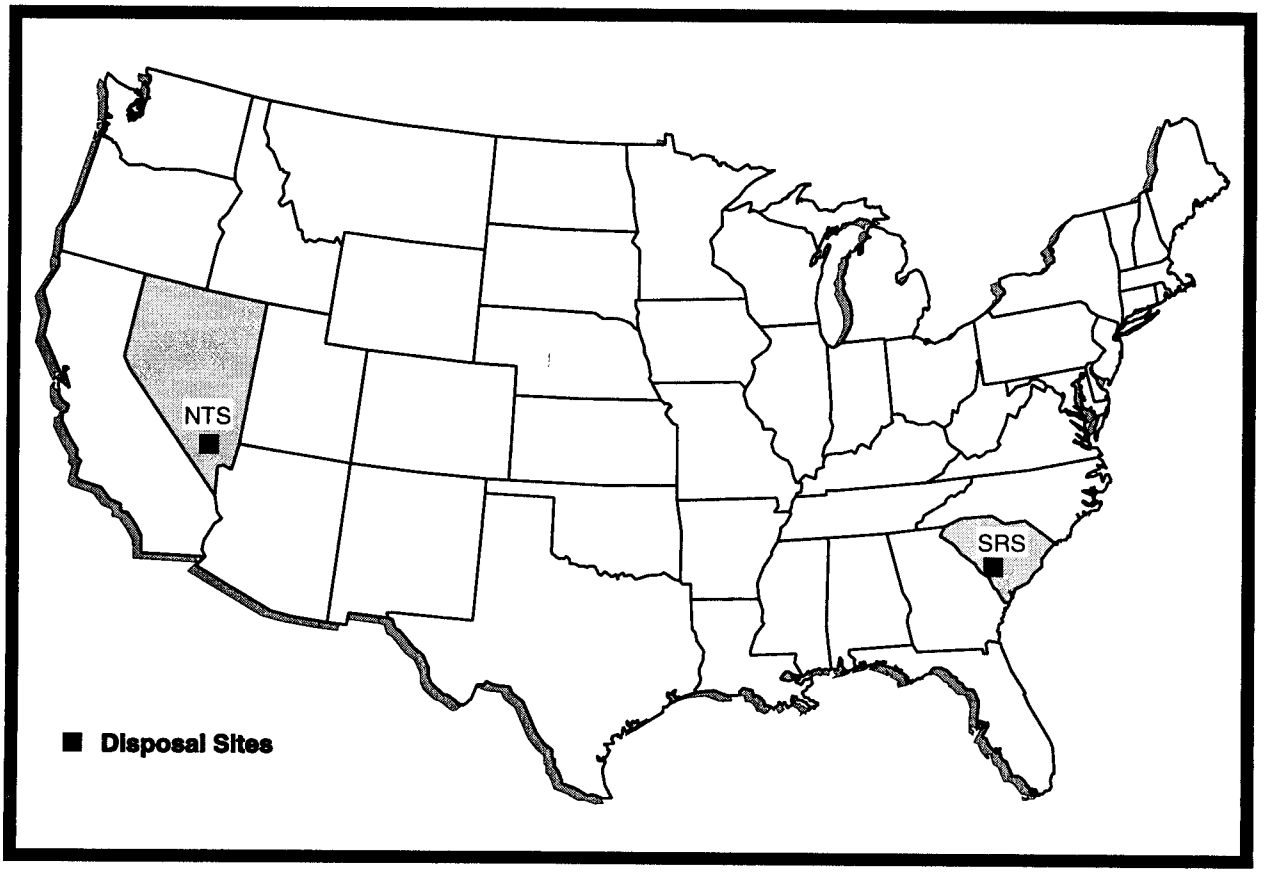


Figure 7.3-9. LLW Regionalized Alternative 7

	Generating Sites	
	Hanford, INEL, LANL, LBL, LLNL, NTS, Pantex, RFETS, SLAC, SNL-NM	Ames, ANL-E, Bettis, BNL, FEMP, Fermi, KAPL, KCP, Mound, ORR, PGDP, Pinellas, PORTS, PPPL, RMI, SRS, WVDP
Treat	MINIMUM TREAT AT ALL GENERATING SITES	
Dispose (% Rec'd From Offsite	NTS (99)	SRS (53)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3-9. LLW Regionalized Alternative 7

7.3.4 CENTRALIZED ALTERNATIVES

DOE analyzed disposal at one site under the Centralized Alternatives. Five alternatives were considered. Centralized Alternatives 1 and 2 would dispose of LLW at the Hanford Site and NTS, respectively, after minimum treatment at all DOE sites. Centralized Alternative 3 evaluates disposal at the Hanford Site after volume reduction treatment at seven sites. In Centralized Alternative 4, NTS would be the single disposal site after volume reduction at the same seven sites considered in Centralized Alternative 3. Centralized Alternative 5 considers both the consolidation of LLW for volume-reducible treatment and disposal at the Hanford Site. Figures 7.3-10 through 7.3-14 provide views of the geographic proximity of the DOE sites involved in the Centralized Alternatives, and Tables 7.3-10 through 7.3-14 describe the Centralized Alternatives 1 through 5.

7.3.5 RATIONALE FOR SELECTION OF SITES

DOE generally selected LLW sites as candidates for treatment and disposal facilities if the sites had large volumes of waste. In addition, the alternatives were formulated to consolidate LLW for treatment and disposal at locations which minimized offsite transportation by shipping to the closest available treatment or disposal site.

Because of the interrelationship between LLW and LLMW, DOE used the same treatment (volume reduction) and disposal locations for LLW as those identified for the LLMW alternatives in Chapter 6.

The number of disposal sites considered covers a reasonable range of sites—from 1 to 16, with intermediate numbers of 2, 6, and 12. Sixteen candidate sites were identified to be consistent with those under consideration for LLMW. Likewise, the actual sites used for each LLW alternative mirror those for comparable LLMW alternatives. As discussed in Chapter 6, Section 6.3.5, the LLMW alternatives were selected using criteria established by DOE in coordination with the States under the Federal Facility Compliance Act (FFCAct) (42 USC 6961 *et seq.*).

LLW Centralized Alternative 1—(Disposal at 1 Site)

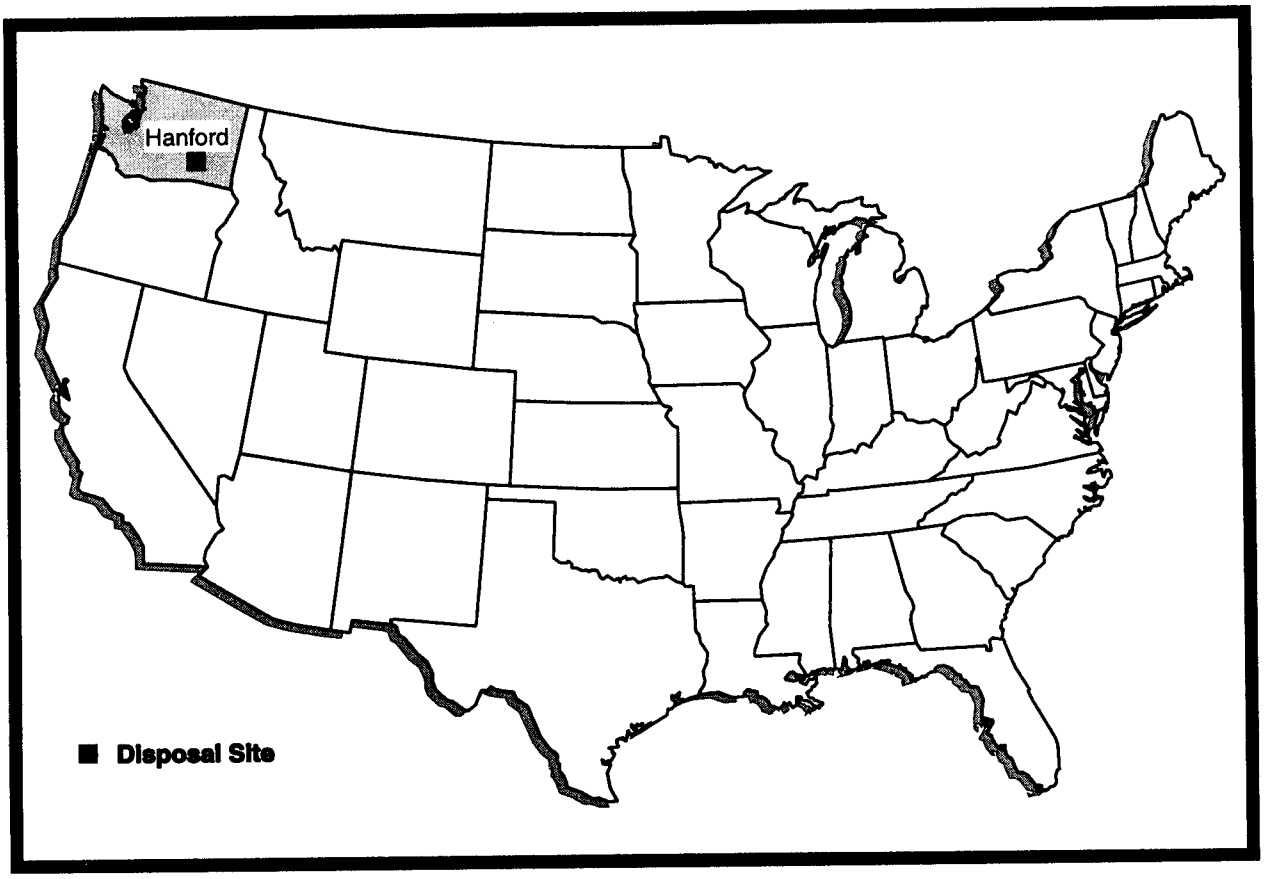


Figure 7.3–10. LLW Centralized Alternative 1

	Generating Sites All Sites
Treat	MINIMUM TREAT AT ALL GENERATING SITES
Dispose (% Rec'd From Offsite)	Hanford (94)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–10. LLW Centralized Alternative 1

LLW Centralized Alternative 2—(Disposal at 1 Site)

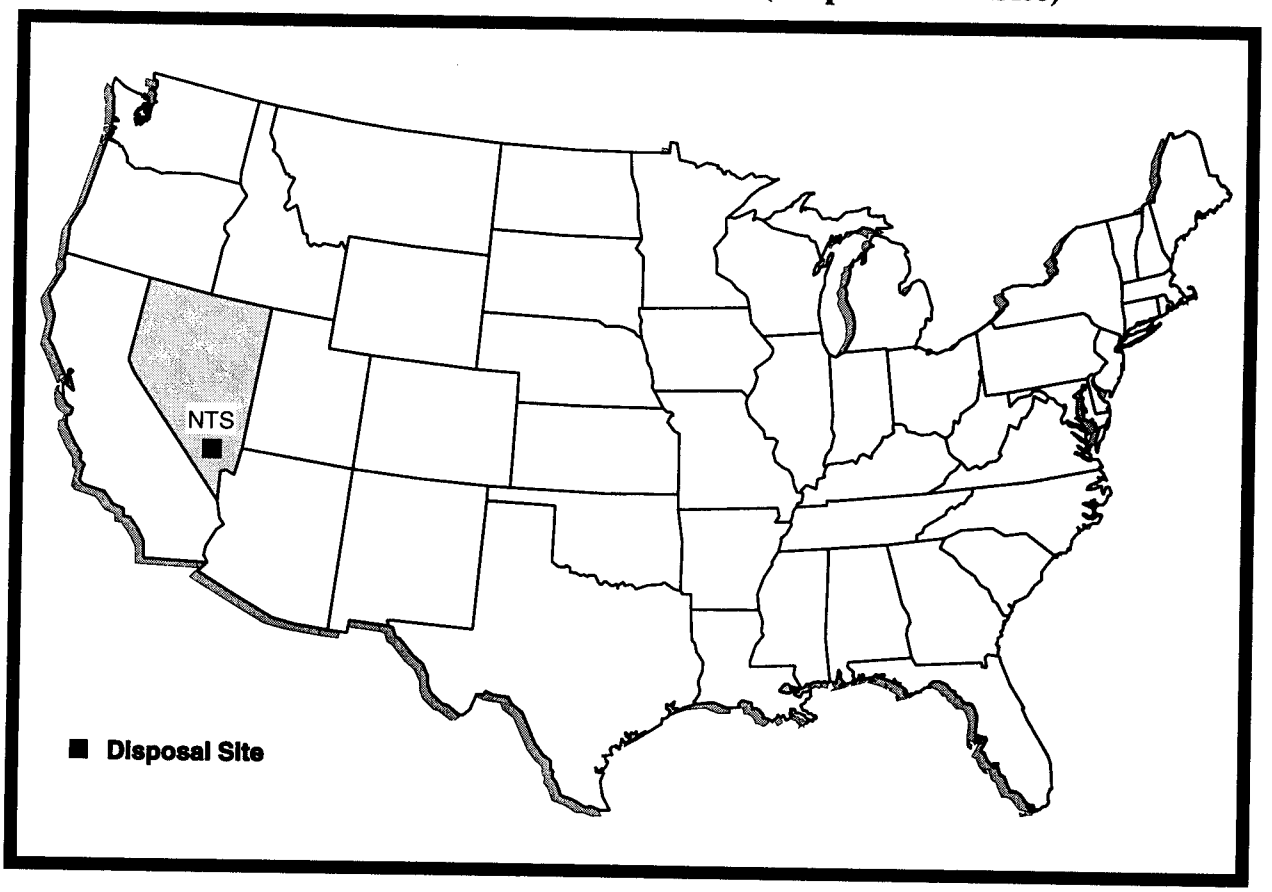


Figure 7.3–11. LLW Centralized Alternative 2

	Generating Sites All Sites
Treat	MINIMUM TREAT AT ALL GENERATING SITES
Dispose (% Rec'd From Offsite)	NTS (99)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–11. LLW Centralized Alternative 2

LLW Centralized Alternative 3—(Treatment at 7 Sites; Disposal at 1)

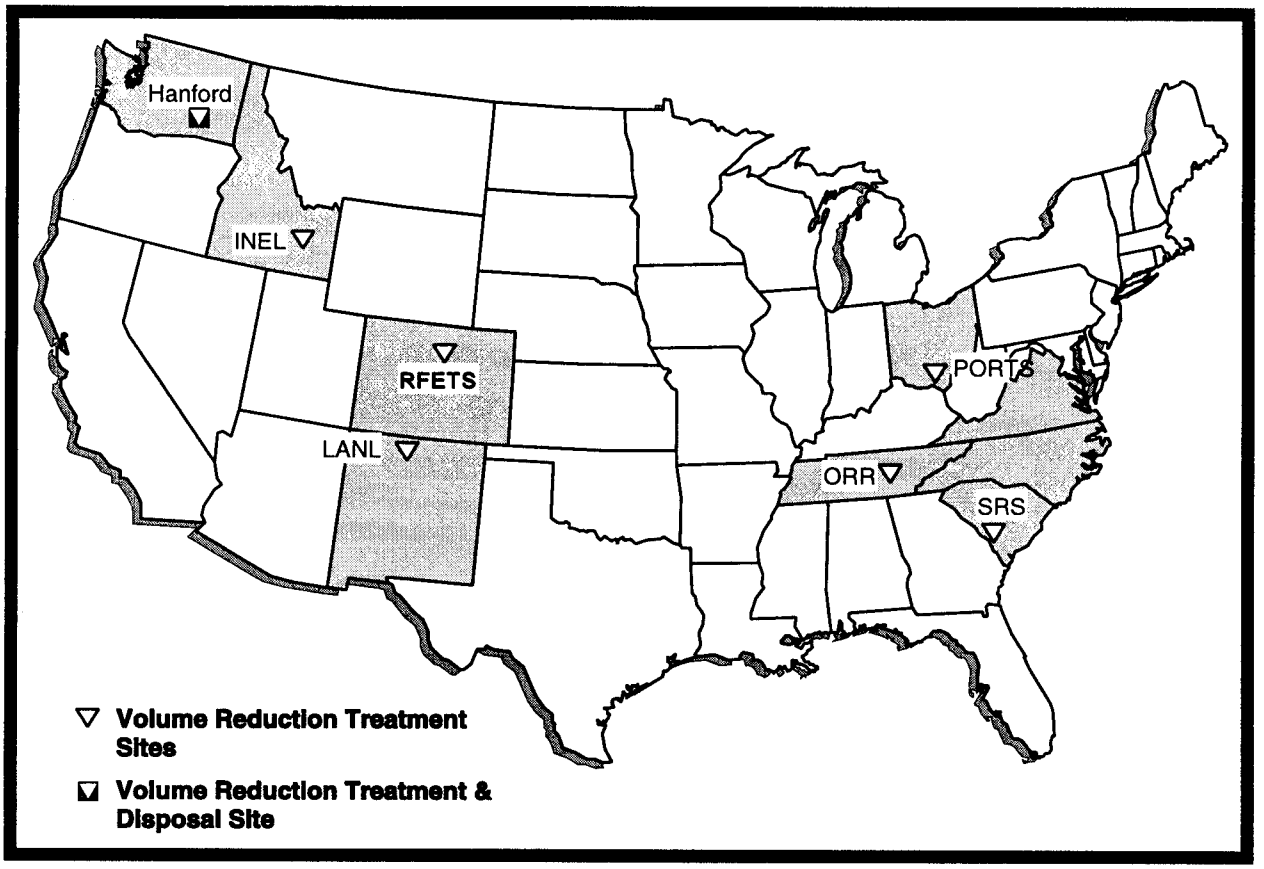


Figure 7.3–12. LLW Centralized Alternative 3

	Generating Sites						
	Ames, ANL-E, Bettis, BNL, Fermi, FEMP, KAPL, Mound, PORTS, PPPL, RMI, WVDP	Hanford, LBL, LLNL, SLAC	INEL NTS	KCP, RFETS	LANL, Pantex, SNL-NM	ORR, PGDP	Pinellas, SRS
Treat (% Rec'd From Offsite)	PORTS (30)	Hanford (3)	INEL (<1)	RFETS (<1)	LANL (<1)	ORR (4)	SRS (<1)
Dispose (% Rec'd From Offsite)	Hanford (97)						

Notes: All sites send minimum treatment wastes directly to the Hanford Site for disposal. Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–12. LLW Centralized Alternative 3

LLW Centralized Alternative 4—(Treatment at 7 Sites; Disposal at 1)

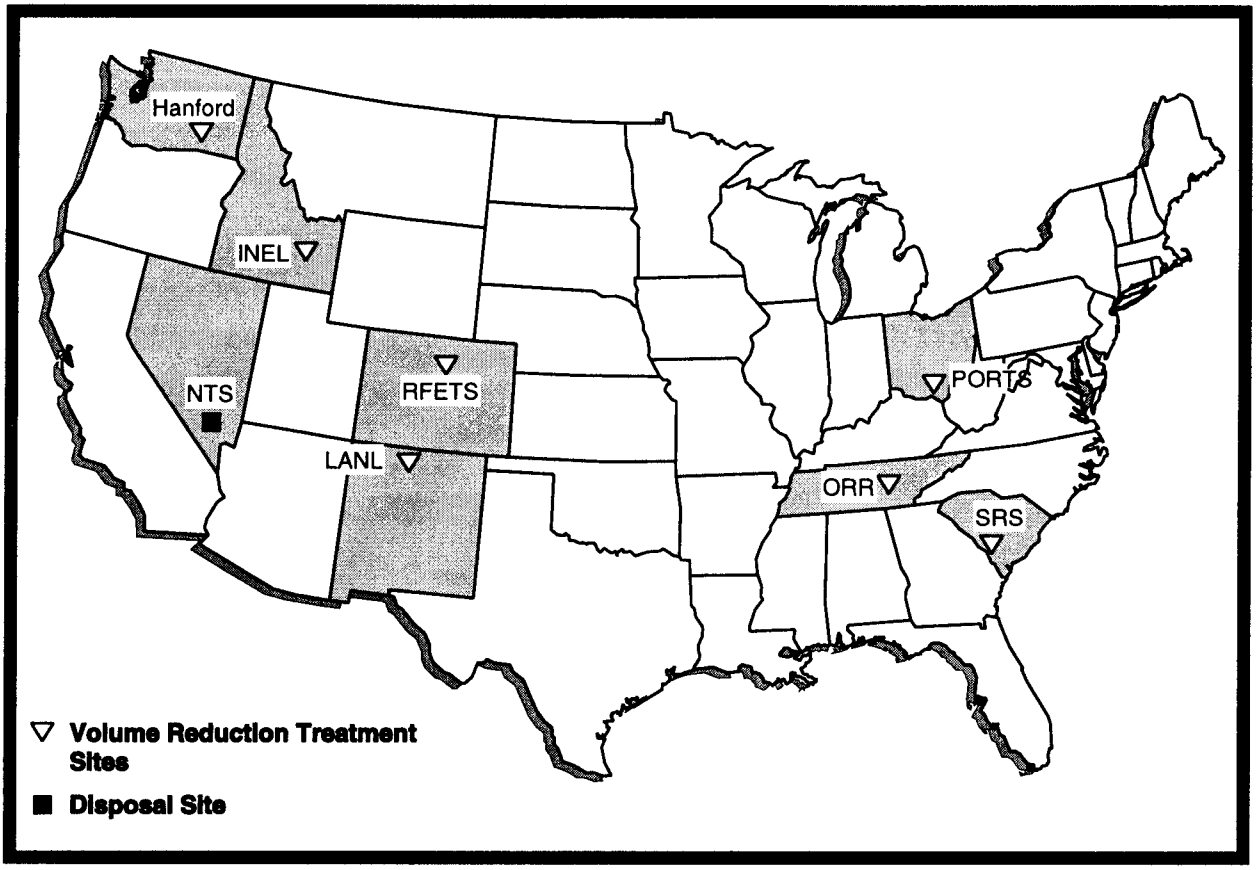


Figure 7.3–13. LLW Centralized Alternative 4

	Generating Sites						
	Ames, ANL-E, Bettis, BNL, Fermi, FEMP, KAPL, Mound, PORTS, PPPL, RMI, WVDP	Hanford, LBL, LLNL, SLAC	INEL, NTS	KCP, RFETS	LANL, Pantex, SNL-NM	ORR, PGDP	Pinellas, SRS
Treat (% Rec'd From Offsite)	**PORTS (30)**	**Hanford (3)**	**INEL (<1)**	**RFETS (<1)**	**LANL (<1)**	**ORR (4)**	**SRS (<1)**
Dispose (% Rec'd From Offsite)	**NTS (99)**						

Notes: All sites send minimum treatment wastes directly to NTS for disposal. Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–13. LLW Centralized Alternative 4

LLW Centralized Alternative 5—(Treatment and Disposal at 1 Site)

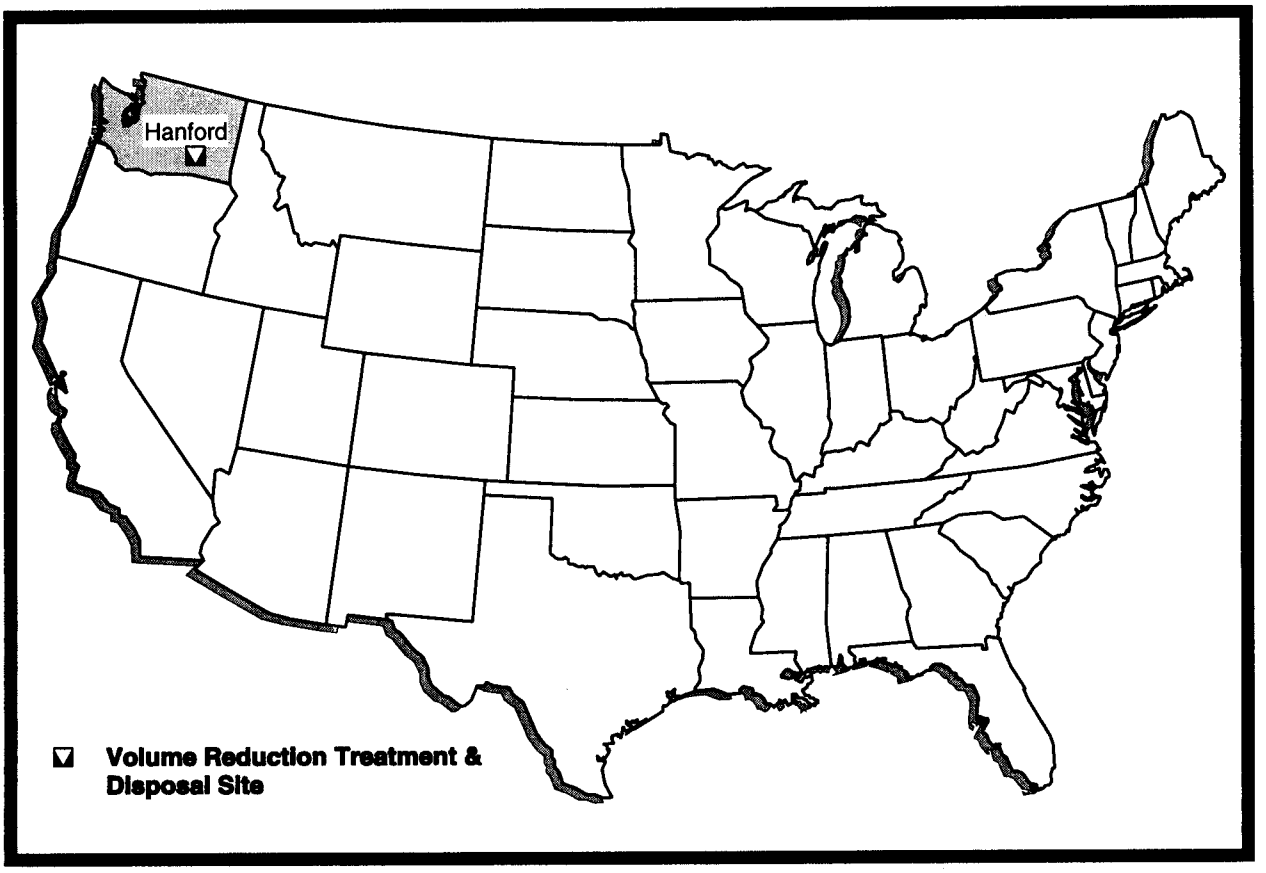


Figure 7.3–14. LLW Centralized Alternative 5

	Generating Sites All Sites
Treat (% Rec'd From Offsite)	Hanford (95)
Dispose (% Rec'd From Offsite)	Hanford (94)

Notes: All sites send minimum treatment waste to the Hanford Site for disposal. Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–14. LLW Centralized Alternative 5

7.4 Health Risks

The greatest fatality risk is to waste management workers, primarily for physical hazards. The number of worker fatalities would decrease as the volume of LLW decreases through volume reduction. Radiation exposure risks to noninvolved worker and offsite populations are a function of the treatment technology and the DOE site. The highest risks to offsite populations would occur at FEMP, Hanford, LLNL, ORR, and Portsmouth as a result of volume reduction of tritium-contaminated waste at these sites. Concentrations of radionuclides in the groundwater near disposal facilities exceed applicable standards at several sites, demonstrating the need for performance based waste acceptance criteria. Management of radionuclide concentrations and waste forms would be required to assure acceptable water quality and human health risks. Transportation risks from both traffic accidents and radiation exposure would be greatest under the Centralized Alternatives, which involves the largest number of vehicle miles traveled.

Health risk impacts can result from exposure to radiation and from physical trauma associated with constructing and operating treatment and disposal facilities or transporting waste. Health effects resulting from radiation exposure, whether from sources external or internal to the body, can affect either the exposed individual's body (known as a "somatic" effect; e.g., cancer) or descendants of the exposed individual (known as a "genetic" effect). This section discusses the estimated adverse health impacts resulting from radiation exposures as well as from physical hazards for each LLW treatment and disposal alternative. Details of the LLW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5, Appendix D, and in ORNL technical reports (ORNL, 1995a-c).

The following sections present the impacts for the LLW Alternatives:

7.4 Health Risks
7.5 Air Quality Impacts
7.6 Water Resources Impacts
7.7 Ecological Resources Impacts
7.8 Economic Impacts
7.9 Population Impacts
7.10 Environmental Justice Concerns
7.11 Land Use Impacts
7.12 Infrastructure Impacts
7.13 Cultural Resources Impacts
7.14 Costs
7.15 Environmental Restoration Analysis
7.16 Comparison of Alternatives Summary

Potential health risks to a number of receptor populations and individuals are presented including:

- The offsite population—those individuals living within a 50-mile radius of the site, as well as along transportation routes
- Noninvolved worker population—the workers on DOE sites who are not involved directly in waste management activities

- Waste management worker population (or "waste management workers")—onsite employees working in a site's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste
- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose
- Farm family most exposed lifetime MEI—hypothetical individual in the most exposed lifetime of the farm family who would receive the highest dose from disposal of LLW
- A hypothetical intruder—an individual who would experience maximum potential future risks from disposal of LLW upon the loss of institutional control

Maximally Exposed Individual

In keeping with the standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of operations analyzed in the WM PEIS.

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer fatalities from radiation exposure
- Cancer incidences from radiation exposure
- Genetic effects from radiation exposure

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for a further discussion of these issues.

7.4.1 ROUTINE OPERATION IMPACTS

7.4.1.1 Treatment

For operations involving LLW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in LLW treatment ("noninvolved workers"), and waste management workers directly involved in treatment activities. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented. Table 7.4–1 provides estimates of the sizes of the offsite and waste treatment worker populations by site. The waste management worker numbers are derived from generic baselines which established the number of personnel required to operate treatment facilities to manage a given amount of waste.

Individual impacts focus on the *probability* that the MEI within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk is presented as a probability (e.g., one-in-one million or 1E–06) of that individual experiencing an adverse health impact, rather than a total number of impacts for a selected population.

DOE analyzed effects of LLW radionuclides on the receptor groups. The pathways of exposure analyzed were inhalation, ingestion of plants and animals, direct gamma radiation, and absorption of tritium through the skin.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment and disposal facilities, and a subsequent 10-year period of operation. However, worker and public risks from exposure to radionuclides (received during the 10-year operation period) were evaluated for an entire lifetime (70 years) because health impacts from airborne contaminants or direct radiation could occur throughout the lifetime of the exposed individual.

Understanding Scientific Notation

Scientific notation is used in this PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10	***Negative Powers of 10***
$10^{1} = 10 \times 1 = 10$	$10^{-1} = 1/10 = 0.1$
$10^{2} = 10 \times 10 = 100$	$10^{-2} = 1/100 = 0.01$
and so on, therefore,	*and so on, therefore,*
$10^{6} = 1{,}000{,}000$ *(or 1 million)*	$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.	*etc.*

A power of 10 is also commonly expressed as "E", where "E" means "× 10". For example, 3×10^{5} can also be written as 3E+05, and 3×10^{-5} is equivalent to 3E-05. Therefore, 3E+05 = 300,000 and 3E-05 = 0.00003.

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3E-06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., fatal cancer) will occur in the period covered by the analysis.

Table 7.4–2 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for LLW treatment.

7.4.1.2 Disposal

Health risks resulting from LLW disposal were evaluated for waste management workers handling the treated LLW, for an onsite "hypothetical farm family" located 300 meters from the center of the disposal facility, and for a hypothetical "intruder" into the disposal facility after the facility has been closed.

The waste management workers were assumed to be exposed through direct radiation during disposal operations. Risks to the waste management workers (resulting from the 10-year operation/exposure period) were estimated for one lifetime (70 years).

Table 7.4-1. Offsite Population and Waste Management Treatment Worker Populations by Site

Site	Offsite Population[a]	WM Treatment Worker Population by Alternative[b]													
		NA	D	R1	R2	R3	R4	R5	R6	R7	C1	C2	C3	C4	C5
ANL-E	7,939,785	402	224	224	224	224	224	224	224	224	224	224	224	224	224
BNL	5,738,554	695	273	417	417	417	417	417	417	417	417	417	417	197	417
FEMP	2,764,589	--	--	--	461	--	--	--	--	--	--	--	--	--	--
Hanford	377,645	997	577	577	1,569	577	1,634	1,634	577	843	577	843	1,634	1,634	9,856
INEL	153,061	2,169	677	677	1,809	677	1,809	3,954	1,032	1,032	1,032	1,032	1,809	1,809	677
LANL	159,152	920	653	653	1,362	653	2,731	902	902	902	902	902	2,731	2,731	902
LLNL	6,324,234	426	191	191	483	227	227	227	227	227	227	227	227	227	227
NTS	14,266	78	64	64	108	64	108	108	108	64	108	64	108	108	108
ORR	881,652	2,895	1,892	1,892	5,198	1,811	5,117	5,819	2,259	2,259	2,259	2,259	5,246	5,246	2,259
PGDP	500,502	654	501	501	800	503	497	497	503	503	503	503	497	497	497
Pantex	265,185	333	214	214	216	214	214	214	214	214	214	214	214	214	214
PORTS	639,602	1,450	730	730	3,434	1,075	3,483	1,087	1,075	1,075	1,075	1,075	3,481	3,481	1,087
RFETS	2,171,877	656	298	298	800	344	800	344	344	344	344	344	800	800	344
SNL-NM	610,714	277	187	210	210	210	210	210	210	210	210	210	232	232	210
SRS	620,618	3,032	1,986	1,986	2,598	1,986	2,598	2,598	1,986	1,986	2,008	2,008	2,598	2,598	1,986
WVDP	1,698,391	539	433	464	463	464	463	463	464	464	464	464	463	463	463

Notes: NA = No Action; D = Decentralized; R1-R7 = Regionalized; C1-C5 = Centralized. -- = no waste treatment at this site under this alternative.
[a] Within 50-mile radius of sites.
[b] Waste management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation period.

For the farm family and intruder analyses, DOE assumed that waste was disposed of in either aboveground or belowground disposal units, depending on the site, each with a capacity of 18,000 and 12,000 cubic meters, respectively. Additional units were added as needed to dispose all of the waste on a site. Each disposal unit was assumed to affect a separate farm family and a separate intruder. Thus, the effects on the farm family (and on the intruder) were assumed to come from a single disposal unit, rather than from a combination of all the units at a site.

The exposure pathways for the hypothetical farm family were ingestion of groundwater and ingestion of plants and animals contaminated by irrigation water. The groundwater was assumed to be contaminated by a breach in each disposal unit immediately after shallow land burial, 300 years after disposal in aboveground vaults, or 750 years after disposal in belowground vaults. The contaminants are assumed to leach over time from their solidified waste form to create a plume of contamination. Individual contaminant plumes were then assumed to migrate to the receptor wells without mixing with each other. The risks to

Table 7.4-2. LLW Treatment Health Risk Analysis Components

LLW Treatment					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of Physical Hazard Fatalities	WM Workers	Physical Hazards	Physical Hazards	20 years	7.4-4
Number of Cancer Fatalities	Offsite Population	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-4
	Noninvolved Workers		Inhalation, Direct Radiation		
	WM Workers		Inhalation, Direct Radiation		
Number of Cancer Incidences	Offsite Population	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-5
	Noninvolved Workers		Inhalation, Direct Radiation		
	WM Workers		Inhalation, Direct Radiation		
Number of Genetic Effects	Offsite Population	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-5
	Noninvolved Workers		Inhalation, Direct Radiation		
	WM Workers		Inhalation, Direct Radiation		
Probability of Cancer Fatality	Offsite MEI	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-6 7.4-7
	Noninvolved Worker MEI		Inhalation, Direct Radiation		7.4-6
Probability of Cancer Incidence	Offsite MEI	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-8
	Noninvolved Worker MEI		Inhalation, Direct Radiation		
Probability of Genetic Effects	Offsite MEI	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-8
	Noninvolved Worker MEI		Inhalation, Direct Radiation		

the hypothetical farm family were estimated over a 10,000-year period because the maximum exposure would occur in the future when the peak of contaminant concentration passes the well. The 10,000-year period was selected for the analysis to maintain consistency with the "Guidelines for Radiological Performance Assessment: DOE Low-Level Radioactive Waste Disposal Sites" that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A. Results of the farm family

analyses are presented as the probability of cancer fatality for an individual during the 70-year lifetime that presents the greatest exposure of the 143 lifetimes (i.e., 10,000 years) analyzed.

The exposure pathways for the hypothetical intruder were inhalation of resuspended contaminated soil, inadvertent ingestion of contaminated soil, ingestion of plants grown in contaminated soil, direct radiation from contaminated soil, and absorption of tritium through the skin. A hypothetical intruder who drills into the disposal unit was assumed to be exposed to radioactively contaminated wastes that remain at the site. Two hypothetical intrusions were assumed to occur: 100 years and 300 years after closure of the disposal unit. The risks to the hypothetical intruder were estimated for one lifetime (70 years).

Hypothetical Farm Family and Intruder

The "hypothetical farm family" is an imaginary family assumed to live 300 meters downgradient of the center of a waste disposal unit. The family engages in farming activities such as growing and consuming their own crops and livestock, and uses groundwater for watering the crops and animals. This is an estimated maximum scenario taking place in the future at a time when institutional controls no longer exist. The scenario is analyzed to determine potential upper-bound exposures by ingestion of contaminated groundwater.

The hypothetical "intruder" is an imaginary adult who drills a well directly through a LLW disposal unit to the groundwater. As a result of the drilling, radioactively contaminated soil from within the unit is brought to the surface, where it mixes with the top layers of the surface soil. The individual farms the land and eats the crops. The intruder scenario occurs after the failure of institutional control. This is consistent with the analysis required for disposal facilities under DOE Order 5820.2A (DOE, 1988).

Table 7.4–3 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for LLW disposal.

The health risk impacts associated with the routine operation of LLW treatment and disposal facilities are presented in Tables 7.4–4 through 7.4–13 of this section. The tables show the estimates of human health risk for both treatment and disposal of LLW. Summary tables show programwide results by alternative. The site tables in Volume II present the health impacts for the 16 major LLW sites.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases. Note that both the *total cancer incidence* and the *nonfatal cancer incidence* values are overestimated by a factor of about two because the estimates contain a relatively large component

Table 7.4–3. LLW Disposal Health Risk Analysis Components

LLW Disposal					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of Physical Hazard Fatalities	WM Workers	Physical Hazards	Physical Hazards	20 years	7.4–4
Number of Cancer Fatalities	WM Workers	Radionuclides	Direct Radiation	10 years	7.4–4
Number of Cancer Incidences	WM Workers	Radionuclides	Direct Radiation	10 years	7.4–5
Number of Genetic Effects	WM Workers	Radionuclides	Direct Radiation	10 years	7.4–5
Probability of Cancer Fatality	Hypothetical Farm Family Most Exposed Lifetime MEI	Radionuclides	Ingestion	70 years	7.4–9
	Hypothetical Intruder		Inhalation, Ingestion, and Direct Radiation		7.4–12 7.4–13
Probability of Cancer Incidence	Hypothetical Intruder	Radionuclides	Inhalation, Ingestion, Direct Radiation	70 years	7.4–12
Probability of Genetic Effects	Hypothetical Intruder	Radionuclides	Inhalation, Ingestion, Direct Radiation	70 years	7.4–12

of skin cancers. The internal exposure pathways evaluated in this PEIS (e.g., inhalation or ingestion of radionuclides) are not likely to induce large numbers of skin cancer cases. However, the International Commission on Radiological Protection (ICRP) dose conversion factor used in the WM PEIS to estimate total cancer incidence includes incidences of skin cancer (ICRP, 1990).

7.4.1.3 Estimated Number of Fatalities

7.4.1.3.1 Programwide

Table 7.4–4 presents an overview, by alternative, of the total estimated programwide fatalities associated with both treatment and disposal of LLW. This table presents the estimated number of latent cancer fatalities

Table 7.4–4. LLW Treatment and Disposal: Estimated Number of Fatalities Programwide

Alternative	Number of Sites		Treatment				Disposal	
			WM Workers				WM Workers	
	T[a]	D	Number of Radiation Cancer Fatalities	Number of Physical Hazard Fatalities	Number of Offsite Population Radiation Cancer Fatalities	Number of Noninvolved Worker Radiation Cancer Fatalities	Number of Radiation Cancer Fatalities	Number of Physical Hazard Fatalities
No Action	10[b]	6	1	3	*	*	3	4
Decentralized		16	1	2	*	*	2	6
Regionalized 1		12	1	2	*	*	3	6
Regionalized 2	11	12	1	4	1	*	2	4
Regionalized 3		6	1	2	*	*	3	5
Regionalized 4	7	6	2	4	*	*	2	4
Regionalized 5	4	6	2	4	*	*	2	4
Regionalized 6		2	1	2	*	*	2	6
Regionalized 7		2	1	2	*	*	1	6
Centralized 1		1	1	2	*	*	3	1
Centralized 2		1	1	2	*	*	2	1
Centralized 3	7	1	1	4	*	*	2	1
Centralized 4	7	1	1	4	*	*	2	*
Centralized 5	1	1	2	4	*	*	2	1

Notes: T = treatment; D = disposal. * = greater than 0 but less than 0.5.

[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction.

in the offsite population, noninvolved workers, and waste management workers caused by radiological exposure. In addition, the table shows the estimated number of waste management worker deaths resulting from physical hazards during facility construction and operation.

For each alternative, there are at least three estimated fatalities associated with treatment operations. These fatalities occur primarily within the waste management worker population, and result mainly from physical hazards involved in construction and operation of LLW treatment facilities. Waste management workers are the only receptor group exposed to these physical hazards, and therefore, have more estimated fatalities than other receptor groups. A single fatality in the offsite population is estimated under Regionalized Alternative 2; no fatalities are estimated in the noninvolved worker population under any treatment alternative. In general, alternatives involving volume reduction present greater treatment risks to workers than alternatives involving only minimum treatment.

Disposal operations show at least six estimated fatalities to waste management workers in all alternatives, except where disposal is consolidated at one site. Waste management worker disposal radiation cancer fatalities are generally greater than those estimated for treatment. Under the single disposal site alternatives, the number of physical hazard fatalities decreases, whereas cancer fatalities from radiation exposure are similar to those estimated for the other disposal alternatives.

For all alternatives, the estimated number of fatalities to waste management workers due to physical hazards exceeds estimated radiological fatalities to the offsite and noninvolved worker populations. In general, risk to waste management workers appears to decrease with increased centralization of disposal activities. Fewer fatalities from physical hazards occur because fewer facilities and worker hours are required when waste management activities are consolidated at one or a few sites.

7.4.1.3.2 Site-Level

At least one fatality resulting from physical hazards or radiation exposure associated with implementing the LLW alternatives is estimated to occur at seven sites: the Hanford Site, NTS, INEL, LANL, ORR, PORTS, and SRS. All of these fatalities are estimated to occur within the waste management worker population, primarily as a result of physical hazards during treatment or disposal activities. Although fewer in number, fatalities due to radiation exposure of waste management workers during treatment and disposal are estimated to occur at the Hanford Site and NTS.

Each of the LLW alternatives results in at least one site with one or more estimated fatalities. Under Regionalized Alternatives 2, 4, 5, 6 and 7 and Centralized Alternatives 3 and 4, at least two of the above sites have estimated waste management worker fatalities exceeding one.

7.4.1.4 Estimated Number of Cancer Incidences and Genetic Effects

7.4.1.4.1 Programwide

Table 7.4–5 presents an overview, by alternative, of the total number of programwide cancers and genetic effects associated with treatment and disposal of LLW. These impacts result from radiation exposure of the offsite population (treatment-related only), noninvolved workers (treatment-related only), and waste management workers (treatment and disposal). In addition, the table includes radiation dose estimates for each receptor group.

Each of the treatment alternatives results in at least three cancer incidences in the waste management workers. Cancer incidence in the other receptor groups is limited to an estimated two cancers in the offsite population under Regionalized Alternative 2 and one cancer incidence under Regionalized Alternative 5. The number of genetic effects was not estimated to equal or exceed one in any receptor group.

At least six radiation-induced cancers among the waste management workers were estimated under each of the disposal alternatives. The volume reduction alternatives (Regionalized 2, 4, and 5 and Centralized 3, 4, and 5) generally had lower estimated numbers of cancers.

7.4.1.4.2 Site-Level

At least one latent cancer incidence resulting from radiation exposure associated with implementation of the LLW alternatives is estimated to occur at seven sites: the Hanford Site, INEL, LANL, LLNL, NTS, ORR, and SRS.

Table 7.4–5. LLW Treatment and Disposal: Estimated Number of Cancer Incidences and Genetic Effects Programwide

Alternative	Number of Sites		Treatment									Disposal		
			Offsite Population			Noninvolved Workers			WM Workers			WM Workers		
	T[a]	D	Radiation Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10[b]	6	5	*	*	*	*	*	2,900	4	*	8,000	11	*
Decentralized		16	58	*	*	*	*	*	1,900	3	*	5,600	8	*
Regionalized 1		12	58	*	*	*	*	*	2,000	3	*	6,100	9	*
Regionalized 2	11	12	1,300	2	*	13	*	*	3,200	5	*	4,900	7	*
Regionalized 3		6	58	*	*	*	*	*	2,000	3	*	6,900	10	*
Regionalized 4	7	6	200	*	*	4	*	*	3,600	5	*	5,300	7	*
Regionalized 5	4	6	750	1	*	10	*	*	4,200	6	*	5,300	7	*
Regionalized 6		2	58	*	*	*	*	*	2,100	3	*	4,400	6	*
Regionalized 7		2	58	*	*	*	*	*	2,100	3	*	3,500	5	*
Centralized 1		1	58	*	*	*	*	*	2,100	3	*	6,900	10	*
Centralized 2		1	58	*	*	*	*	*	2,100	3	*	5,500	8	*
Centralized 3	7	1	200	*	*	4	*	*	3,600	5	*	4,400	6	*
Centralized 4	7	1	200	*	*	4	*	*	3,600	5	*	3,900	6	*
Centralized 5	1	1	200	*	*	2	*	*	5,500	8	*	4,400	6	*

Notes: T = treatment; D = disposal. * = greater than 0 but less than 0.5.

[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction.

At all of these sites except LLNL and ORR, waste management workers are the only receptor group with cancer incidence equal to or greater than one. At LLNL, the cancer incidence is estimated to occur within the offsite population under Regionalized Alternative 2 as a result of exposure to tritium. At ORR, the cancer incidence is estimated to occur within the offsite population under Regionalized Alternative 5 as a result of exposure to tritium. No sites are estimated to have one or more genetic effects.

7.4.1.5 Probability of MEI Cancer Fatalities

Table 7.4–6 summarizes, by alternative, the highest estimated *probability* at any site of fatal cancer from exposure to radiation associated with each LLW alternative. This table presents the probability of cancer fatality to the MEIs within the offsite and noninvolved worker populations. The numbers in this table are the estimated *probabilities* that the MEI will die of latent cancer from radiation exposure.

The probability of a cancer fatality for the MEI was calculated at each site, and the highest value at a single site under each alternative is presented in Table 7.4–6. The MEI risk is not a combined total of risks across all of the sites.

The volume reduction alternatives generally have cancer fatality probability values that are about one order of magnitude higher than the values in other alternatives for the offsite MEI and about one to two orders of magnitude higher than the values in the other alternatives for the noninvolved worker MEI.

Table 7.4–7 presents the probability of a latent cancer fatality from radiological exposure for the offsite MEI for all sites by treatment alternative. The data in Table 7.4–7 are graphically presented in Figure 7.4–1. The highest cancer fatality probabilities are found at FEMP, the Hanford Site, LLNL, ORR, and Portsmouth. The radionuclide contaminant released during treatment operations that drives the cancer risk at each of these sites is tritium.

7.4.1.6 Probability of MEI Cancer Incidence and Genetic Effects

Table 7.4–8 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidences and genetic effects resulting from radiation exposure. This table presents these estimated risks for the MEIs within the offsite and the noninvolved worker populations.

Table 7.4–6. LLW Treatment: Greatest Probability of Cancer at Any LLW Site

Alternative	Number of Sites		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
	T[a]	D		
No Action	10[b]	6	2E–08	3E–08
Decentralized		16	2E–07	5E–08
Regionalized 1		12	2E–07	5E–08
Regionalized 2	11	12	6E–06	2E–06
Regionalized 3		6	2E–07	5E–08
Regionalized 4	7	6	2E–06	9E–07
Regionalized 5	4	6	9E–06	4E–06
Regionalized 6		2	2E–07	5E–08
Regionalized 7		2	2E–07	5E–08
Centralized 1		1	2E–07	5E–08
Centralized 2		1	2E–07	5E–08
Centralized 3	7	1	2E–06	6E–07
Centralized 4	7	1	2E–06	6E–07
Centralized 5	1	1	2E–06	2E–06

T = treatment; D = disposal. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[b] Ten sites use existing facilities for volume reduction.

Table 7.4–8 indicates that the highest radiation cancer incidence probability for the offsite MEI is found under Regionalized Alternative 5. Cancer incidence probabilities generally are 5–20 times higher for the volume reduction alternatives than for the minimum treatment alternatives. A similar trend can be seen in the cancer incidence probabilities for the noninvolved worker MEI.

Offsite MEI radiation cancer incidence probability is highest for alternatives involving Regionalized or Centralized volume reduction, including thermal treatment. Highest values are at FEMP (under Regionalized Alternative 2), the Hanford Site (under Regionalized Alternatives 4 and 5 and Centralized Alternatives 3, 4, and 5), LANL (under Regionalized Alternatives 2 and 4 and Centralized Alternatives 3 and 4), LLNL (under Regionalized Alternative 2), ORR (under Regionalized Alternative 5), and at

Table 7.4–7. LLW Treatment: Offsite MEI Cancer Fatality Probabilities

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP[c]
	T[a]	D																
No Action	10[b]	6	1E–11	3E-11	--	9E–12	2E–10	2E–08	6E–12	~0	1E–10	2E–12	8E–11	2E–13	2E–12	7E–11	6E–09	5E–11
Decentralized		16	1E–11	1E–13	--	6E–11	1E–10	2E–08	2E–07	~0	2E–10	4E–11	4E–11	3E–14	5E–12	7E–11	2E–10	2E–11
Regionalized 1		12	1E–11	3E-11	--	6E–11	1E–10	2E–08	2E–07	~0	2E–10	4E–11	4E–11	3E–14	5E–12	7E–11	2E–10	3E-11
Regionalized 2	11	12	1E–11	3E-11	4E–06	7E–11	2E–10	8E–07	6E–06	~0	3E–09	4E–11	4E–11	7E–09	3E–09	7E–11	6E–09	3E-11
Regionalized 3		6	1E–11	3E-11	--	6E–11	1E–10	2E–08	2E–07	~0	2E–10	2E–10	4E–11	2E–13	5E–12	7E–11	2E–10	3E-11
Regionalized 4	7	6	1E–11	3E-11	--	1E–06	2E–10	8E–07	7E–08	~0	3E–09	2E–12	4E–11	2E–06	3E–09	7E–11	6E–09	3E-11
Regionalized 5	4	6	1E–11	3E-11	--	1E–06	5E–09	2E–08	7E–08	~0	9E–06	2E–12	4E–11	2E–13	5E–12	7E–11	6E–09	3E-11
Regionalized 6		2	1E–11	3E-11	--	6E–11	2E–10	2E–08	2E–07	~0	4E–10	2E–12	4E–11	2E–13	5E–12	7E–11	2E–10	3E-11
Regionalized 7		2	1E–11	3E-11	--	9E–11	2E–10	2E–08	2E–07	~0	4E–10	2E–12	4E–11	2E–13	5E–12	7E–11	2E–10	3E-11
Centralized 1		1	1E–11	3E-11	--	6E–11	2E–10	2E–08	2E–07	~0	4E–10	2E–12	4E–11	2E–13	5E–12	7E–11	2E–10	3E-11
Centralized 2		1	1E–11	3E-11	--	9E–11	2E–10	2E–08	2E–07	~0	4E–10	2E–12	4E–11	2E–13	5E–12	7E–11	2E–10	3E-11
Centralized 3	7	1	1E–11	3E-11	--	1E–06	2E–10	8E–07	7E–08	~0	3E–09	2E–12	4E–11	2E–06	3E–09	7E–11	6E–09	3E-11
Centralized 4	7	1	1E–11	3E-11	--	1E–06	2E–10	8E–07	7E–08	~0	3E–09	2E–12	4E–11	2E–06	3E–09	7E–11	6E–09	3E-11
Centralized 5	1	1	1E–11	3E-11	--	2E–06	1E–10	2E–08	7E–08	~0	4E–10	2E–12	4E–11	2E–13	5E–12	7E–11	1E–10	3E-11

Notes: T = treatment; D = disposal; -- = action not applicable for the alternative. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction.

[c] No waste reported for WVDP.

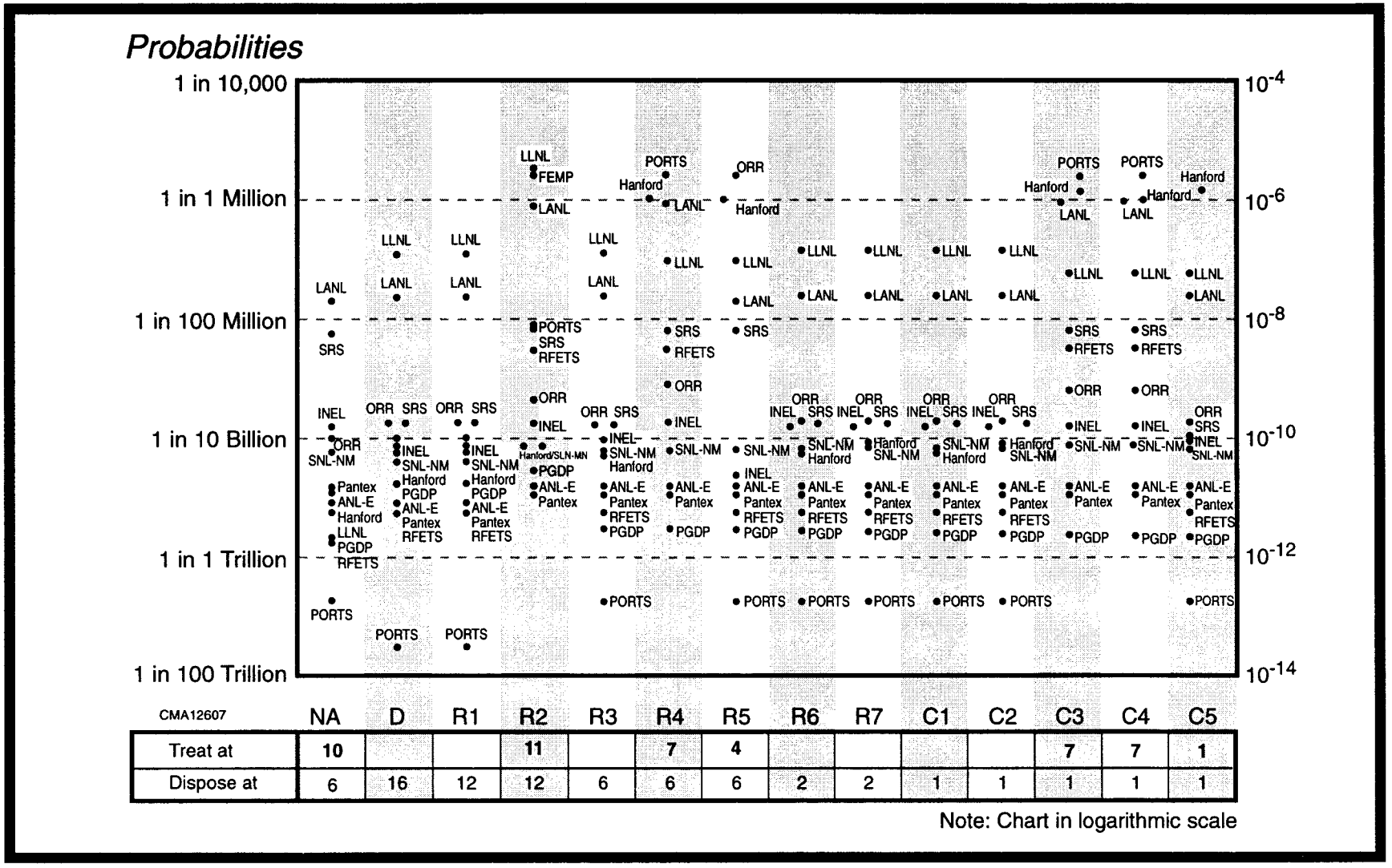


Figure 7.4-1. LLW Treatment: Probability of Cancer Fatality to Offsite MEI

Table 7.4–8. LLW Treatment: Greatest Probability of Cancer Incidences and Genetic Effects at Any LLW Site

Alternative	Number of Sites		Offsite MEI			Noninvolved Worker MEI		
	T[a]	D	Radiation Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Radiation Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10[b]	6	4E-05	7E-08	4E-09	6E-05	1E-07	6E-09
Decentralized		16	6E-04	1E-06	6E-08	9E-05	2E-07	9E-09
Regionalized 1		12	6E-04	1E-06	6E-08	9E-05	2E-07	9E-09
Regionalized 2	11	12	1E-02	2E-05	1E-06	4E-03	6E-06	4E-07
Regionalized 3		6	6E-04	1E-06	6E-08	9E-05	2E-07	9E-09
Regionalized 4	7	6	5E-03	8E-06	5E-07	2E-03	3E-06	2E-07
Regionalized 5	4	6	2E-02	3E-05	2E-06	8E-03	1E-05	8E-07
Regionalized 6		2	6E-04	1E-06	6E-08	9E-05	2E-07	1E-08
Regionalized 7		2	6E-04	1E-06	6E-08	9E-05	2E-07	9E-09
Centralized 1		1	6E-04	1E-06	6E-08	9E-05	2E-07	1E-08
Centralized 2		1	6E-04	1E-06	6E-08	1E-04	2E-07	1E-08
Centralized 3	7	1	5E-03	8E-06	5E-07	1E-03	2E-06	1E-07
Centralized 4	7	1	5E-03	8E-06	5E-07	1E-03	2E-06	1E-07
Centralized 5	1	1	3E-03	5E-06	3E-07	3E-03	6E-06	3E-07

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.0005. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction.

Portsmouth (under Centralized Alternatives 3 and 4). Tritium is the radionuclide that accounts for most of the risk at FEMP, the Hanford Site, LLNL, ORR, and Portsmouth, whereas uranium-238 (U-238) accounts for most of the risk at LANL. More recent estimates show potential increased air releases of tritium at FEMP, Hanford, and Portsmouth and U-238 at LANL (see Appendix I). Genetic effects incidence probability for the offsite MEI is highest at LLNL under Regionalized Alternative 2 as a result of exposure to tritium released during treatment of LLW. Cancer incidence probabilities for the noninvolved worker MEI are highest at FEMP, the Hanford Site, LANL, LLNL, ORR, and Portsmouth.

7.4.1.7 Hypothetical Farm Family Risk

In addition to the disposal risks to workers, already presented, disposal risks were evaluated using hypothetical receptors—a farm family and an intruder—as defined in Section 7.4.1. Risks to both the

hypothetical farm family and the hypothetical intruder (Section 7.4.1.9) were analyzed in keeping with the requirements of DOE Order 5820.2A, "Radioactive Waste Management" (DOE, 1988). This order requires that site-specific performance assessments be conducted in order to demonstrate that a given disposal practice is in compliance with the set of performance objectives quantified in the DOE Order. These objectives specify concentrations and dose limits that are intended to be protective of the general public, an inadvertent intruder, and groundwater resources. Releases from the disposal facility occur as the result of natural causes (e.g., through leaching upon breakdown of the facility) and by inadvertent human intrusion.

The farm family scenario generically addresses potential contamination of groundwater resources as well as the potential health effect consequences of exposure of the general public to radionuclides released from the disposal facility. The radionuclides are assumed to leach from the disposal site through the unsaturated zone to contaminate groundwater that is used by a future farm family as a source of drinking water and irrigation water. See Section 5.4.1 for a further discussion of the presentation of farm family risk results.

Although the disposal facility risk analysis conducted in this WM PEIS uses scenarios that are similar to those used in the performance assessment process, it is important to note that the objectives of the two types of analysis are different. The WM PEIS hypothetical farm family and intruder scenario analyses assume the use of generic disposal facilities and generic waste forms (e.g., grout or polymers), and that the entire inventory of waste will be disposed (i.e., no exclusion of particular radionuclides). These assumptions lead to overestimates of contaminant concentration in groundwater. The objective of the WM PEIS analyses is to provide a relative comparison of potential risk among LLW management alternatives. The outputs of the analyses are risk estimates for the hypothetical farm family and intruder.

In contrast, the performance assessment analysis process involves the use of more detailed site-specific data in the design of a disposal facility at a particular location on a site. The objective of the analysis is to design a facility that will satisfy the performance objectives specified in DOE Order 5820.2A (DOE, 1988). In practice, implementation of this latter requirement may involve: (1) modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration); (2) modifying the form of the waste to be disposed (such as changing to a vitrified waste form); (3) changing the specific location of the waste disposal facility so that it is sited over an area with more favorable hydrologic conditions; and (4) imposing waste acceptance criteria (i.e., restricting the amounts

of radionuclides allowed in a given waste disposal facility). The output of the analysis is a set of waste disposal facility design criteria.

As a result of these differences, the WM PEIS analyses produce estimates of groundwater contamination and farm family risk that are higher than those that would be expected upon actual implementation of the LLW disposal alternatives. For example, the generic WM PEIS analysis estimates that radionuclide groundwater contamination will exceed existing drinking water quality protection standards at certain sites (see Section 7.6.2). However, the groundwater resource protection objectives contained in DOE Order 5820.2A would require that the waste disposal facility designs developed by the performance assessment analyses subsequently conducted at those sites ensure that drinking water standards would not be exceeded upon disposal of LLW. Consequently, the hypothetical farm family risk estimates presented in this section have been adjusted to reflect groundwater contamination that does not exceed existing standards. That is, radionuclides whose estimated groundwater concentrations exceeded drinking water standards were adjusted to concentrations that represent 100% of existing standards. The unadjusted risk estimates from the WM PEIS analysis are presented in the Volume II site tables and in Appendix D.

MEI cancer fatality probability estimates for each site that disposes LLW under the various alternatives are presented in Table 7.4–9. The results of the WM PEIS analysis indicate that disposal of uranium-238 (U-238) must be carefully controlled at the Hanford Site (under all alternatives), SNL-NM (under the Decentralized Alternative), and SRS (under all alternatives except Regionalized 6 and 7). More recent estimates show potential increased release of U-238 to the groundwater at Hanford and SRS (see Appendix I). Requisite controls are likely to result in additional costs and potentially to increased impacts in other resources areas. If the amount or form of U-238 is not controlled as previously described, the groundwater concentrations of the radionuclide at these sites are estimated to exceed drinking water standards. These elevated groundwater concentrations would produce cancer fatality probability estimates that are about an order of magnitude higher than those presented in Table 7.4–9 at SRS, one to two orders of magnitude higher at the Hanford Site, and more than two orders of magnitude higher at SNL-NM (see Volume II site tables and Appendix D). In a similar manner, the disposal of neptunium-237 (Np-237) would require careful control at Paducah (under the Decentralized and Regionalized Alternatives 1 and 2).

Table 7.4–9. LLW Disposal: Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probabilities

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T[a]	D																
No Action	10[b]	6	--	--	--	4E-05[c]	~0	~0	--	~0	2E-07	--	--	--	--	--	4E-06[c]	--
Decentralized		16	3E-05	5E-04	--	4E-05[c]	~0	~0	1E-06	~0	2E-07	8E-05[c]	~0	6E-08	3E-08	5E-05[c]	4E-06[c]	1E-04
Regionalized 1		12	--	--	--	4E-05[c]	~0	~0	1E-06	~0	2E-07	8E-05[c]	~0	5E-07	3E-08	--	4E-06[c]	--
Regionalized 2	11	12	--	--	--	4E-05[c]	~0	~0	1E-06	~0	4E-07	8E-05[c]	~0	9E-07	8E-08	--	4E-06[c]	--
Regionalized 3		6	--	--	--	4E-05[c]	~0	~0	--	~0	1E-07	--	--	--	--	--	4E-06[c]	--
Regionalized 4	7	6	--	--	--	4E-05[c]	~0	~0	--	~0	2E-07	--	--	--	--	--	4E-06[c]	--
Regionalized 5	4	6	--	--	--	4E-05[c]	~0	~0	--	~0	2E-07	--	--	--	--	--	4E-06[c]	--
Regionalized 6		2	--	--	--	4E-05[c]	--	--	--	--	--	--	--	--	--	--	9E-06	--
Regionalized 7		2	--	--	--	--	--	--	--	~0	--	--	--	--	--	--	9E-06	--
Centralized 1		1	--	--	--	4E-05[c]	--	--	--	--	--	--	--	--	--	--	--	--
Centralized 2		1	--	--	--	--	--	--	--	~0	--	--	--	--	--	--	--	--
Centralized 3	7	1	--	--	--	4E-05[c]	--	--	--	--	--	--	--	--	--	--	--	--
Centralized 4	7	1	--	--	--	--	--	--	--	~0	--	--	--	--	--	--	--	--
Centralized 5	1	1	--	--	--	4E-05[c]	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; -- = action not applicable for alternative. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those sites or alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction.

[c] These are adjusted values. They represent the estimated risks when groundwater concentrations of radionuclides are adjusted to 100% of existing standards. Radionuclides that drive risks and exceed groundwater standards include uranium-238 at the Hanford Site, SRS, and SNL-NM and neptunium-237 at Paducah. Unadjusted risk estimates are presented in the Volume II site data tables and in Appendix D.

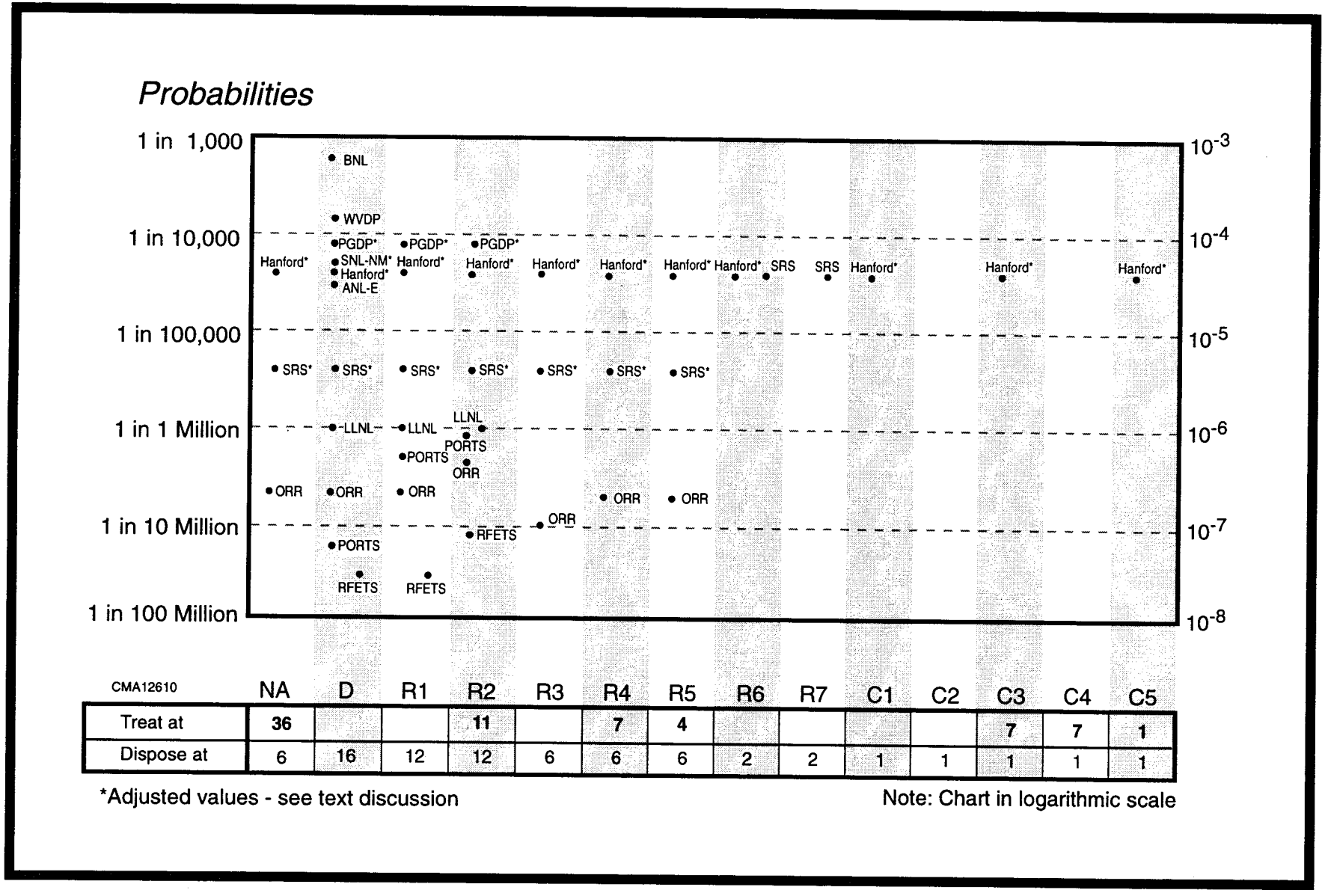
The estimated times of maximum future radionuclide exposure at these sites are as follows:

- The Hanford Site—U-238 at 1,260 years
- SNL-NM—U-238 at 1,050 years
- SRS—U-238 at 11,460 years
- Paducah—Np-237 at 3,240 years

In addition, although groundwater concentrations of radionuclide contaminants are not estimated to exceed drinking water standards, the estimated cancer fatality probabilities at BNL and WVDP under the Decentralized Alternative are high. Technetium-99 is the contaminant that accounts for most of the risk at BNL, whereas neptunium-237 drives the estimated farm family risk at WVDP.

The results of this analysis, graphically presented in Figure 7.4–2, also indicate that, on the basis of estimated MEI cancer fatality probability, disposal of LLW at ANL-E, INEL, LANL, LLNL, NTS, ORR, the Pantex Plant, PORTS, and RFETS could be accomplished for the WM PEIS-assumed wastes without additional radionuclide constraints. Of these sites, INEL, LANL, NTS, and the Pantex Plant had the lowest (zero) estimated cancer fatality probabilities.

The hypothetical farm family risks represent individual receptors assumed to be exposed through location of a drinking water well at 300 m from the center of a single disposal unit. Concentrations of groundwater contaminants at this location are assumed to be higher than those that could be expected at greater distances from the unit due to dispersion of contaminants. Construction of multiple units is expected to be required to dispose of the projected waste volumes at certain sites under the various LLW alternatives. Although the farm family scenario evaluates only a single receptor 300 m from an individual unit, DOE assumes that each of these close-in receptors will be affected primarily by the contaminant plume from the closest facility. DOE recognizes that commingling of contaminant plumes from multiple disposal units may occur as distance from the units increases but anticipates that, at 300 m, the highest concentration of contaminants is likely to result from the single closest plume. At greater distances from the disposal units, where overlap of the plumes is more likely, the concentrations in any given plume should be lower than those estimated at the 300-m well as a result of dispersion and dilution. However, the WM PEIS cannot address groundwater contaminant concentrations at distances greater than 300 meters from disposal units. More detailed analyses, such as the performance assessments required under DOE Order 5820.2A, will address the issues of existing groundwater contamination and multiple disposal units. For example, in April 1996, DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help



	NA	D	R1	R2	R3	R4	R5	R6	R7	C1	C2	C3	C4	C5
Treat at	**36**			**11**		**7**	**4**					**7**	**7**	**1**
Dispose at	6	16	12	12	6	6	6	2	2	1	1	1	1	1

*Adjusted values - see text discussion

Note: Chart in logarithmic scale

Figure 7.4–2. LLW Disposal: Probability of Cancer Fatality to Hypothetical Farm Family Most Exposed Lifetime MEI

ensure that continuing disposal of LLW will not compromise the future radiological protection of the public. A composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned LLW disposal facility and other sources of radioactive material in the ground that might interact with the LLW disposal facility.

7.4.1.8 Potential Collective Risk to Offsite Population From Waste Disposal

Risk assessments generally evaluate both collective and individual health risks, that is, risks for both populations of receptors and for MEIs. However, the WM PEIS disposal risk analysis quantitatively estimates risks only for the farm family MEI. Although the farm family scenario disposal risk analysis uses site-specific hydrogeologic and meteorologic data, use of "conceptual" disposal units was assumed. The analysis did not attempt to identify exact locations of these generic units on a site; rather, they were assumed to be placed either near existing disposal units where such units existed, or at a location on the site expected to be most sensitive to groundwater contamination. Since the analysis does not attempt to actually locate the disposal units on the site, DOE believes it is not possible to develop plausible quantitative estimates of the collective risks to current or future offsite populations resulting from exposure to contaminated groundwater. Both the concentrations of contaminants in the groundwater and the number of people potentially exposed will be strongly influenced by the locations of the disposal units and receptor wells. A hypothetical siting decision to support such an analysis is not favored because the choice of a site so strongly influences the results as to make them a direct reflection of the choice.

To address the relative potential of the proposed disposal sites and alternatives for collective risk to offsite populations, values for site parameters that are expected to influence potential groundwater contamination or that are associated with the relative size of populations at risk were statistically analyzed. These variables included the size of the site (acres), depth to aquifer, size of offsite population living within 50 miles of the site, annual rainfall, natural recharge rate, and time of travel of groundwater from the surface to a downgradient well. Statistical analysis of these variables produced clusters or groupings of sites according to their relative potential risk vulnerability. These groupings are believed to be more appropriate metrics for decision making, given the lack of facility siting and other relevant information, than quantitative estimates of person-rem doses and latent cancer fatalities.

Section C.4.1 of Appendix C contains additional information about the methodology and results of the offsite population risk vulnerability analysis. This section also describes other DOE efforts to assess

potential risks from waste disposal, including those of the Federal Facility Compliance Act Disposal Workgroup and the performance assessment process required by DOE Order 5820.2A.

Section 5.4.1 of Chapter 5 contains a discussion of the results of the collective risk vulnerability analysis. The sites are grouped into three population risk vulnerability (PRV) roups, with Group 1 having the lowest potential vulnerability for offsite population risks from groundwater contamination following LLW disposal, and Group 3 having the highest potential. It is important to note that this is a screening-level analysis that does not take into account any measures that would limit migration of disposed wastes into the groundwater, such as engineered disposal units or changes in waste acceptance criteria. The objective of the analysis is not to rule out any sites for disposal—a number of sites are currently disposing LLW—but to indicate where such disposal mitigation measures are more likely to be necessary and where the costs of disposal would likely increase as a result. In particular, though some sites may be listed in Group 3, this does not mean that disposal would be unacceptable there. Rather, it means that mitigation would be an important part of a disposal plan for these sites.

As previously described, the waste volume, total radioactivity, and number of potential disposal units required at a given site varies by waste management alternative. Table 7.4–10 presents data on disposal volumes, number of disposal units, and curies for each site as they vary over the proposed alternatives, in conjunction with the results of the population risk vulnerability factor and cluster analyses. This information is summarized by risk vulnerability cluster for each alternative and is displayed in Table 7.4–11. The summary data in Table 7.4–11 suggest that the Centralized Alternatives present lower potential collective risks to offsite populations from disposal than the Decentralized or Regionalized Alternatives.

Note that the results of this screening-level risk vulnerability analysis are useful in discussing the relative potentials among the sites and the proposed waste management alternatives. However, more refined risk analyses will be included in the site-specific performance assessments that will be conducted for the design and siting of new disposal facilities. In addition, DOE will consider a number of other factors in the development of waste disposal decisions. These include the results of safety analyses for disposal facility operation, the extent of existing contamination or waste disposal at a site, the costs and benefits involved in transporting waste among sites, and other environmental and socioeconomic concerns.

Table 7.4–10. Disposal Variables (by Site and Alternative) and Population Risk Vulnerability Group For LLW

Disposal Alternative Variables	ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
Population Risk Vulnerability Group	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**3**	**3**	**1**	**3**	**2**	**2**	**3**	**2**
No Action Alternative																
Number of disposal units				6	5	14		29	12						39	
Disposal waste volume (m^3)				240,000	36,000	160,000		150,000	260,000						420,000	
Total radioactivity (Ci × 100,000)				76.6	27.6	77.3		330	1.27						17.9	
Decentralized Alternative																
Number of disposal units	1	1	NA	9	8	15	1	1	17	4	1	12	3	1	51	3
Disposal waste volume (m^3)	9,100	5,760		94,000	94,000	163,000	8,300	1,830	294,000	53,800	2,900	231,000	45,000	2,700	560,000	49,440
Total radioactivity (Ci × 100,000)	5.3E-02	0.12		1.55	27.6	77.3	6.37	3.6E-05	1.27	2.5E-04	9.6E-05	75	2.3E-03	5.1E-02	17.9	0.14
Regionalized 1 Alternative																
Number of disposal units			NA	9	7	14	1	NA	14	4	4	12	3		48	
Disposal waste volume (m^3)				94,000	94,000	166,000	8,300	1,830	294,000	53,800	2,900	295,000	45,000		560,000	
Total radioactivity (Ci × 100,000)				1.55	27.6	77.3	3.6	0	1.27	2.5E-04	9.6E-05	75	2.33E-02		17.9	
Regionalized 2 Alternative																
Number of disposal units			NA	2	4	5	1	NA	3	3	1	7	1		40	
Disposal waste volume (m^3)				20,700	51,000	50,900	6,200	0	130,000	41,500	2,920	123,000	12,000		455,000	
Total radioactivity (Ci × 100,000)				1.55	27.6	77.3	3.6	0	1.27	2.5E-04	9.6E-05	75	2.33E-02		17.9	
Regionalized 3 Alternative																
Number of disposal units				9	7	22		1	30						48	
Disposal waste volume (m^3)				94,000	94,000	255,000		6,840	415,000						560,000	
Total radioactivity (Ci × 100,000)				1.55	27.6	77.3		0.90	345						17.9	
Regionalized 4 Alternative																
Number of disposal units				2	4	7		1	13						40	
Disposal waste volume (m^3)				21,000	51,000	72,000		1,970	264,000						455,000	
Total radioactivity (Ci × 100,000)				2.87	27.6	77.3		5.4E-04	346						17.9	
Regionalized 5 Alternative																
Number of disposal units				2	5	7		1	13						40	
Disposal waste volume (m^3)				21,000	59,000	63,700		1,970	264,000						455,000	
Total radioactivity (Ci × 100,000)				2.87	27.6	77.2		5.4E-04	346						17.9	
Regionalized 6 Alternative																
Number of disposal units				37											94	
Disposal waste volume (m^3)				460,000											1,100,000	
Total radioactivity (Ci × 100,000)				113											93	

Table 7.4–10. Disposal Variables (by Site and Alternative) and Population Risk Vulnerability Group For LLW—Continued

Disposal Alternative Variables	ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
Regionalized 7 Alternative																
Number of disposal units								37							94	
Disposal waste volume (m^3)								270,000							1,100,000	
Total radioactivity (Ci × 100,000)								79							93	
Centralized 1 Alternative																
Number of disposal units				131												
Disposal waste volume (m^3)				1,500,000												
Total radioactivity (Ci × 100,000)				427												
Centralized 2 Alternative																
Number of disposal units								131								
Disposal waste volume (m^3)								1,500,000								
Total radioactivity (Ci × 100,000)								427								
Centralized 3 Alternative																
Number of disposal units				72												
Disposal waste volume (m^3)				810,000												
Total radioactivity (Ci × 100,000)				427												
Centralized 4 Alternative																
Number of disposal units								73								
Disposal waste volume (m^3)								810,000								
Total radioactivity (Ci × 100,000)								427								
Centralized 5 Alternative																
Number of disposal units				72												
Disposal waste volume (m^3)				810,000												
Total radioactivity (Ci × 100,000)				427												

Table 7.4–11. Disposal Variables by LLW Alternative and Population Risk Vulnerability Group

Alternative	Group 3	Group 2	Group 1
No Action Alternative			
Number of disposal units	51	0	54
Disposal waste volume (m^3)	680,000	0	586,000
Total radioactivity (Ci × 100,000)	17.9	0	511
Decentralized Alternative			
Number of disposal units	84	10	34
Disposal waste volume (m^3)	1,140,000	120,000	355,000
Total radioactivity (Ci × 100,000)	93	6.4	105
Regionalized 1 Alternative			
Number of disposal units	78	4	34
Disposal waste volume (m^3)	1,200,000	53,000	355,000
Total radioactivity (Ci × 100,000)	93	3.6	105
Regionalized 2 Alternative			
Number of disposal units	53	2	12
Disposal waste volume (m^3)	750,000	14,000	126,000
Total radioactivity (Ci × 100,000)	93	3.6	116
Regionalized 3 Alternative			
Number of disposal units	78	0	39
Disposal waste volume (m^3)	975,000	0	450,000
Total radioactivity (Ci × 100,000)	362	0	107
Regionalized 4 Alternative			
Number of disposal units	53	0	14
Disposal waste volume (m^3)	719,000	0	146,000
Total radioactivity (Ci × 100,000)	362	0	107
Regionalized 5 Alternative			
Number of disposal units	53	0	15
Disposal waste volume (m^3)	719,000	0	146,000
Total radioactivity (Ci × 100,000)	362	0	107
Regionalized 6 Alternative			
Number of disposal units	94	0	37
Disposal waste volume (m^3)	1,100,000	0	460,000
Total radioactivity (Ci × 100,000)	93	0	113

Table 7.4–11. Disposal Variables by LLW Alternative and Population Risk Vulnerability Group—Continued

Alternative	Group 3	Group 2	Group 1
Regionalized 7 Alternative			
Number of disposal units	94	0	37
Disposal waste volume (m^3)	1,100,000	0	270,000
Total radioactivity (Ci × 100,000)	93	0	79
Centralized 1 Alternative			
Number of disposal units	0	0	131
Disposal waste volume (cubic meters)	0	0	1,500,000
Total radioactivity (Ci × 100,000)	0	0	427
Centralized 2 Alternative			
Number of disposal units	0	0	131
Disposal Waste Volume (m^3)	0	0	1,500,000
Total radioactivity (Ci × 100,000)	0	0	427
Centralized 3 Alternative			
Number of disposal units	0	0	72
Disposal waste volume (m^3)	0	0	810,000
Total radioactivity (Ci × 100,000)	0	0	427
Centralized 4 Alternative			
Number of disposal units	0	0	73
Disposal waste volume (cubic meters)	0	0	810,000
Total radioactivity (Ci × 100,000)	0	0	427
Centralized 5 Alternative			
Number of disposal units	0	0	72
Disposal waste volume (cubic meters)	0	0	810,000
Total Radioactivity (Ci × 100,000)	0	0	427

7.4.1.9 Intruder Scenario Risks

Table 7.4–12 presents an overview, by alternative, of the total programwide risks to a hypothetical intruder 100 and 300 years after the disposal facility has closed. Because the focus is on an individual intruder, the risks are presented as the probability of that individual experiencing an adverse health impact rather than a total number of impacts for a selected population.

Table 7.4-12. LLW Disposal: Summary Risks to Hypothetical Intruders at LLW Sites

Alternative	Number of Sites		Radionuclides			
	T[a]	D	Dose (rem)	Cancer Fatality Probability	Cancer Incidence Probability	Genetic Effects Probability
100 Years After Disposal Facility Closure						
Decentralized		16	160	8E-02	3E-01	2E-02
Regionalized 3		6	110	5E-02	2E-01	1E-02
Centralized 1		1	2	8E-03	3E-02	2E-03
300 Years After Disposal Facility Closure						
Decentralized		16	2	8E-03	3E-03	2E-04
Regionalized 3		6	1	6E-04	2E-03	1E-04
Centralized 1		1	0.2	8E-05	3E-04	2E-05

Notes: T = treatment; D = disposal. Please refer to Section 5.4.1 of Volume 1 for guidance in interpreting hypothetical intruder risks.

[a] All sites perform "minimum treatment" under all alternatives, consisting of solidification of liquids and "fines" (powdered material), packaging, and shipment.

The intruder scenario risks were not estimated for all alternatives. Regionalized Alternative 3 and Centralized Alternative 1 were selected to be representative of the Regionalized and Centralized Alternatives, respectively. For both the 100-year and 300-year scenarios, each of the evaluated alternatives is estimated to result in relatively high maximum probabilities of cancer fatality, cancer incidence, and genetic effects from radionuclide and direct radiation exposure.

Table 7.4-13 presents the cancer fatality probabilities by site for each of the alternatives evaluated 100 years and 300 years after the disposal facility has closed. The data in Table 7.4-13 are graphically presented in Figure 7.4-3. Under the Decentralized Alternative, cancer fatality probability values span a range of about five orders of magnitude. Cancer fatality probabilities generally are lower for the 300-year scenario by one to two orders of magnitude under all alternatives, which suggests that risks decrease as radionuclides decay. Strontium-90 (half-life 29 years) was the main radionuclide risk driver at 100 years, under each of the alternatives evaluated, whereas the risk drivers at 300 years included thorium-232 (half-life 1E+10 years), uranium-238 (half-life 2E+09 years), nickel-63 (half-life 96 years), americium-241 (half-life 432 years),

Table 7.4–13. LLW Disposal: Hypothetical Intruder Cancer Fatality Probabilities 100 and 300 Years After Disposal Facility Closure

Site	Decentralized Alternative				Regionalized Alternative 3				Centralized Alternative 1			
	100 years		300 years		100 years		300 years		100 years		300 years	
	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)
ANL-E	3E–04	6.6E–01	4E–06	8.0E–03	--	--	--	--	--	--	--	--
Hanford	3E–03	6.8E+00	3E–05	6.0E–02	3E–03	6.8E+00	3E–05	6.0E–02	8E–04	1.7E+00	8E–05	1.7E–01
INEL	4E–04	7.0E–01	7E–05	1.3E–01	4E–04	7.0E–01	7E–05	1.3E–01	--	--	--	--
LANL	7E–02	1.4E+02	6E–04	1.2E+00	5E–02	9.1E+01	4E–04	7.6E–01	--	--	--	--
LLNL	3E–03	5.8E+00	5E–05	1.0E–01	--	--	--	--	--	--	--	--
NTS	--	--	--	--	3E–03	5.8E+00	5E–05	1.0E–01	--	--	--	--
ORR	7E–04	1.3E+00	5E–06	1.1E–02	4E–04	8.1E–01	3E–05	6.0E–02	--	--	--	--
PGDP	3E–06	7.0E–03	3E–06	7.0E–03	--	--	--	--	--	--	--	--
Pantex	3E–06	5.0E–03	3E–06	5.0E–03	--	--	--	--	--	--	--	--
PORTS	2E–04	4.8E–01	6E–05	1.2E–01	--	--	--	--	--	--	--	--
RFETS	1E–06	2.0E–03	1E–06	2.0E–03	--	--	--	--	--	--	--	--
SNL-NM	7E–04	1.5E+00	1E–05	3.0E–02	--	--	--	--	--	--	--	--
SRS	1E–03	2.3E+00	1E–05	3.0E–02	1E–03	2.3E+00	1E–05	3.0E–02	--	--	--	--

Notes: -- = action not applicable for the alternative. Please refer to Section 5.4.1 of Volume I for guidance in interpreting hypothetical intruder risks.

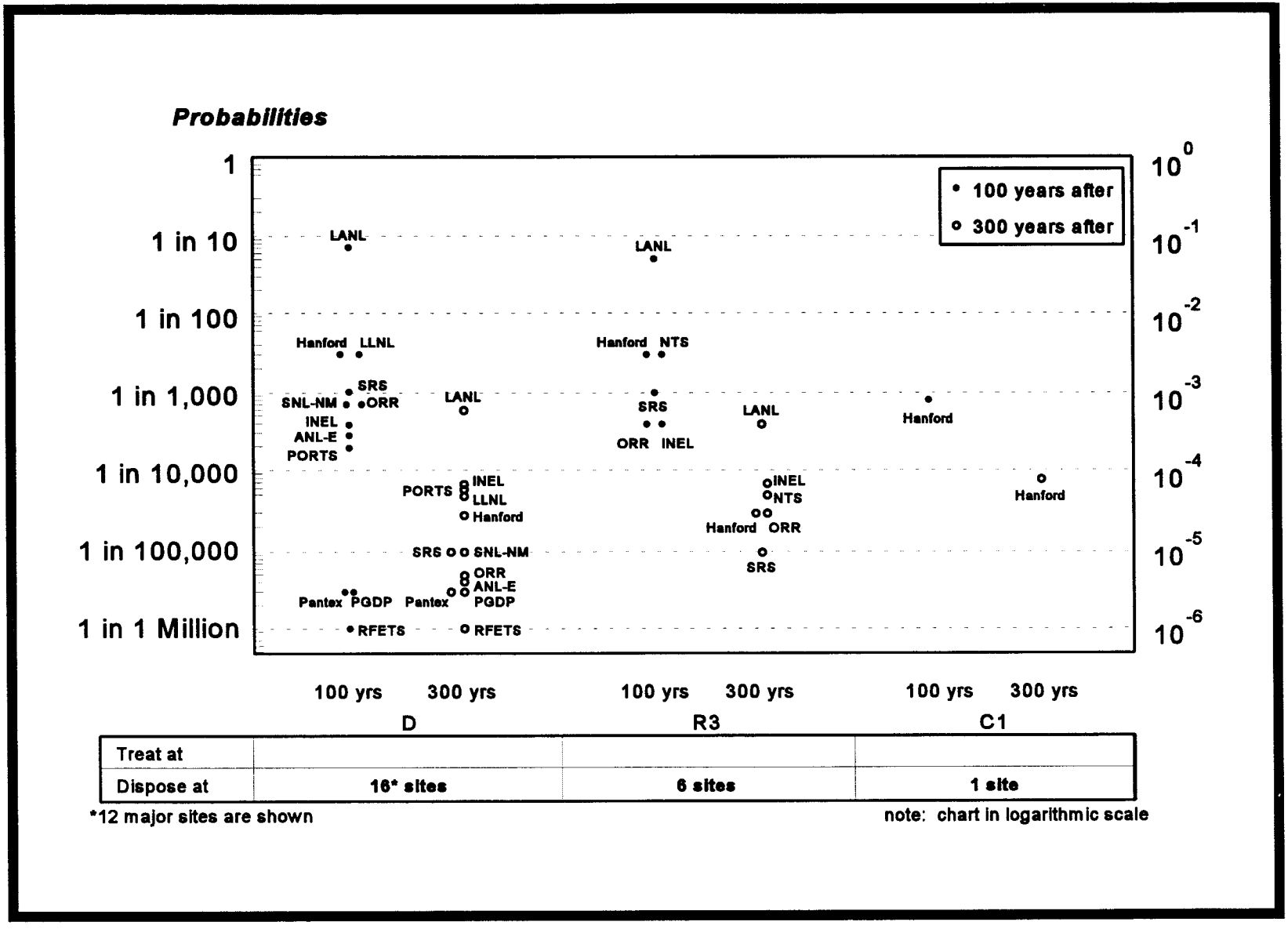


Figure 7.4–3. LLW Disposal: Probability of Cancer Fatality to an Intruder Into Disposal Facility 100 and 300 Years Post Closure

and neptunium-237 (half-life 2E+06 years). There is no general trend in intruder risk among the disposal alternatives evaluated.

The estimated doses presented in Tables 7.4–13 exceed the DOE Order 5820.2A (DOE, 1988) performance assessment objective limits for intruders of 100 millirem per year for continuous exposure and 500 millirem per year for acute exposure at LANL under the Decentralized and Regionalized 3 Alternatives. Figure 7.4–3 shows the intruder cancer fatality risks. Similar to the discussion in Section 7.4.1.7, site-specific considerations during design, construction, and operation would be expected to mitigate these exceedances. These mitigation measures are also described in Chapter 12.

7.4.2 TRANSPORTATION-RELATED IMPACTS

Transporting LLW for treatment and disposal may affect the health of the truck or rail crew and the public along the transportation route. These impacts are the result of radiation exposure during normal operations, and accidents in which the waste containers are assumed to be opened, as well as exposure to vehicle exhaust and physical injury after vehicle accidents. For the No Action Alternative shipments, it was assumed that the shipments would be distributed uniformly over a 20-year period. For all other alternatives, shipments were assumed to occur uniformly over a 10-year period, assuming a 10-year period to build treatment, storage, and disposal facilities.

Tables 7.4–14 and 7.4–15 present the total number of estimated fatalities associated with truck and rail transportation of LLW, respectively. The total number of estimated fatalities resulting from radiation exposure when LLW is transported by truck ranges from less than 1 to 16 for the normal operations population and crew combined (Centralized Alternative 1). The number of estimated fatalities resulting from nonradiological causes (vehicle exhaust-induced cancers and physical injury resulting from accidents) ranges from 1 to 38 when LLW is transported by truck (Table 7.4–14). The number of estimated fatalities resulting from both radiological exposure and nonradiological causes ranges from less than 1 to approximately 5 when the LLW is transported by rail (Table 7.4–15).

Table 7.4–14. LLW Truck Transportation: Estimated Fatalities From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Number of Shipments	Shipment Miles (in Millions)	Estimated Number of Radiological Fatalities[a]			Estimated Number of Nonradiological Fatalities	
	T[b]	D			Normal Operations Public	Normal Operations Crew	Exposure From Traffic Accidents	Fuel Emission	Injury From Traffic Accidents
No Action	10[c]	6	87,360	166	3	2	*	1	11
Decentralized		16	24,420	9	*	*	*	*	1
Regionalized 1		12	25,800	9	*	*	*	*	1
Regionalized 2	11	12	25,880	9	*	*	*	*	1
Regionalized 3		6	84,200	38	1	1	*	*	3
Regionalized 4	7	6	87,390	37	1	1	*	*	3
Regionalized 5	4	6	92,200	64	1	1	*	*	4
Regionalized 6		2	174,390	124	2	2	*	1	9
Regionalized 7		2	188,930	125	2	2	*	1	9
Centralized 1		1	242,730	563	10	6	*	2	35
Centralized 2		1	257,270	505	9	6	*	3	35
Centralized 3	7	1	250,020	530	9	6	*	2	33
Centralized 4	7	1	264,060	478	8	6	*	3	34
Centralized 5	1	1	241,540	560	9	6	*	2	35

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced latent cancer.
[b] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[c] Ten sites use existing facilities for volume reduction.

Table 7.4–15. LLW Rail Transportation: Estimated Fatalities From Rail Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Number of Shipments	Shipment Miles (in Millions)	Estimated Number of Radiological Fatalities[a]			Estimated Number of Nonradiological Fatalities	
	T[b]	D			Normal Operations Public	Normal Operations Crew	Exposure From Traffic Accidents	Fuel Emission	Injury From Traffic Accidents
No Action	10[c]	6	33,420	70	*	*	*	1	*
Decentralized		16	9,210	4	*	*	*	*	*
Regionalized 1		12	9,740	4	*	*	*	*	*
Regionalized 2	11	12	9,900	4	*	*	*	*	*
Regionalized 3		6	31,850	17	*	*	*	*	*
Regionalized 4	7	6	33,460	17	*	*	*	*	*
Regionalized 5	4	6	35,430	25	*	*	*	*	*
Regionalized 6		2	66,040	51	*	*	*	1	*
Regionalized 7		2	71,480	54	*	*	*	1	*
Centralized 1		1	91,440	224	1	1	*	2	1
Centralized 2		1	96,880	219	1	1	*	2	1
Centralized 3	7	1	96,710	218	1	1	*	2	1
Centralized 4	7	1	102,100	212	1	1	*	2	*
Centralized 5	1	1	90,980	223	1	1	*	2	1

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.5.

[a] Fatalities are from radiation-induced latent cancer.

[b] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for volume reduction.

The number of fatalities estimated for both truck and rail transportation is directly related to the number of shipments and shipment miles required under each alternative. Therefore, most fatalities from both truck and rail transport are estimated to occur in the alternatives that have the most shipments and vehicle miles, which are the Centralized Alternatives (when treatment and/or disposal of all LLW occur at one site). Approximately 250,000 truck shipments covering 500 to 600 million vehicle miles or approximately 100,000 rail shipments covering 200 million vehicle miles are required in the Centralized Alternatives. The least number of fatalities is estimated to occur in the Decentralized and Regionalized Alternatives, which require approximately 25,000 to 190,000 truck shipments covering 9 to 125 million vehicle miles, or approximately 10,000 to 70,000 rail shipments covering 4 to 50 million vehicle miles. Due to the uncertainties involved in the calculations (see Section E.8 of Volume I), these results suggest that there may not be significant differences between the radiological risks associated with truck and rail transport. However, members of the public traveling on the truck routes have a potential to receive higher exposures than those members of the public traveling near rail routes. The risks from injury directly related to traffic accidents suggest rail transport may be slightly less hazardous than truck transport.

7.4.3 Facility Accident Impacts

7.4.3.1 Storage Facility Accidents

Accidents and source terms for current storage of LLW were not analyzed. Unlike treatment, which will predominantly use new facilities that will have common characteristics, current (pretreatment) storage will use a variety of predominantly preexisting facilities that vary greatly in the amounts and types of waste inventories stored, the configurations in which they are stored, and the containment or confinement characteristics of the storage buildings or enclosures. However, recent DOE safety analysis reports (SARs) and NEPA information provide guidance on the potential risk impacts applicable to LLMW and TRUW storage facility accidents and can be used to evaluate the anticipated risks of LLW storage facility accidents.

Information in these current SARs and DOE site EISs can be used as indicators of the predicted consequences for a range of waste storage facility accidents of varying frequency. A brief summary of some of the key accidents and assumptions used by the sites in preparing these analyses, and the related health effects results are shown in Appendix F. Examples of results applicable to LLW storage facilities include accidents ranging from violent single drum breaches to large fires in centralized facilities. The recent SARs

and EISs that are relevant portray results for TRUW and LLMW releases, and thus the consequences, per se, are not directly comparable to those for LLW. However, the accident scenarios, estimates of airborne material due to the accidents, and atmospheric dispersion and health effects calculations are analogous. As a result, LLW storage facility accident results are analogous to LLMW storage facility results because of their similar radionuclide profiles. See Section 6.4.3 for a discussion of these results which suggest that the public risk from storage accidents is very low.

It should be noted that explicitly analyzing risks from storage would not help to discriminate among alternatives because of the assumption used in the WM PEIS for estimating the treatment throughputs that dictate the inventories to be stored prior to treatment. This assumption is that all sites will accumulate or at least not reduce these inventories for roughly 10 years, at which time complex-wide treatment will begin. Thus, all sites will achieve their maximum inventories (leading to maximum potential releases during a storage facility accident) independently of alternative.

7.4.3.2 Treatment Facility Accidents

Although there are many processes used for treating LLW, to date, thermal treatment technologies have been the most effective in destroying and reducing in volume the combustible materials contained in LLW. Because significant data on incineration are available and because the results achieved through incineration are representative and bounding of other thermal treatment processes, this risk analysis focused on incineration. Like other LLW treatment processes, incinerator operations/accidents can result in airborne releases of radionuclides. Potential treatment facility accidents identified for all LLW alternatives include: (1) incineration facility fires or explosions initiated from internal causes; (2) an earthquake or tornado that causes damage and possible fires in the facility; and (3) the crash of a large or small aircraft into the facility resulting in fire and possible explosion. All of these accidents can involve release of the radioactive contents of the kiln, the stored ash byproduct of the incineration process, or the trapped contents of the filtration systems in the facility. The accident with the highest potential consequences at each site was evaluated.

The radiological risks and health effects calculations were based upon very conservative assumptions. Table 7.4–16 summarizes the estimated cancer fatalities resulting from radiation exposures associated with potential treatment facility accidents. This table contains cancer fatality estimates for the maximum reasonably foreseeable accidents with the highest potential consequences at each site and the estimated

Table 7.4–16. LLW Facility Accidents: Radiation-Induced Cancer Fatalities From Maximum Reasonably Foreseeable Potential Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Dose (rem)	Offsite MEI Cancer Fatality Probability	Offsite Population Dose (person-rem)	Offsite Population Number of Cancer Fatalities	Worker Dose (person-rem)	WM Workers Number of Cancer Fatalities
No Action Alternative								
INEL	Thermal Treatment, Aircraft Crash[a]	< 1E–06	1E–05	7E–09	1E–01	*	5E–02	*
SRS	Thermal Treatment, Aircraft Crash[a]	< 1E–06	2E–03	1E–06	1E+02	*	3E+01	*
Regionalized Alternative 2								
FEMP	Thermal Treatment, Natural Phenomena	< 1E–06 to < 1E–04	4E–05	2E–08	1E–01	*	1E–03	*
Hanford	Thermal Treatment, Aircraft Crash[a]	< 1E–06	1E–04	6E–08	4E+00	*	3E–02	*
INEL	Thermal Treatment, Aircraft Crash[a]	1E–06 to 1E–04	1E–05	7E–09	1E–01	*	5E–02	*
LANL	Thermal Treatment, Natural Phenomena	1E–06 to 1E–04	8E–01	4E–04	2E+03	1	8E+02	*
LLNL	Thermal Treatment, Natural Phenomena	1E–06 to 1E–04	8E–01	4E–04	6E+03	3	1E+01	*
ORR	Thermal Treatment, Natural Phenomena	1E–06 to 1E–04	2E–03	1E–06	3E+01	*	2E+00	*
PGDP	Thermal Treatment, Natural Phenomena	1E–06 to 1E–04	1E–04	7E–08	6E–01	*	1E–01	*
PORTS	Thermal Treatment, Natural Phenomena	1E–06 to 1E–04	4E–05	2E–08	6E–02	*	1E–02	*
RFETS	Thermal Treatment, Natural Phenomena	1E–06 to 1E–04	2E–03	1E–06	6E+01	*	5E+00	*
SRS	Thermal Treatment, Aircraft Crash	< 1E–06	2E–03	1E–06	1E+02	*	3E+01	*
Centralized Alternative 5								
Hanford	Thermal Treatment, Aircraft Crash	< 1E–06	2E–01	1E–04	1E+04	5	2E+03	1

Notes: "Natural Phenomena" refer to accidents initiated either by earthquake or by high wind or tornado, depending on the site and the associated recurrence frequencies. Incineration was the thermal treatment analyzed. * = greater than 0 but less than 0.5. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] The aircraft crash scenario is included because of its high estimated consequences even though it may not be considered "reasonably foreseeable" in terms of accident frequency (i.e., annual frequency of occurrence greater than 1E–06).

frequency of those accidents occurring annually. The doses indicated are a function of the severity of the accident and the size and distribution of the population affected. The indicated probabilities of excess cancer are based on the assumption that the accident occurs.

Consistent with standard practice in radiological safety analysis, the fatalities are derived only from the cancers associated with radiation. In general, local worker fatalities in severe accidents from trauma would primarily result from the initiation of the accident, e.g., the initial impact and fire of an airplane crash. These trauma fatalities would tend to be independent of the inventory or process characteristics of a particular site for a given consolidation alternative and, therefore, would not tend to be a significant discriminator among the alternatives. Trauma fatalities to the offsite populations from severe accidents would be almost totally independent of the site consolidation and process characteristics that are driven by alternative selection and would not discriminate among alternatives.

Assuming that the accident occurs, each of the alternatives poses a cancer fatality probability equal to or greater than one in one million for the offsite MEI. Under the No Action Alternative, the cancer fatality probability is estimated to be equal to one in one million for the indicated accident affecting the offsite MEI at SRS. Under Regionalized Alternative 2, an offsite MEI cancer fatality probability of equal to or greater than one in one million is estimated for accidents at five sites (LANL, LLNL, ORR, RFETS and SRS). Centralized Alternative 5 is expected to have an offsite MEI cancer fatality probability of greater than one in one million for accidents at the Hanford Site. However, when the frequencies of the accidents are considered, none of the alternatives pose an offsite MEI cancer risk of greater than one in one million.

Centralized Alternative 5 is estimated to produce the highest number of cancer fatalities resulting from accidents affecting the offsite population (5 individuals at the Hanford Site). Under Regionalized Alternative 2, three cancer fatalities in the offsite population are estimated to result from accidents at LLNL, and one cancer fatality is estimated in the offsite population at LANL. Under the No Action Alternative, no cancer fatalities within the offsite population are estimated. The overall risks from accidents for all the alternatives, derived by multiplying the health risk value by the frequencies of the accidents, are very small.

Only Centralized Alternative 5 is expected to produce a cancer fatality within the WM worker population as a result of radiation exposures from severe accidents. The overall risk from severe accidents, taking into account the very low frequency of these accidents, is much less. It is also important to note that use of the latest safety analysis documentation (described in the preceding section on storage facility accidents) would

reduce all predicted impacts. In addition, the health risks presented in Table 7.4–16 assume no mitigation of the accident and take no credit for emergency response actions. The reduction in impacts due to these mitigation actions would be significant.

7.4.3.3 Disposal Facility Accidents

As discussed in Appendix F, disposal accidents were not evaluated because of the lack of details of ultimate disposal. However, except for dedicated centralized disposal facilities (e.g., Yucca Mountain and WIPP for HLW and TRUW, respectively), disposal sites would generally lack a concentrated volume of material at risk being stored in a configuration susceptible to phenomena such as fires and explosions capable of causing significant releases. These repositories have accident analyses performed as part of their site-specific EISs. Although seismic events could breach in-ground containers, leading to airborne releases, such events would be bounded by accidents breaching the concentrated volumes of waste being held in a treatment or storage facility. The available safety literature does not indicate any credible accident sequence in which the risk from airborne releases in a low-level waste disposal facility would be sufficiently significant to rule out a site from consideration and thereby serve as a discriminator among disposal alternatives.

7.5 Air Quality Impacts

The management of LLW would not appreciably affect the air quality at most sites. However, decentralizing treatment and disposal at BNL, or centralizing at NTS could cause adverse air quality impacts requiring additional emission control measures for criteria pollutants. Emissions of radionuclides were estimated to be below the applicable standards at all sites.

As illustrated in Table 7.5–1, DOE evaluated air quality impacts at each proposed LLW treatment and disposal site based on estimated increases in emissions of the six criteria pollutants and radionuclides. Pollutant emission estimates were made for the construction and O&M activities of LLW facilities.

The Clean Air Act (42 USC 7401 *et seq.)* regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new emissions

Table 7.5-1. Air Quality Impacts Evaluated for LLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Table 7.5-2
	Operations	Estimated for thermal treatment units for fuel use by all other LLW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 7.5-3
Radionuclide emissions	Operations	For all LLW treatment and disposal facilities	Percent of standard	Text discussion only

from both "stationary" (e.g., treatment and storage facilities) and "mobile" (e.g., vehicles) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria air pollutant for nonattainment areas. An entity which seeks to engage in an activity that will result in emissions that equal or exceed those limits in a nonattainment area must first obtain a permit.

In "attainment areas" (where air pollution standards are met), only new emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit is required for a new stationary source that equal or exceeds the allowable increase. However, a permit is not required for criteria pollutant emissions from mobile sources.

7.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site. Both are considered to be "mobile sources."

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities

Major Types of Air Pollutants

Criteria Air Pollutants—*carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10}).*

Hazardous Air Pollutants—*189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act.*

under all the LLW alternatives would result in mobile source emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. Table 7.5–2 lists those sites. DOE chose the 10% threshold to highlight those sites where criteria air pollutant emissions could result in adverse air quality impacts.

As indicated in Table 7.5-2, six of the 16 major proposed LLW sites are located in nonattainment areas. As a result of LLW construction activities, these sites are predicted to have emissions that equal or exceed 10% of the allowable limit for a particular criteria air pollutant. NTS is predicted to have emissions of 189% of allocated limits under the Centralized Alternative 2 and 128% under Centralized Alternative 4. This analysis may overestimate potential impacts because it assumes that NTS is in a nonattainment region since it is adjacent to the Clark County nonattainment region for CO and PM_{10}. The NTS EIS (DOE, 1996b) does not show any exceedances for criteria air pollutants. For carbon monoxide, BNL is estimated to be at the limit in the Decentralized Alternative. The WM PEIS analysis suggests that NTS and BNL may need to obtain Clean Air Act permits under these alternatives.

7.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants would also be emitted during operations and maintenance of LLW facilities (stationary sources) and by vehicles driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

Twelve of the 16 major proposed LLW sites are predicted to equal or exceed 10% of applicable air pollutant emission standards (Table 7.5–3). Of these, six sites are located in nonattainment areas; six sites are in attainment areas. As many as seven sites would have pollutant standards that equal or exceed 10% of the levels under an alternative. Only NTS is estimated to exceed the standard; carbon monoxide would be 118 to 183% above the standard in the Centralized 2 and Centralized 4 Alternatives, primarily from worker vehicle emissions. This analysis may overestimate potential impacts because it assumes that NTS is in a nonattainment region since it is adjacent to the Clark County nonattainment region for CO and PM_{10}. The NTS EIS (DOE, 1996b) does not show any exceedances for criteria air pollutants. Based on the

Table 7.5-2. Percent of Sites' Allowable Air Emissions Discharged During Construction—LLW Sites Equaling or Exceeding 10% of Standard in Nonattainment Regions[a]

Alternative	Number of Sites		Criteria Pollutants—Construction[b]											
			ANL-E	BNL		NTS		PGDP		RFETS			SNL-NM
	T[c]	D	NO_2	NO_2	VOC	CO	PM_{10}	NO_2	VOC	CO	NO_2	VOC	CO
No Action	10[d]	6	36 (31/5)	26 (20/6)				13 (11/2)		12 (4/8)	12 (10/2)		
Decentralized		16	58 (52/6)	100 (88/12)	15 (8/7)			88 (85/3)	20 (16/4)	28 (16/12)	45 (43/2)	11 (8/3)	10 (1/9)
Regionalized 1		12	12 (6/6)	26 (20/6)				88 (85/3)	20 (16/4)	28 (16/12)	45 (43/2)	11 (8/3)	10 (1/9)
Regionalized 2	11	12	12 (6/6)	26 (20/6)				81 (74/7)	22 (14/8)	38 (28/10)	76 (74/2)	16 (14/2)	10 (1/9)
Regionalized 3		6	12 (6/6)	26 (20/6)		12 (5/7)				15 (1/14)			10 (1/9)
Regionalized 4	7	6	12 (6/6)	26 (20/6)						26 (21/5)	55 (54/1)	11 (10/1)	10 (1/9)
Regionalized 5	4	6	12 (6/6)	26 (20/6)						15 (1/14)			10 (1/9)
Regionalized 6		2	12 (6/6)	26 (20/6)						15 (1/14)			10 (1/9)
Regionalized 7		2	12 (6/6)	26 (20/6)		64 (20/44)				15 (1/14)			10 (1/9)
Centralized 1		1	12 (6/6)	26 (20/6)						15 (1/14)			10 (1/9)
Centralized 2		1	12 (6/6)	26 (20/6)		189 (79/110)	16 (16/0)			15 (1/14)			10 (1/9)
Centralized 3	7	1	12 (6/6)	26 (20/6)						26 (21/5)	55 (54/1)	11 (10/1)	10 (1/9)
Centralized 4	7	1	12 (6/6)	26 (20/6)		128 (49/79)	10 (10/0)			26 (21/5)	55 (54/1)	11 (10/1)	10 (1/9)
Centralized 5	1	1	12 (6/6)	26 (20/6)						15 (1/14)			10 (1/9)

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives use the same sites; each of the 12-site disposal alternatives use the same 12 sites.

[a] Values less than 10% are shown as blanks. Refer to the *Waste Management Environmental and Socioeconomic Impacts Methods and Results Technical Report* (DOE, 1996a) for complete results. CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter equal to or less than 10 micrometers in diameter, NO_2 = nitrogen dioxide; VOC = volatile organic compounds.

[b] Sites that exceed 10% of the standard specified by the General Conformity rule; total % (% equipment /% worker vehicles). Sites that do not exceed 10% are left blank.

[c] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[d] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

analysis performed for the WM PEIS, mitigation measures may be needed at NTS to reduce emissions of carbon monoxide to acceptable levels. These mitigation measures could include ride sharing, transit programs, parking management, compressed work weeks, flextime, and telecommuting. Mitigation could also include reducing emissions from existing activities to compensate for increased emissions from new WM activities. More recent estimates show increased releases of criteria air pollutants at ANL-E (see Appendix I).

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because of national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 km (62 miles) of a PSD Class I area. Nine sites proposed for LLW activities under the alternatives are located within 100 km of a PSD area: BNL, FEMP, INEL, LANL, LLNL, NTS, ORR, RFETS, and SNL-NM. None of these would have sufficient quantities of emissions to affect a PSD Class I area.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

7.5.3 Hazardous Air Pollutant Emissions

Thermal treatment of LLW will result in emission of small quantities of radionuclides. Since by definition LLW does not contain significant quantities of hazardous chemicals, emissions of other hazardous air pollutants were assumed to be negligible. Radionuclides from air emissions were evaluated by comparing the annual radiation dose to a maximally exposed individual (MEI) to the National Emissions Standard for Hazardous Air Pollutants—10 millirems per year (mrem/yr) (40 CFR 61).

Doses from airborne radionuclides were estimated not to equal or exceed 10% of the dose standard at any site except for LLNL (13%) under Regionalized Alternative 2. This exceedance is due to thermal treatment of LLW.

Table 7.5-3. Percent of Sites' Allowable Air Emissions Discharged During Operations—LLW Sites Equaling or Exceeding 10% of Standard[a]

Alternative	Number of Sites		Criteria Pollutants—Operations and Maintenance																			
			PSD or General Conformity																			
			ANL-E	BNL	Hanford		INEL		LANL	NTS	ORR		PORTS		PGDP		RFETS			SNL-NM	SRS	
	T[b]	D	NO_2[c]	NO_2[c]	NO_2[d]	PM_{10}[d]	NO_2[d]	PM_{10}[d]	PM_{10}[d]	CO[e]	NO_2[d]	PM_{10}[d]	NO_2[d]	PM_{10}[d]	NO_2[c]	VOC[c]	CO[e]	NO_2[c]	VOC[c]	CO[e]	NO_2[d]	
No Action	10[f]	6								67 (0/67)											11	
Decentralized		16	17 (2/15)	14 (4/10)							21	10	11		10 (3/7)		39 (0/39)			13 (0/13)		
Regionalized 1		12									21	10	16		10 (3/7)		39 (0/39)					
Regionalized 2	11	12							12				16	10	11 (3/8)	10 (0/10)	55 (0/55)	12 (1/11)	13 (0/13)			
Regionalized 3		6								11 (0/11)	47	21					11 (0/11)					
Regionalized 4	7	6							13		22	12					33 (0/33)					
Regionalized 5	4	6					15	22			27	18					11 (0/11)					
Regionalized 6		2															11 (0/11)					
Regionalized 7		2								67 (0/67)							11 (0/11)					
Centralized 1		1			19												11 (0/11)					
Centralized 2		1								183 (0/183)							11 (0/11)					
Centralized 3	7	1			19				12								33 (0/33)					
Centralized 4	7	1							12	118 (0/118)							33 (0/33)					
Centralized 5	1	1			27	36											11 (0/11)					

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives use the same sites; each of the 12-site disposal alternatives use the same 12 sites. CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = Particulate matter less than or equal to 10 micrometers in diameter; VOC = volatile organic compound.

[a] Blank cells are less than or equal to 10%.

[b] All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Nonattainment area for the pollutant ozone; NO_2 and VOC are ozone precursor emissions; General Conformity regulations applied; total % (% stationary-source / % mobile-source).

[d] Attainment area for this pollutant; PSD regulations applied; total % represents stationary-source emissions only.

[e] Nonattainment area for this pollutant; General Conformity regulations applied; total % (% stationary-source / % mobile-source).

[f] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

7.6 Water Resources Impacts

Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL Site-300 and the WVDP. Modeling indicates that groundwater concentration reduction measures may be needed for radionuclides when disposal occurs at the Hanford Site, Paducah, SNL-NM, and SRS. Concentration reduction measures would not be needed when disposal occurs at NTS, even under the Centralized 2 and 4 (one disposal site) Alternatives.

As illustrated in Table 7.6-1, DOE analyzed the impacts on water resources of treatment and disposal activities. DOE evaluated the effects on water availability from building and operating treatment and disposal facilities. DOE also examined the effects of migration of radionuclides from disposal facilities on groundwater quality.

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from effluent discharges
- Impacts on small onsite streams from effluent discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface water and groundwater quality from routine transportation and transportation accidents

7.6.1 Water Availability

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of LLW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 7.6–1. Water Resource Impacts Evaluated for LLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts are Assessed	Impacts Measure	Location of Impacts Assessment
Water Availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Table 7.6–2
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by treatment and disposal processes	Percent increase in current water use	Table 7.6–2
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only
Groundwater Quality	Post-Closure	Disposal of LLW	Percent of drinking water quality standard	Table 7.6–3

Table 7.6–2 identifies sites where projected water usage under any alternative would increase by more than 1%. This 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Eleven of the 16 major sites are predicted to exceed the 1% threshold. Most exceedances shown are due largely to water used during the 2- to 3-year period for construction of treatment and disposal facilities. Nine of these sites, ANL-E, FEMP, the Hanford site, INEL, NTS, ORR, Portsmouth, RFETS, and SRS, are not likely to experience adverse impacts because of sufficient capacities and the relatively small amount of additional water needed (DOE, 1996a). Two sites that could experience adverse impacts, LLNL and WVDP, are discussed further.

Water use at LLNL would exceed 1% of current use for all alternatives, and approach 23% under Regionalized Alternative 2. This is based on the conservative assumption that water at Site 300, the assumed location for proposed waste management facilities at LLNL, would be supplied by groundwater. However, most of the water would probably be supplied by the new municipal hook-up to Site 300, or the Livermore Valley municipal system that currently serves LLNL. If the water were supplied by the new 500,000 gallons

Table 7.6-2. Maximum Percent of Current Water Use for Construction or Operations—LLW Sites Predicted to Exceed 1%[a]

Alternative	Number of Sites		ANL-E	FEMP	Hanford	INEL	LLNL	NTS	ORR	PORTS	RFETS	SRS	WVDP
	T[b]	D											
No Action	10[c]	6					1.4					1.4	9.2
Decentralized		16	1.9				8.1		1.4		4.6	6.6	84
Regionalized 1		12					8.1		1.4	1.3	4.6	6.6	9.2
Regionalized 2	11	12		1.3			23			1.1	6.6	6.2	9.2
Regionalized 3		6					4.8		2.9		1.5	6.6	9.2
Regionalized 4	7	6					4.8		1.5		4.2	6.2	9.2
Regionalized 5	4	6				1.1	4.8		1.5		1.5	6.2	9.2
Regionalized 6		2					4.8				1.5	11	9.2
Regionalized 7		2					4.8				1.5	11	9.2
Centralized 1		1					4.8				1.5	1.5	9.2
Centralized 2		1					4.8	4.0			1.5	1.5	9.2
Centralized 3	7	1					4.8				4.2	1.7	9.2
Centralized 4	7	1					4.8	2.5			4.2	1.7	9.2
Centralized 5	1	1			2.1		4.8				1.5	1.5	9.2

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. D = Dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.

[a] Blank cells are less than or equal to 1%. Water sources assumed as follows: Groundwater for ANL-E, FEMP, INEL, LLNL, NTS, Ports, and SRS; Surface water for the Hanford site, ORR and WVDP; and Municipal water for RFETS.

[b] All sites perform "minimum treatment" under all alternatives consisting of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

per day municipal hook-up at Site-300, the maximum water use would be 4.1% of the capacity of the system. If the water were supplied by the municipal system in Livermore Valley, it would be 2.8% of the current water use rate of 717,000 gallons per day. If water for LLNL is supplied by an offsite municipal system, onsite water resources would not be affected. Therefore, adverse impacts to onsite water resources are unlikely. Impacts on the source of the municipal supply are not within the scope of this PEIS.

Water use at WVDP would be 84% of current use for the Decentralized Alternative. Water at WVDP would be supplied by surface water from two onsite reservoirs that impound water on tributaries of Buttermilk

Creek. Water use would be 53% of the 110,000-gallons-per-day capacity of the water supply system and less than 1% of the average flow in Buttermilk Creek of 41 million gallons per day. Major impacts to surface water levels and availability would be unlikely.

As shown in the Volume II tables, for DOE sites that withdraw water directly from a surface water source (the Hanford site, ORR, Paducah, and WVDP), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, FEMP, ORR, Paducah, Portsmouth, RFETS, SRS, and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

7.6.2 WATER QUALITY

DOE evaluated the impacts to groundwater quality caused by the migration of radionuclides that leach from disposal facilities over time. DOE calculated concentrations of radionuclides at a hypothetical well located 300 meters from the center of the disposal facility, and compared these to DOE or EPA drinking water standards (which have been adopted in DOE's internal orders). For radionuclides, the allowable drinking water concentrations equate to a 4 mrem per year effective dose equivalent.

The drinking water standards are used as comparison criteria for groundwater quality. Although they are not enforceable standards, they are often used as goals for contaminated site cleanup actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Because EPA established the drinking water standards to protect human health, groundwater concentrations of radionuclides at or below these levels present a low risk.

The discussions of impacts concentrate on contaminants that are near or exceed drinking water standards. Concentrations in the groundwater that equal or exceed 25% of the drinking water standard are presented.

Table 7.6–3 identifies sites where LLW would be disposed and where, under any alternative, the calculated value for any pollutant would exceed 25% of the drinking water standards.

Table 7.6–3. Percent of Drinking Water Standards in Groundwater From Disposal of LLW — Sites Exceeding 25% of Standard [a]

Alternative	Number of Sites		BNL	Hanford			PGDP	SNL-NM					SRS	
	T[b]	D	Tc-99	Tc-99	U-234	U-238	Np-237	Pu-239	Pu-240	Tc-99	U-234	U-238	Np-237	U-238
No Action	10[c]	6				100*	--	--	--	--	--	--		100*
Decentralized		16	30			100*	100	100*	100*	100*	100*	100*		100*
Regionalized 1		12				100*	100	--	--	--	--	--		100*
Regionalized 2	11	12				100*	100*	--	--	--	--	--		100*
Regionalized 3		6				100*	--	--	--	--	--	--		100*
Regionalized 4	7	6		30	30	100*	--	--	--	--	--	--		100*
Regionalized 5	4	6		30	30	100*	--	--	--	--	--	--		100*
Regionalized 6		2			40	100*	--	--	--	--	--	--	60	100*
Regionalized 7		2		--	--	--	--	--	--	--	--	--	60	100*
Centralized 1		1				100*	--	--	--	--	--	--	--	--
Centralized 2		1		--	--	--	--	--	--	--	--	--	--	--
Centralized 3	7	1				100*	--	--	--	--	--	--	--	--
Centralized 4	7	1		--	--	--	--	--	--	--	--	--	--	--
Centralized 5	1	1				100*	--	--	--	--	--	--	--	--

Notes: T = treatment. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D=disposal. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = no disposal at this site under this alternative. * = PEIS modeling indicates that a reduction in the estimated concentration in the groundwater would be necessary to meet drinking water standards. See Volume II tables for the value of the exceedance.

[a] Only radionuclides equal to or above 25% of drinking water standards are listed. Blanks indicate concentrations less than 25% of standards. See Appendix C for a list of the drinking water standards.

[b] All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above, include volume reduction facilities.

Disposal of LLW at BNL, the Hanford Site, Paducah, SNL-NM, and SRS is predicted to cause 25% of drinking water standards for radionuclides to be exceeded in the groundwater. BNL is located above an EPA-designated sole-source aquifer. Twenty-five percent of standards would not be exceeded when LLW is disposed at ANL-E, INEL, LANL, LLNL, NTS, ORR, the Pantex Plant, Portsmouth, RFETS, or WVDP. Only under the Centralized 2 and 4 Alternatives (disposal of all LLW at NTS) are 25% of drinking water standards not exceeded at any site. More recent estimates show increased releases of uranium-238 at Hanford and SRS (see Appendix I).

Radionuclides that would exceed 25% of the drinking water standards are neptunium-237, plutonium-239, plutonium-240, technetium-99, uranium-234, and uranium-238. These radionuclides all have long half-lives, with the minimum half-life being 6,537 years for plutonium-240. Shorter half-life radionuclides (e.g., cesium-137, strontium-90) tend to decay to acceptable levels before reaching the 300-meter well.

For radionuclides with long half-lives, disposal inventory, infiltration rate, depth to groundwater, and the character of the media through which the water flows are some of the primary factors that determine the concentration in the groundwater. The infiltration rate is related to rainfall; sites in arid regions generally perform better than sites in humid regions because of their smaller infiltration rate. Sites with a large depth to groundwater are generally better because of longer travel times. Sites located over areas with large percentages of materials that retard the movement of radionuclides (e.g., clays, organic materials) generally perform better than sites located over areas devoid of these materials.

Uranium-238 is the most problematic radionuclide, exceeding 100% of the standard at three sites (the Hanford site, SNL-NM, and SRS). In all of these cases, concentrations in the groundwater would have to be reduced to meet drinking water standards. Neptunium-237 (Paducah), plutonium-239 (SNL-NM), plutonium-240 (SNL-NM), technetium-99 (SNL-NM), and uranium-234 (SNL-NM) would also have to be reduced to meet drinking water standards. Measures that could be used to reduce the estimated concentration of radionuclides in the groundwater include:

- Modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration)
- Modifying the form of the waste to be disposed to reduce the release rate (e.g., changing to a vitrified waste form)

- Changing the specific location of the disposal facility so it is sited over an area with more favorable hydrologic conditions
- Imposing waste acceptance criteria (i.e., restricting the amount of the radionuclide allowed in the disposal facility)

The performance of disposal facilities at a specific site would also be evaluated in greater detail in DOE's Performance Assessment process under DOE Order 5820.2A (DOE, 1988). This process would help to ensure that all regulatory requirements are met and significant contamination of groundwater would not occur.

7.7 Ecological Resources Impacts

Loss of limited acreages of habitat at some LLW sites during construction site clearing would not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. Because construction site acreages are small compared to the total acreage at each site suitable for waste operations, DOE would be able to locate new LLW facilities to avoid impacts to nearby wetlands and other sensitive habitats. A screening level risk assessment of LLW facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to ecological resources, including threatened and endangered species, based on site-specific conditions. Transportation accidents leading to spills of LLW into aquatic environments could have serious short and long term consequences, but would be extremely rare. The Centralized alternatives have the highest probability of accidents because they require the greatest number of shipments; the Decentralized Alternative has the lowest probability.

As illustrated by Table 7.7-1, DOE analyzed the effects of construction site clearing to build LLW treatment and disposal facilities, and the operation of treatment facilities on ecological resources at representative sites. Accidental releases during intersite transportation of LLW, that could affect aquatic resources offsite, were also evaluated.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats

Table 7.7–1. Ecological Resources Impacts Evaluated for the LLW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive Habitat Effects	Terrestrial plants and animals	Comparison of habitat loss at LLW construction sites to general habitat range.	Text discussion only
Terrestrial Species Exposures	Terrestrial animal species	Comparison of estimated radiation dose of representative species with toxicity standard.	Text discussion only
Sensitive Habitat Effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats by comparing construction acreage to available acreage of nonsensitive habitats.	Text discussion only
Sensitive Species Concerns	Federally- and State-listed endangered and threatened species	Numbers of Federally- and State-listed species displayed by site/alternative.	Table 7.7–2
Effects of Transportation Accidents	Aquatic species in streams crossing transportation corridors	Results of scenario-based modeling analysis of accidental spill effects on fish in various size streams.	Text discussion only

based on site-specific conditions. Should sitewide or project-level NEPA reviews indicate that a site is not suitable for a waste management facility because of adverse impacts to sensitive species or habitats that cannot be avoided or mitigated, then DOE will reconsider its decision to locate a waste management facility at that site.

7.7.1 General Impacts of Site Clearing

None of the alternatives would require extensive site clearing for construction of LLW facilities. No more than 86 acres would be disturbed at any site under any LLW alternative. These acreage requirements are small compared to the available habitat for nonsensitive species represented at the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small mammals and song birds with limited home ranges), no significant effects to populations of these species are expected from the implementation of the LLW alternatives because nonsensitive species habitats are well established regionally.

7.7.2 Site Clearing Effects on Sensitive Habitats

For those sites that contain sensitive habitats, the degree to which these habitats may be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby LLW construction activities depends on DOE's ability to avoid siting near these habitats. A measure of this ability is the percentage of available land required for facility construction under any LLW alternative. Available acreage was estimated from site development plans either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage required for LLW facilities ranged from 0.0001% at NTS (under Regionalized Alternative 6 and Centralized Alternatives 1, 3, and 5) to 10.9% at WVDP (under Decentralized Alternative). Considering the available land required for the LLW facilities, DOE should have a great degree of flexibility in their siting and can employ a range of mitigative measures, so that site clearing to implement any of the LLW alternatives should not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices would minimize these effects. Direct discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

7.7.3 Effects of LLW Treatment Facility Emissions

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of radionuclides from treatment facilities. This analysis used the same atmospheric emissions estimates as the human health risk assessment and provided estimates of radionuclides deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Potential toxicity to terrestrial wildlife was analyzed for selected sites under the No Action, Decentralized Alternative, Regionalized Alternatives 2 and 5, and Centralized Alternative 5. The radionuclides Cs-137, H-3, Ni-63, Co-60, Sr-90, U-238, Pu-238, Pu-239, Pu-241, Y-90, Am-241, Pm-147, Th-234, and Ba-137 were selected for the analysis. These radionuclides comprised 80% of the total activity expected to be emitted. The

remaining activity was contributed by smaller emissions of a large number of radionuclides. The conservative assumptions used to characterize the scenario (e.g., accumulation of contaminants for 10-year period with no loss due to decay or transport) might compensate for limiting the analyses to 80% of the released activity. The concentrations of these radionuclides were used in calculating Hazard Indexes for each selected site/alternative combination as composite ratios between the estimated species exposures to each of the contaminants and estimated, contaminant-specific toxic levels. A Hazard Index greater than one would indicate a potential for the combined exposures to adversely affect the health of terrestrial species. The maximum estimated dose occurred at LLNL under Regionalized Alternative 2 and led to a maximum estimated Hazard Index of 0.09. This value suggests that the maximum total doses should be less than one-tenth of those of potential concern for ecotoxicity. Therefore, impacts to terrestrial receptor populations from radioisotope emissions from LLW treatment facilities are expected to be minimal. Additional information on the methods used to assess potential toxicity to terrestrial animals, as well as the results of the analysis, is presented in Section C.4.4. of Volume III and the impacts technical report (DOE, 1996a).

7.7.4 Consideration of Sensitive Species

For comparison of the LLW management program's potential to affect sensitive species, Table 7.7-2 lists the numbers of Federal- and state-listed sensitive species occurring or potentially occurring at each LLW site under each alternative. Site-specific analysis would be required to assess sensitive species impacts. That analysis would take into account specific locations for the LLW facilities in relation to the location of sensitive habitats and species at each site, including species listed by the U.S. Fish and Wildlife Service as endangered or threatened.

7.7.5 Effects of Low-Level Waste Transportation

The ecological impacts of a transportation accident involving shipment of LLW were analyzed based on an estimate of a waste spill release rate and stream characteristics for a hypothetical aquatic environment. The impacts of waste transportation accidents were evaluated by ORNL (1995d) as consequence assessments that did not include estimates of the probability of occurrence of these events. The transportation accident scenario analyzed spilling the contents of a rail shipment of LLW from INEL (ANL-W) into surface waters of different sizes. As a result of the packaging used in the transportation of LLW, it was assumed that the

Table 7.7–2. Numbers of Federally Listed and State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the LLW Sites by Alternative (Federal/State)

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T[a]	D																
No Action	10[b]	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	--	--	--	8/8	--
Decentralized		16	2/5	2/6	--	3/11	2/2	2/4	6/5	--	1/11	9/12	5/8	1/9	2/2	1/8	8/8	1/8
Regionalized 1		12	--	--	--	3/11	2/2	2/4	6/5	--	1/11	9/12	5/8	1/9	2/2	--	8/8	--
Regionalized 2	11	12	--	--	2/10	3/11	2/2	2/4	6/5	--	1/11	9/12	5/8	1/9	2/2	--	8/8	--
Regionalized 3		6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	--	--	--	8/8	--
Regionalized 4	7	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	1/9	2/2	--	8/8	--
Regionalized 5	4	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	--	--	--	8/8	--
Regionalized 6		2	--	--	--	3/11	--	--	--	--	--	--	--	--	--	--	8/8	--
Regionalized 7		2	--	--	--	3/11	--	--	--	2/2	--	--	--	--	--	--	8/8	--
Centralized 1		1	--	--	--	3/11	--	--	--	--	--	--	--	--	--	--	8/8	--
Centralized 2		1	--	--	--	3/11	--	--	--	2/2	--	--	--	--	--	--	8/8	--
Centralized 3	7	1	--	--	--	3/11	--	2/4	--	--	1/11	--	--	1/9	2/2	--	8/8	--
Centralized 4	7	1	--	--	--	3/11	--	2/4	--	2/2	1/11	--	--	1/9	2/2	--	8/8	--
Centralized 5	1	1	--	--	--	3/11	--	--	--	--	--	--	--	--	--	--	8/8	--

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = no major action proposed at the site under the alternative.

[a] All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are blank.

[b] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

entire contents of the shipments could be released to surface waters following an accident, but that only a small fraction of the release would be soluble.

According to the results of this analysis, an estimated 30,000 curies of radioactivity, including nearly 15,000 curies of Co-60, would be released into surface waters. Such a release would produce adverse impacts on aquatic populations in 385 meters of a second-order stream and in 1 meter of a fourth-order stream; larger streams are expected to be unaffected. DOE also evaluated the potential impacts of the spill under the assumption that all released material partitioned to sediment. Since LLW typically includes a large fraction of insoluble material, this scenario probably is a more accurate model of the potential consequences of a LLW transportation accident. The results of the sediment deposition scenario analysis suggest that more than 2,000 metric tons of sediment could be contaminated to a level requiring remediation. Additional information on the methods used to assess the potential consequences of LLW transportation accidents on aquatic environments, as well as the results of the analysis, is presented in Section C.4.4 of Volume III and the impacts technical report (DOE, 1996a).

7.8 Economic Impacts

LLW facility construction and operations expenditures would substantially benefit the local economy at 6 of the 16 major LLW sites through job or personal income of 1% or greater of the regional baseline under one or more of the alternatives. None of the LLW alternatives would affect the national economy.

DOE estimated the effects of expenditures for LLW management on the local and national economies (see Table 7.8-1). Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of treatment and disposal facilities. The socioeconomic region-of-influence (ROI) where local effects were evaluated, consists of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data for the ROI counties. Local jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at the national level only.

Table 7.8-1. Economic Impacts Analyzed for LLW Alternatives

Economic Impact Analyzed	Affected Aspect of Economy	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional employment multiplier at each LLW site	Table 7.8-2
Increased regional incomes	Regional personal income for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional income multiplier at each LLW site	Table 7.8-2
National economic effects	National economy	Proposed site expenditures plus total transportation expenditures multiplied by national employment and income multipliers	Text discussion only

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined to estimate total project effects at each site. For all alternatives (except No Action), the construction phase at any site was assumed to take 4 years; the operations phase was assumed to take 15 years (a 10-year operations and maintenance period and a 5-year decontamination period). Under the No Action Alternative, in place of distinct construction and operational phases, all costs were assumed to occur in a 20-year workoff of all existing waste (plus 5 years decontamination and decommissioning). Five years were added to both the construction and the operations phases to account for the continued effects on employment and income after each project phase ended. Job and personal income increases are shown for each site in the Volume II site tables.

Across the LLW alternatives, six DOE sites would experience a 1% or greater change in the number of jobs as a result of expenditures (see Table 7.8-2). The Hanford site would experience the greatest increase in the number of direct, indirect, and induced jobs under any of the alternatives, with a maximum increase of 3.3% under the Centralized Alternative 5. Other substantial increases in jobs occur at INEL and LANL under Regionalized Alternative 5, at LANL under Regionalized Alternatives 3 and 4, and at SRS under Regionalized Alternatives 6 and 7. Regionalized Alternative 2 and Centralized Alternative 3 would result in increases of 1% or greater in the number of jobs in five regional economies.

Changes in personal income of 1% or greater occur only at INEL under Regionalized Alternative 5 and at the Hanford site under the Centralized Alternative 5. In general, alternatives that include expenditures for

Table 7.8–2. LLW Jobs and Personal Income (P.I.) as a Percent of Jobs and Personal Income in the Regional Economic Baseline (LLW Sites Where Percentages Are 1% or Greater)[a]

Alternative	Number of Sites		Hanford		INEL		LANL		ORR		PORTS		SRS	
	T[b]	D	Jobs	P.I.	Jobs	P.I.	Jobs	P.I.	Jobs	P.I.	Jobs	P.I.	Jobs	P.I.
No Action	10[c]	6			1.1		1.2		1.1				1.4	
Decentralized		16			1.1		1.3				1.4		1.8	
Regionalized 1		12			1.1		1.6				1.6		1.8	
Regionalized 2	11	12			1.3		1.5		1.4		1.7		1.8	
Regionalized 3		6			1.1		2.1		1.0				1.8	
Regionalized 4	7	6			1.5		2.4		1.6		1.1		1.8	
Regionalized 5	4	6			3.0	1.1	2.2		1.8				1.8	
Regionalized 6		2											2.5	
Regionalized 7		2											2.5	
Centralized 1		1	1.7											
Centralized 2		1												
Centralized 3	7	1	1.5		1.0		1.4		1.3		1.1			
Centralized 4	7	1			1.0		1.4		1.3		1.1			
Centralized 5	1	1	3.3	1.2										

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = Dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. Blank cells equal jobs or personal income growth less than 1%.

[a] Blank cells are less than 1%.

[b] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

volume reduction at DOE sites would cost more than alternatives that employ only minimum treatment at those same DOE sites. Since economic impacts are linearly proportional to the amount of money spent, the alternatives employing volume reduction treatment would result in larger increases in the number of jobs and personal income.

Comparing the alternatives, the sum of the new direct, indirect, and induced jobs from combined weighted construction and operations and maintenance activities across site ROIs ranges from 9,000 under Centralized Alternative 1 to 18,600 under Regionalized Alternative 2.

In addition to analyzing the impacts on the regional economy, a comparison of these impacts was made on the national economy. None of the LLW alternatives would substantially affect the national economy. The total number of jobs generated in the national economy from combined weighted construction and operations phase activities range from 16,650 under Centralized Alternative 2 to 27,400 jobs under Regionalized Alternative 5. Although the number of jobs appears large in absolute terms, 27,400 jobs represent only 0.02% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. Changes would represent a shift in the source of income from previous employment to employment in LLW projects, rather than a net change in national personal income.

7.9 Population Impacts

Substantial population increases are anticipated at one of five DOE sites under seven of the LLW alternatives, at two sites under Regionalized Alternative 5. These increases could affect community structure and provision of services.

Potential population changes in the ROI at each LLW site were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used as an indicator of the likelihood that such population changes would cause effects, such as changes in community size, stability, diversity, and identity, and effects on the provision of necessary services. Sites identified with potential increases greater than or equal to 1% of the total ROI population are presented in Table 7.9-1.

Table 7.9–1. Percentage Population Increase for LLW Alternatives at Sites Identified With Potential Increases Over 1% of the Current ROI Population

Alternative	Number of Sites		Hanford	INEL	LANL	ORR	SRS
	T[b]	D					
No Action	10[c]	6					
Decentralized		16					
Regionalized 1		12			1.0		
Regionalized 2	11	12					
Regionalized 3		6					
Regionalized 4	7	6			1.4		
Regionalized 5	4	6		3.2		1.0	
Regionalized 6		2					1.3
Regionalized 7		2					1.3
Centralized 1		1					
Centralized 2		1					
Centralized 3	7	1			1.0		
Centralized 4	7	1			1.0		
Centralized 5	1	1	1.5				

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.
[a] Blank cells indicate that potential increases do not exceed 1%.
[b] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[c] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

For No Action and the Regionalized and Centralized minimum treatment alternatives, population in-migrations are not expected to be greater than or equal to 1% at any of the LLW sites, except SRS under Regionalized Alternatives 6 and 7. SRS would experience population increases of 1.3% and thus some impact to community characteristics and the provision of services may be anticipated. Under the Decentralized Alternative, LANL would experience a 1% population increase.

For those alternatives based on treatment by volume reduction, the Hanford site under the Centralized Alternative 5; INEL under Regionalized Alternative 5; LANL under Regionalized Alternative 4 and Centralized Alternatives 3 and 4; and ORR under Regionalized Alternative 5 would have population increases greater than or equal to 1%. Only one volume reduction alternative, Regionalized Alternative 2, has no sites with major population increases. One site is affected by more than one volume reduction alternative—LANL under Regionalized Alternative 4 and Centralized Alternatives 3 and 4. INEL and ORR

are affected only under Regionalized Alternative 5. Some minor impact may also be expected at the Hanford Site and SRS under Regionalized Alternatives 2, 4, and 5 and at ORR and Portsmouth under Regionalized Alternative 2.

All site population increases including those less than 1% are shown in Volume II site data tables.

7.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of LLW indicated that, with the exception of low-income populations at PORTS, minority and low-income populations at the LLW sites would not experience disproportionately high and adverse health risks or environmental impacts under most of the LLW alternatives.

Analysis of environmental justice impacts from management of LLW was based on a review of the impacts reported in this chapter regarding the LLW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the 16 major LLW sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done, and the maps illustrating the distribution of minority and low-income populations within 50 miles of each LLW site.

7.10.1 Results

The potential for adverse human health effects from exposures to radionuclide emissions from LLW treatment facility operations is low for most LLW management alternatives. Incident-free LLW treatment facility operations were analyzed (see Section 7.4.1) in terms of risk to workers and the public. Overall, at most sites, incident-free operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the surrounding populations.

Screening criteria for the nonworker MEI (see Appendix C) indicated a cancer fatality probability of 1.0E-06 or greater for facility operations at FEMP under Regionalized Alternative 2; at Hanford under Regionalized Alternatives 4 and 5 and Centralized Alternatives 4 and 5; at LLNL under Regionalized

Alternative 2; at ORR under Regionalized Alternative 5; and at PORTS under Regionalized Alternative 4 and Centralized Alternative 3. However, demographic analysis of the five ROIs (FEMP, Hanford, LLNL, ORR, PORTS) indicated that only at PORTS would the MEI be located in a minority or low-income census tract. At PORTS (under the Regionalized 4 and Centralized 3 Alternatives), the MEI would be located in a census tract with a low-income proportion (32.7%) that exceeds the national average (13.1%).

A more detailed analysis of environmental justice impacts would be included in NEPA documents that deal with site-specific activities. The number of potential fatalities due to both radiological and nonradiological exposures to truck or rail transportation of LLW is small.

7.10.1.1 Transportation

Because incident-free LLW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income populations, no environmental justice impacts are expected from transportation. As Section 7.4.2 indicates, total fatalities programwide to the collective population (all individuals within 0.5 mile of the transportation corridors) resulting from incident-free transportation range from less than 0.5 fatality to 12 fatalities or approximately 1 fatality for each 47 million shipment miles. This small number of collective population fatalities is spread across a large number of shipments. A disproportionate share of minority and low-income populations reside near interstate highways and railroads; however, the major routine risks to the public from truck transportation are from exposure during rest stops to travelers who are at the same rest stops. Minority and low-income populations are found to be disproportionately lower in representation at highway rest stops (DOT, 1992). For rail shipments, the primary risks to the public are from radiological exposure during railcar classification in railyards, primarily at the start and end of each shipment, and from the emission of diesel exhaust from the trains in urban areas. Even for the individuals expected to be exposed most frequently—residents near a site entrance, individual cancer fatality risk was only minimally elevated. This is true even at sites such as the Hanford Site and NTS, which handle 240,000 to 260,000 shipments (about 100 shipments per operational day) under various Centralized Alternatives during the 10-year operations period. Because the risks to these MEIs were found to be minimal (about 2 in 1 million), no segment of the population anywhere in the transportation corridors is expected to be at high risk. Therefore, no disproportionately high and adverse health effects to minority or low-income populations from incident-free LLW transportation are expected to occur.

The expected number of cancer fatalities due to radiation exposure from transportation accident releases, taking into account both the consequences of such a release and the probability that such a release will occur, is less than 0.5 under all alternatives. Estimated transportation accident fatalities from physical injuries range from less than 0.5 under the No Action Alternative to 35 under the Centralized Alternative 1 (approximately one fatality per 16 million shipment miles).

7.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 7.10.1 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Air quality impacts are possible at two sites, but no disproportionately high and adverse impacts are expected for any segment of the population.

None of the LLW management alternatives would have an adverse impact on land use, ecology, or cultural resources because of the limited amount of previously undisturbed land that would be needed for use onsite (no offsite lands are involved) and mitigation programs already in place. Because reasonably foreseen environmental impacts, if any, to land use, ecological resources, or cultural resources are expected to be small under any of the alternatives, DOE expects no disproportionately high and adverse environmental impacts to minority and low-income populations at the LLW sites.

7.11 Land Use Impacts

Land requirements for LLW facility construction are minimal at most sites under the LLW alternatives. However, under several alternatives, land requirements at FEMP, Hanford (under Centralized Alternative 5), ORR, Portsmouth, and WVDP would exceed 1% of land designated or suitable for waste operations. Further evaluation of these sites indicated no impacts are expected to current onsite land uses and no conflicts with offsite uses are expected. Review of site development plans indicated no conflict between proposed treatment or disposal facilities and other plans for the major sites.

DOE evaluated the impacts of the alternatives on land use by comparing the acreage required for new treatment and disposal facilities to the acreage either designated for waste operations or suitable for development (Table 7.11-1). Suitable land is the total site acreage, minus the acreage required for existing

Table 7.11-1. Land Use Impacts Analyzed for the LLW Alternatives

Land Use Impact Analyzed	Affected Land Use	Analysis Method	Presentation of Results
Effect on land use onsite at each LLW site	Land use shown in site development plans	Comparison of required land area with amount designated (or estimated land) for LLW plan—all instances where requirements are 1% or higher are noted.	Table 7.11-2
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed WM uses and nearby land uses.	Text discussion only

structures and roads, known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts between the proposed facilities required under each alternative and plans for future site uses.

The land requirements analysis indicated that for the majority of LLW sites under all the LLW alternatives, land required to build treatment, storage, and disposal facilities is less than 1% of designated or suitable site land. Sites where the facility land requirements constituted 1% or more of designated or suitable acreage are listed in Table 7.11-2. The land use requirements exceed 1% of site land at WVDP under all alternatives. With the single exception of WVDP under the Decentralized Alternative, none of the other sites would be expected to exceed 3% of the total available land area. Because the analysis showed that LLW facilities would require only a small portion of the designated or suitable land at these sites, no land impacts onsite are expected. For the same reason, no conflicts with adjacent land uses are expected.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations within a site. Should a sitewide or project-level NEPA review indicate that a site is not suitable for a waste management facility because of land use considerations that cannot be avoided or mitigated, then DOE will reconsider its decision to locate a waste management facility at that site.

Table 7.11–2. Percent of Waste Management-Designated or Suitable Land Required for LLW Facility Construction at Sites Where the Requirement is 1% or Greater [a]

Alternative	Number of Sites		FEMP	Hanford	ORR	PORTS	SNL-NM	WVDP
	T[b]	D						
No Action	10[c]	6	--		1.5	--	--	2.4
Decentralized		16	--		1.4	--	1	10.9
Regionalized 1		12	--		1.4	1.4	--	2.4
Regionalized 2	11	12	1.4			1.4	--	2.4
Regionalized 3		6	--		2.4	--	--	2.4
Regionalized 4	7	6	--		1.4		--	2.4
Regionalized 5	4	6	--		1.5	--	--	2.4
Regionalized 6		2	--		--	--	--	2.4
Regionalized 7		2	--		--	--	--	2.4
Centralized 1		1	--		--	--	--	2.4
Centralized 2		1	--		--	--	--	2.4
Centralized 3	7	1	--				--	2.4
Centralized 4	7	1	--				--	2.4
Centralized 5	1	1	--	1.4			--	2.4

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = No major actions are proposed at the site under the alternative.

[a] Blank cells indicate a requirement of less than 1%.

[b] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

7.12 Infrastructure Impacts

Proposed LLW activities would affect onsite infrastructure at 13 of the major sites, although no offsite infrastructure impacts are expected. New requirements for water, wastewater treatment, or electrical power for proposed LLW facilities equal or exceed 5% of current system capacity at seven sites. Hanford Site and WVDP would approach or exceed the total site wastewater treatment capacity (new requirement plus current treatment load) in the alternatives where Hanford accepts offsite waste for treatment and disposal and in the Decentralized Alternative for WVDP. At WVDP, power and water requirements exceed the total capacity of the current system. Wastewater requirements for all other alternatives for WVDP exceed the current capacity. Twelve sites experience employment increases of 5% or more of current site employment during construction which could lead to traffic increases that would affect onsite transportation infrastructure.

DOE evaluated impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and electrical power (See Table 7.12–1). Water and power were evaluated

Table 7.12-1. Infrastructure Impacts Analyzed for the LLW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support LLW facilities	Capacity of onsite water, power, and wastewater systems	Add increased LLW facility use to current use and compare to current capacities	Table 7.12-2
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Table 7.12-3
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to the onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on the community infrastructure.

Table 7.12-2 shows the increase in onsite demand for water, wastewater treatment, and electrical power at sites where the increase exceeds 5%. The potential for a major impact is assumed to exist where an increase of 5% or greater causes total demand to exceed 90% of capacity. A moderate impact is assumed possible where total demand remains below 90% of capacity. Impacts to offsite infrastructure are not expected because population increases do not exceed 5% at any site under any alternative.

As shown in Table 7.12-2, most of the infrastructure impacts relate to demand for wastewater treatment and power. Major wastewater treatment impacts would occur at the Hanford Site under Centralized Alternatives 3 and 5 and at WVDP under the Decentralized Alternative. For the Decentralized Alternative at WVDP, the new demands would exceed 90% of the capacity for all three resources. Because WVDP is currently using full capacity of the wastewater system, all alternatives will impact the treatment system infrastructure.

Table 7.12-2. Increase in Demand for Water, Wastewater, or Power as a Percent of Current Capacity—LLW Sites With Increases Exceeding 5%

Alternative	Number of Sites		ANL-E	Hanford	INEL	NTS	ORR	SRS	WVDP
	T[a]	D							
No Action	10[b]	6		Ww (6.6)					W (5.8) P (10.7)
Decentralized		16	P (7.4)		P (5.8)	--	P (5.6)		W (53.45) Ww (8.03) P (130.63)
Regionalized 1		12			P (5.8)	--	P (5.6)		W (5.8) P (10.7)
Regionalized 2	11	12		Ww (5.5)	P (7.1)	--			W (5.8) P (10.7)
Regionalized 3		6			P (5.8)		P (12.2)		W (5.8) P (10.7)
Regionalized 4	7	6		Ww (5.7)	P (7.2)		P (5.7)		W (5.8) P (10.7)
Regionalized 5	4	6		Ww (5.7)	**P (17.5)**		P (6.0)		W (5.8) P (10.7)
Regionalized 6		2		Ww (6.3)		--		Ww (5.4) P (5.6)	W (5.8) P (10.7)
Regionalized 7		2						Ww (5.4) P (5.6)	W (5.8) P (10.7)
Centralized 1		1		**Ww (8.26)** **P (6)**		--			W (5.8) P (10.7)
Centralized 2		1				P (12.3)			W (5.8) P (10.7)
Centralized 3	7	1		**Ww (15.9)** **P (6.3)**	P (7.2)	--			W (5.8) P (10.7)
Centralized 4	7	1			P (7.2)	P (7.6)			W (5.8) P (10.7)
Centralized 5	1	1		**Ww (50.8)**		--			W (5.8) P (10.7)

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = No major actions are proposed at the site under the alternative. Bold indicates major impact; all others are moderate. W = water; Ww = wastewater; P = power. Blank cells indicate an increase of 5% or less of current capacity.

[a] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

Table 7.12-3 identifies sites where the increase in site employment from construction activities exceeds 5%. These sites could experience impacts to the onsite transportation infrastructure from increased worker traffic. The Decentralized Alternative at WVDP would have an increase of approximately 41% for the site employment due to construction activities, which is the largest increase in site employment for the LLW waste management activities.

Table 7.12-3. Percent Increase in Site Employment From Construction—LLW Sites With Employment Increases Equal to or Greater Than 5%

Alternative	Number of Sites		FEMP	Hanford	INEL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SRS	WVDP
	T[a]	D												
No Action	10[b]	6	--						5	--	7	--	--	13
Decentralized		16	--			24	--	10	**16**		**16**		22	41
Regionalized 1		12	--			7	--		16		16		22	13
Regionalized 2	11	12	11		5	10	--	8	**24**		**29**	8	19	13
Regionalized 3		6	--			8	--	5	7	5		--	22	13
Regionalized 4	7	6	--		5	17		9	7	5	20	6	19	13
Regionalized 5	4	6	--		23	5		10	7	5		--	19	13
Regionalized 6		2	--	**5**	--	--			7	5		--	**36**	13
Regionalized 7		2	--		--	--	14		7	5		--	**36**	13
Centralized 1		1	--	**9**	--	--	--	--	7	5		--		13
Centralized 2		1	--		--	--	**26**	--	7	5		--		13
Centralized 3	7	1	--	**9**		13	--	7	7	5	20	7		13
Centralized 4	7	1	--			13	**8.6**	7	7	5	20	7		13
Centralized 5	1	1	--	**20**	--	--	--	--	7	5		--		13

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = Dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = No major action proposed for the site under the alternative. Bold indicates major impact; all others are moderate. Blank cells indicate site employment increases of less than 5%.

[a] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

7.13 Cultural Resources Impacts

Construction and operation of LLW facilities could adversely affect cultural resources. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where LLW treatment and disposal facilities are proposed to be built. Table 4.3-8 in Chapter 4 describes the status of cultural resources surveys at the 16 major proposed LLW sites and lists the reported cultural resources at those sites. However, the impacts of the construction of LLW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Land requirements for the construction of LLW waste management facilities are sufficiently small under all alternatives so that DOE would probably have enough flexibility in siting LLW facilities to avoid impacts on cultural resources. If not, measures would be taken to mitigate negative effects on these resources.

7.14 Costs

Costs decrease as the number of treatment and disposal sites decrease, ranging from $17 to $11 billion for minimum treatment, and from $20 to $15 billion for volume reduction treatment. At the alternative level, the increased cost of volume reduction treatment more than offsets the disposal savings achieved from reduced volume. Transportation costs are lower than facility costs, making shipment to available facilities at another site generally less expensive than building new onsite facilities.

Table 7.14-1 outlines the cost-analysis components that DOE used to estimate costs for building and operating LLW treatment and disposal facilities and for transporting LLW (INEL, 1995a,b). DOE evaluated costs associated with LLW management from both a life-cycle and process perspective, using 1994 dollars.

7.14.1 LIFE-CYCLE COST

DOE evaluated facility costs for four phases representing the life-cycle of the facilities and their operations: preoperations, construction, O&M, and decontamination and decommissioning. Life-cycle costs do not include speculative factors, such as impacts on the long-term value of land.

Costs for preoperation activities consist of technology and site adaptation, including bench-scale tests and demonstrations; permitting; plant startup and cold run costs; and related conceptual design, safety analysis, project management, and contingencies.

Facility construction costs consist of building construction, equipment purchase and installation, contractor overhead, and related design, construction management, project management, and contingencies. Mobilization and demobilization costs are included for portable treatment units.

Table 7.14-1. Components of Cost Analysis

Impacts Assessed	Functions Analyzed	Activities for Which Impacts Were Assessed	Location of Impacts Assessment
Process Costs	Treatment[a]	Life-cycle costs for treatment including support facilities; estimated for minimum treatment and volume reduction	Table 7.14-2
	Storage	No life-cycle costs for storage facilities were estimated; on-site storage was assumed to be adequate	Not applicable
	Disposal[b]	Life-cycle costs for disposal facilities	Table 7.14-2
Transportation Cost	Truck	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 7.14-2
	Rail	See above	Table 7.14-2

[a] No Action Alternative includes 20 years of treatment at the current mix of minimum treatment and volume reduction per site capabilities.
[b] Disposal includes closure and 300 years of postclosure custodial support.

Operations and maintenance costs consist of annual operations labor and material, maintenance labor and equipment, utilities, contractor supervision and overhead, and related project management and contingencies.

Decontamination and decommissioning costs consist of facility decontamination and demolition, closure, post-closure, and environmental monitoring activities.

7.14.2 PROCESS COST

DOE also analyzed costs for treatment, storage, and disposal activities. Treatment costs include costs to build and operate treatment facilities (such as incineration) and common support facilities (such as maintenance and certification/shipping facilities). For the No Action Alternative, DOE estimated the costs of a mix of minimum treatment and volume reduction, as accomplished currently by the sites. For the Decentralized Alternative, Regionalized Alternatives 1, 3, 6, and 7, and Centralized Alternatives 1 and 2, DOE estimated the costs of minimum treatment (solidification of liquids and fines as required to transport or for disposal). For Regionalized Alternatives 2, 4, and 5, and for Centralized Alternatives 3, 4, and 5, DOE estimated the cost of volume reduction (incineration, shredding, supercompaction, and follow-on solidification) at various combinations of regional treatment sites.

For the purpose of the WM PEIS analysis, existing LLW storage capacity is assumed to be sufficient for all alternatives. DOE assumed that after being treated, the waste would be disposed of in a timely manner. The minimal costs for storage were not estimated separately.

Disposal costs include costs to build and operate front-end administration and receiving facilities for disposal as well as the actual disposal units.

Transportation costs include the costs associated with the physical movement of the waste from one site to another, for either treatment or disposal. Transportation costs are evaluated for both truck transportation and rail shipments (INEL, 1995a).

Support facilities were assumed to be available for the No Action Alternative but were assumed to require construction for the other alternatives. Packaging and certification/shipping facilities were assumed to

require construction in each alternative because of their critical role in the proper control and tracking of waste, and because an inventory of existing support facilities was not available.

The summary of costs is shown in Table 7.14-2 (INEL, 1996). Construction accounts for 15% to 33% of the total costs, and O&M accounts for 49% to 72% of those costs. As waste is consolidated at fewer sites, costs for treatment and disposal facilities decrease, reflecting the economy of scale of using larger and fewer facilities. In considering minimum treatment, the reduction in cost between the Decentralized Alternative and Centralized Alternative 2 is $5.7 billion; the reduction is in disposal costs, partially offset by $2.2 billion of increased transportation costs. For volume reduction, the decrease in cost between Regionalized Alternative 2 and Centralized Alternative 5 is $4.2 billion. This is potentially offset by increased transportation costs of approximately $2.4 billion. Volume reduction treatment costs are twice as high as minimum treatment costs, and more than offset savings achieved in lowered disposal costs from less waste being disposed.

Although the quantity of waste requiring transport is at its maximum in the alternatives that centralize functions at NTS or the Hanford Site, the relative proportion of transportation costs remains relatively small, less than 21% of total costs. For the decentralized and regionalized alternatives, transportation costs are less, ranging from 0.1% to 5% of total costs.

7.15 Environmental-Restoration-Transferred Waste

The volume of LLW generated by environmental restoration activities that would be transferred to the waste management program is currently estimated to be about 140% of the volume of waste management LLW requiring treatment. The radiological profiles and physical characteristics of the environmental restoration (ER) transferred LLW have not yet been determined to the extent necessary to allow a meaningful evaluation of the potential environmental and human health impacts. The potential effects resulting from the treatment of the ER transferred LLW within the waste management program are discussed separately in the WM PEIS. When the radiological and physical characteristics of the ER transferred waste are better known, DOE may be required to assess the impacts of managing the ER transferred LLW on a site-specific basis.

Table 7.14-2. Life-Cycle Costs (billions of 1994 dollars)

Alternatives	Number of Sites		Total Costs[a] (Including Truck Transportation)	Life-Cycle Costs				Process Costs[b]		Transport Costs	
	T[c]	D		Preops	Const	O&M	D&D	T	D	Truck	Rail
No Action	10[d]	6	18.1	0.32	3.54	13.11	1.08	7.06	11.1	0.07	0.14
Decentralized		16	16.8	1.24	4.66	9.47	1.42	5.85	10.95	0.05	0.02
Regionalized 1		12	16.4	1.24	4.43	9.32	1.34	5.89	10.43	0.06	0.02
Regionalized 2	11	12	19.5	1.65	4.75	11.92	1.16	12.73	6.78	0.06	0.02
Regionalized 3		6	14.9	1.02	4.91	7.73	1.00	5.96	8.71	0.23	0.07
Regionalized 4	7	6	19.8	1.6	4.77	12.04	1.14	13.4	6.2	0.22	0.07
Regionalized 5	4	6	19.7	1.48	4.87	11.94	1.08	12.8	6.57	0.34	0.08
Regionalized 6		2	13.0	0.99	4.08	6.50	0.77	6.31	6.03	0.65	0.17
Regionalized 7		2	13.9	0.98	4.08	7.60	0.61	6.31	6.95	0.67	0.18
Centralized 1		1	12.2	0.77	1.89	6.02	1.09	6.47	3.3	2.46	0.44
Centralized 2		1	11.1	0.70	1.88	5.50	0.79	6.45	2.42	2.25	0.43
Centralized 3	7	1	18.2	1.39	3.14	10.47	0.94	13.3	2.57	2.34	0.43
Centralized 4	7	1	17.3	1.33	3.14	9.74	0.94	13.3	1.82	2.15	0.43
Centralized 5	1	1	15.3	1.08	2.59	8.17	0.98	10.23	2.57	2.45	0.43

Notes: Preops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning. T = treat; "treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose; each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.

[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. Total Costs, also in the table, add truck costs to the facility costs. Therefore, Total Costs equals the sum of life-cycle costs and truck costs and also equals the sum of process costs and truck costs.

[b] Since sites are routinely treating/packaging and shipping to disposal sites, the current storage is included in the site infrastructure accounts which are not included in this PEIS.

[c] All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[d] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

DOE is responsible for the management of wastes currently in inventory and those generated by future operations (referred to as "waste management" wastes). As discussed in Chapter 1, DOE is also responsible for the management and remediation of contaminated media including soils, groundwater, and buildings. DOE expects that most of the contaminated media at its DOE sites will be remediated under the Environmental Restoration Program. The extent to which media are "cleaned up" is site specific and will depend largely on regulatory requirements and decisions regarding future land use. For analytical purposes, a standard "base case" scenario has been developed that estimates remediation costs across the DOE complex (DOE, 1996c). Although most waste generated by cleanup activities will be managed within the Environmental Restoration Program, a certain subset of the waste generated by these remediation activities will be transferred to waste management facilities. In the WM PEIS, these wastes are referred to as "environmental restoration (ER) transferred wastes." At present, only estimates of the volumes of ER transferred waste are available. These estimates were used to provide a qualitative assessment about how the addition of ER transferred waste may affect LLW alternatives.

Appendix B provides more detail on how certain wastes generated during environmental restoration will be transferred to the waste management program for final disposition and provides estimates of the volumes of ER transferred LLW. Appendix B also discusses the assumptions and uncertainties involved in assessing how ER transferred LLW may affect waste management alternatives.

To conduct an impact analysis for the additional ER transferred LLW similar to that conducted for waste management LLW, additional information is needed on the ER transferred waste streams. In addition to the volume of ER transferred waste, information is needed on the treatability characterization of the individual transferred LLW streams, including data about the radiological profile, chemical constituents, and physical form of the ER transferred waste. The wastes would also have to be categorized according to alpha and non-alpha radionuclide composition. Physical characterization of the ER transferred wastes into one of the treatment categories identified for TRUW is needed to estimate management costs. Information about the timing for the transfer of ER wastes to the waste management program is needed to determine the capacities of treatment or disposal facilities. This information is also crucial to conduct transportation and socioeconomic analyses. However, in many cases, this information will not be available until site-specific cleanup is conducted.

To identify how the addition of ER transferred LLW could affect the comparison among waste management alternatives made in the WM PEIS, DOE compared the volumes of waste management LLW with the

expected volumes of ER transferred LLW. This analysis reveals the potential for overloading treatment facilities for those sites and alternatives where the volumes of ER transferred LLW are projected to equal or exceed the volumes of waste management LLW. Strategies that can be used to manage the additional loading of ER transferred LLW in order to avoid overloading facilities include increasing facility operational capacity and operating a facility longer to "work off" the increased waste load. The WM PEIS treatment facilities are assumed to have an effective operational life of at least 30 years, which allows for an additional 20 years of operational capacity beyond the 10 years needed to work off the waste management wastes.

Increased radiation and chemical exposure risks to site workers, offsite populations, and the environment are related to the radiological activity in the ER transferred wastes, which at present cannot be reliably predicted. However, because radiological activities and chemical concentrations in ER transferred waste are, in general, expected to be lower than those for comparable waste management waste, risks from the addition of ER transferred wastes are expected to be lower than the risks resulting from the treatment of equivalent volumes of waste management wastes. In addition, because most ER transferred LLW (e.g., soils and debris) is expected to be amenable to the minimal treatment (e.g., packaging or solidification) criteria to meet LLW disposal requirements rather than to the full volume reduction treatment, risks and impacts to offsite populations are expected to be comparable or lower than those for similar types of waste management LLW. Site-specific performance assessments would be conducted, and appropriate disposal restrictions would be imposed to manage any potential increased risks. The risks from physical hazards associated with operating facilities to manage the ER transferred waste are related to the volume relationship between the ER transferred and waste management wastes. Transportation risks and costs are also dependent on waste volumes rather than the composition of the waste.

Overall, the volume of ER transferred LLW is expected to be about 127% of the waste management LLW load (1,900,000 cubic meters compared with 1,500,000 cubic meters, respectively; see Table B.6-1). The additional ER transferred LLW would exceed the waste management LLW load at five sites (ANL-E, FEMP, INEL, NTS, and SNL-NM) under the Decentralized Alternative (see Table B.7-1). The additional ER transferred LLW would be 130% of the waste management load at ANL-E and would represent a 130% increase to the INEL LLW load. The large increase in ER transferred LLW at NTS and SNL-NM (650× and 14× the respective WM LLW loads) would require increased capacity for the minimal LLW treatment facility, along with a longer period of operation. Because the bulk of the ER transferred LLW would require minimal treatment at most sites, the effects of the additional ER transferred waste loads at

NTS and SNL-NM in the Regionalized Alternatives would be small. Using the minimal treatment option, the additional ER transferred LLW would also be expected to influence the Centralized Alternative. The large input of ER transferred LLW at FEMP (180,000 cubic meters compared to 0 for waste management LLW) is due to the fact that FEMP is considered an ER site, and thus all waste at the site is, by definition, ER waste. The ER transferred LLW at FEMP is designated for offsite disposal.

7.16 Comparison of Alternatives Summary

The LLW impacts were evaluated across all the LLW alternatives to identify trends and ultimately the preferred alternative. The following discussion focuses on each impact area, identifying alternative trends when appropriate, and highlighting noteworthy findings at particular sites.

Health Risks. For routine treatment, radiation exposure risks to offsite and noninvolved worker populations correlate most closely to the choice of treatment technology (volume reduction risks are 4-20 times higher than those for minimum treatment). Secondarily, the presence of particular sites and waste characteristics in the alternative influences risks. FEMP, Hanford, LLNL, ORR, and Portsmouth experience the highest offsite risk under volume reduction alternatives that consider thermal treatment of tritium-contaminated waste. The number of worker fatalities is about one order of magnitude higher than for other receptors, driven by physical hazards. The increase in treatment worker fatalities as a result of volume reduction treatment operations exceeds the decrease in disposal worker fatalities from handling smaller disposal volumes. Concentrations of radionuclides in groundwater exceed applicable standards at several sites, demonstrating the need for upgraded waste acceptance criteria and other site-specific considerations. Management of radionuclide concentrations and waste forms would be required to assure acceptable water quality and human health risks. One of the most prevalent causes of these exceedances was unconstrained disposal of uranium-238-containing wastes at Hanford and SRS, which was evaluated under most of the alternatives. Disposal of LLW containing uranium-238 must be carefully managed at these sites. In addition, radionuclide exceedances in groundwater were recorded for unconstrained disposal at SNL-NM in the Decentralized Alternative and at Paducah in Regionalized Alternative 2. All other sites meet groundwater standards based on the technical and wasteload assumptions used for the WM PEIS analysis.

The greatest potential consequences for facility accidents occur at sites treating wastes with high concentrations of radioactivity. Only three sites, LLNL, LANL, and Hanford, experience one or more fatalities for accidents evaluated in the WM PEIS.

Transportation risks are proportional to vehicle-miles traveled; consequently, the large volumes of LLW transported in the centralized alternatives lead to relatively high numbers of expected fatalities from both traffic accidents and radiation exposure. Rail accident nonradiological risks are lower than those for truck.

Air Quality Impacts. The management of LLW does not affect the air quality at most sites. However, decentralized treatment and disposal at BNL or centralized disposal at NTS could cause adverse air quality impacts requiring additional emission control measures for criteria pollutants. Emissions of radionuclides were estimated to be below the applicable standards at any site.

Water Resources Impacts. Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL Site-300 and WVDP. As discussed in Section 7.4.1.7, management of radionuclide concentrations from disposal at the Hanford Site, SRS, SNL-NM, and Paducah may be necessary to protect groundwater resources.

Ecological Resources, Cultural Resources, Environmental Justice Concerns, and Land Use. The WM PEIS analysis did not provide discriminators among the alternatives in these four impact areas. The programmatic analysis that was conducted did not reveal any major impacts in any alternative. However, impacts to ecological and cultural resources are dependent to some degree on specific technologies and their location at each site. These were not determined at the programmatic level of the WM PEIS, and these impact areas would be evaluated in more detail when such site-level details are evaluated. Land use is not a discriminator because the LLW alternatives do not use much land compared to the amount available at every site. Assessment of potential environmental justice impacts indicated that with the exception of low-income populations at PORTS, minority and low-income populations at the LLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the LLW alternatives.

Economic Impacts. Regional economies at six of the 16 major sites would benefit more substantially in jobs expected, in addition to the increased employment at the Hanford Site expected under all the LLW alternatives. None of the LLW alternatives would affect the national economy.

Population Impacts. Generally, the more sites considered in an alternative, the lower the level of impacts at the most affected sites. As waste is consolidated at fewer sites, effects at the shipping sites diminish but effects at the receiving sites and in the transportation corridors increase. The largest increases are evident at INEL under Regionalized Alternative 5 for treatment and disposal.

Infrastructure Impacts. Proposed LLW activities would affect onsite infrastructure at 13 of the major sites, although no offsite impacts are expected. New requirements for wastewater treatment or electrical power for proposed LLW facilities equal or exceed 5% of current system capacity at seven sites. The most significant increases are at INEL in Regionalized Alternative 5 (when volume reduction and disposal are regionalized at the site), at the Hanford Site (Centralized Alternatives 1, 3, and 5) when disposal is consolidated at these sites, and at WVDP (all alternatives). Increased wastewater inputs at Hanford could cause wastewater treatment capacity to be exceeded. For the Decentralized Alternative at WVDP, water, wastewater, and power requirements would exceed the current capacity. Because WVDP is already operating at capacity for wastewater, requirements for all the alternatives will impact the site's wastewater system. Twelve sites would experience employment increases of 5% or more of current site employment during construction, which could lead to traffic increases that would affect the onsite transportation infrastructure.

Costs. Costs decrease as the number of treatment and disposal sites decrease, ranging from $17 to $11 billion for minimum treatment, and $20 to $15 billion for volume reduction treatment. At the national level, the increased cost of volume reduction treatment more than offsets the disposal savings achieved from reduced volume. Transportation costs are lower than facility costs, making shipment to available facilities at another site generally less expensive than building new onsite facilities. The reason for pursuing both privatization and commercialization is the belief that private vendors may be able to perform the same tasks faster and at a lower cost than DOE, through innovative technology, efficient oversight, and application of other streamlined business practices. In the experience of other institutions that have attempted privatization, savings are more common than increased costs. Actual cost differences have not been calculated for this document for the privatization of DOE waste management activities. The details of cost estimating are covered in Section 5.3.3 in Volume I.

Summary of Impacts by Alternative. Tables 7.16–1 and 7.16–2 summarize key impacts for each alternative.

The Preferred Alternative for Treatment. Each site with LLW would treat its waste onsite. Each site would perform minimum treatment on its wastes to prepare them for disposal, although DOE would allow each of its sites the flexibility to perform additional treatment if it would decrease costs and requirements for transportation by significantly reducing the volume of LLW requiring disposal. The potential environmental impacts of all alternatives for treatment of LLW evaluated in the WM PEIS are small. The impacts of DOE's preferred alternative for LLW are identified in Regionalized Alternative 3 as shown in Table 3.7–1 in Chapter 3, under which the potential impacts associated with minimum treatment of LLW at each site were analyzed, assuming regionalized disposal, as discussed below.

The Preferred Alternative for Disposal. The Department's preferred alternative at this time is to send its LLW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW disposal operations and, except for NTS, each has large waste volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLW the Department will need to dispose of, there is no need to establish additional sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, with correspondingly higher traffic accident fatalities, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. However, a disposal configuration that included at least one eastern site and one western site would require less transportation and produce fewer fatalities from traffic accidents than an eastern-only or western-only configuration. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Table 7.16-1. Comparison of LLW Alternatives—Projected Risks Results

Alternative	Number of Sites		Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Disposal Worker Physical Hazard Fatalities	Disposal Worker Cancer Fatalities	Groundwater Impacts from Disposal			Truck Radiation Fatalities	Truck Non-Radiation Fatalities
	T[a]	D						Number of Sites That Meet Standards Without Additional Constraints	Number of Sites That Require Additional Constraints to Meet Standards	Radionuclides That Must Be Constrained for Sites to Meet Standards		
No Action	10[b]	6	3	1	*	4	3	4	2	U-238	5	12
Decentralized		16	2	1	*	6	2	12	3	Pu-239, Pu-240, Tc-99, U-234, U-238	*	1
Regionalized 1		12	2	1	*	6	3	9	2	U-238	*	1
Regionalized 2	11	12	4	1	1	4	2	8	3	U-238, Np-237	*	1
Regionalized 3		6	2	1	*	5	3	4	2	U-238	2	3
Regionalized 4	7	6	4	2	*	4	2	4	2	U-238	2	3
Regionalized 5	4	6	4	2	*	4	2	4	2	U-238	2	4
Regionalized 6		2	2	1	*	6	2	0	2	U-238	4	10
Regionalized 7		2	2	1	*	6	1	1	1	U-238	4	10
Centralized 1		1	2	1	*	1	3	0	1	U-238	16	37
Centralized 2		1	2	1	*	1	2	1	0	--	15	38
Centralized 3	7	1	4	1	*	1	2	0	1	U-238	15	35
Centralized 4	7	1	4	1	*	*	2	1	0	--	14	37
Centralized 5	1	1	4	2	*	1	2	0	1	U-238	15	37

Notes: T = treat; D = dispose. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. * = greater than 0 but less than 1.

[a] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites include volume reduction facilities.

Table 7.16–2. Comparison of LLW Alternatives—Selected Impacts

Alternative	Number of Sites		Number of Sites With Air Pollutants That Exceed Standards	Highest Air Pollutant Percentages at Any Site	Cost ($Billions)	Truck Shipments	Comment
	T[a]	D					
No Action	10[b]	6	0	67 (CO-NTS)	18.1	87,000	Current Program
Decentralized		16	1	100 (NO_2-BNL)	16.8	24,000	Expand from 6 current disposal sites to 16
Regionalized 1		12	0	88 (NO_2-PGDP)	16.4	26,000	Expand from 6 current disposal sites to 12
Regionalized 2	11	12	0	81 (NO_2-PGDP)	19.5	26,000	Volume reduce at 6 western, 5 eastern sites; expand from 6 current disposal sites to 12
Regionalized 3		6	0	47 (NO_2-ORR)	14.9	84,000	Disposal at 6 current sites, but ship based on proximity
Regionalized 4	7	6	0	55 (NO_2-RFETS)	19.8	87,000	Volume reduce at 4 western, 3 eastern sites; disposal at 6 current disposal sites
Regionalized 5	4	6	0	23 (NO_2-ORR)	19.7	92,000	Volume reduce at 2 western, 2 eastern sites; disposal at 6 current disposal sites
Regionalized 6		2	0	16 (CO-LLNL)	13.0	174,000	Disposal at SRS and Hanford
Regionalized 7		2	0	67 (CO-NTS)	13.9	189,000	Disposal at SRS and NTS
Centralized 1		1	0	19 (NO_2-HS)	12.2	243,000	Centralized disposal at Hanford
Centralized 2		1	1	189 (CO-NTS)	11.1	257,000	Centralized disposal at NTS
Centralized 3	7	1	0	55 (NO_2-RFETS)	18.2	250,000	Volume reduce at 4 western, 3 eastern sites; disposal at Hanford
Centralized 4	7	1	1	128 (CO-NTS)	17.3	264,000	Volume reduce at 4 western, 3 eastern sites; disposal at NTS
Centralized 5	1	1	0	36 (PM_{10}-HS)	15.3	242,000	Volume reduce and dispose at Hanford

Notes: T = treat; "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.

[a] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites include volume reduction facilities.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Table 7.16–3 provides potential impacts for the preferred alternative by combining the impacts evaluated in the WM PEIS for the preferred alternative at each site. Although it is not possible to estimate disposal impacts with precision until the disposal sites have been selected, the table provides approximate values and ranges expected for the preferred LLW alternatives. Treatment and disposal impacts are taken from Volume II site data tables for the preferred alternatives specified in the second and third rows of Table 7.16–3. Values presented in the table for regionalized disposal use impacts estimated at Hanford, INEL, LANL, NTS, ORR, and SRS for Regionalized Alternative 3 (six disposal sites), Centralized Alternative 1 (one disposal site—Hanford), and Centralized Alternative 2 (one disposal site—NTS) to provide a range of potential impacts. Impact estimates under Centralized Alternative 1 at Hanford and Centralized Alternative 2 at NTS are greater than expected at either site. They provide an upper limit for the range of impacts at these sites, using impacts that result when all LLW is disposed of at one site—Hanford or NTS. The preferred disposal alternative would distribute disposal impacts over two to three sites, lowering values shown for Hanford or NTS.

Table 7.16-3. The Preferred LLW Alternative — Selected Impacts

Impact Area	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Total
Preferred alternative	T	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	
	D[a]	—	—	—	R	R	—	R	R	R	—	—	—	—	—	R	—	
Worker physical hazard fatalities	T	5.1E-02	4.3E-02	—	1.2E-01	1.5E-01	5.7E-02	1.4E-01	6.2E-03	2.8E-02	1.1E-01	2.5E-02	2.3E-01	8.0E-02	5.1E-02	4.4E-01	5.3E-02	1.6E+00
	D	—	—	—	0.0E+00–<1.4E+00	0.0E+00–2.5E-01	—	0.0E+00–4.1E-01	0.0E+00–<6.1E-01	0.0E+00–4.0E-01	—	—	—	—	—	0.0E+00–3.5E+00	—	6.1E-01–4.8E+00
	Total	5.1E-02	4.3E-02	—	1.2E-01–<1.5E+00	1.5E-01–4.0E-01	5.7E-02	1.4E-01–5.5E-01	6.2E-03–<6.2E-01	2.8E-02–4.3E-01	1.1E-01	2.5E-02	2.3E-01	8.0E-02	5.1E-02	4.4E-01–3.9E+00	5.3E-02	2.2E+00–6.4E+00
Worker cancer fatalities	T	3.2E-02	3.9E-02	—	9.9E-02	1.7E-01	2.5E-03	1.4E-01	3.0E-04	6.1E-02	1.5E-03	7.8E-04	4.6E-03	1.2E-03	4.1E-04	2.3E-01	1.3E-02	8.0E-01
	D	—	—	—	0.0E+00–<2.8E+00	0.0E+00–4.2E-01	—	0.0E+00–7.8E-01	0.0E+00–<2.2E+00	0.0E+00–5.5E-01	—	—	—	—	—	0.0E+00–5.8E-01	—	2.2E+00–2.8E+00
	Total	3.2E-02	3.9E-02	—	9.9E-02–<2.9E+00	1.7E-01–5.9E-01	2.5E-03	1.4E-01–9.2E-01	3.4E-04–<2.2E+00	6.1E-02–6.1E-01	1.5E-03	7.8E-04	4.6E-03	1.2E-03	4.2E-04	2.3E-01–8.1E-01	1.3E-02	3.0E+00–3.6E+00
Offsite population cancer fatalities	T	2.5E-06	2.3E-06	—	2.7E-06	8.0E-07	1.0E-02	2.1E-04	1.4E-12	5.0E-06	2.1E-08	4.4E-07	1.8E-09	4.0E-07	1.8E-06	1.9E-05	2.1E-06	1.0E-02
Radionuclides requiring constraints to meet groundwater standards	D	—	—	—	None or U-238	None	—	None	None	None	—	—	—	—	—	None or U-238	—	0-2 sites exceed

Table 7.16–3. The Preferred LLW Alternative — Selected Impacts—Continued

Impact Area	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Total
Preferred alternative	T	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	
	D[a]	—	—	—	R	R	—	R	R	R	—	—	—	—	—	R	—	
Truck radiation fatalities		These numbers reflect intersite transportation results and are not attributable to individual sites																2-16
Truck nonradiation fatalities																		3-38
Highest air pollutant percentage	T	12% NO_2	26% NO_2	—	0%	1% NO_2/PM_{10}	0%	1% NO_2/PM_{10}	5% CO	47% NO_2	7% NO_2	0%	0%	15% CO	0%	3% NO_2	0%	no sites exceed
	D	—	—	—	0% - 19% NO_2	—	—	—	0% - 183% CO	—	—	—	—	—	—	—	—	0-1 sites exceed
Cost $ billions	T	.11	.11	—	.24	.66	.21	.29	.04	.71	.28	.14	.17	.23	.11	.90	.33	4.53
	D	0	0	—	.0–3.8	0-.61	0	0–1.72	0–<2.95	0–2.16	0	0	0	0	0	0-4.04	0	3.0-9.3
	Total[b]	.11	.11	—	.24–<4.05	.66–1.27	.21	.29–2.0	.04–<3.0	.71–2.87	.28	.14	.17	.23	.11	.90–4.95	.35	7.5E-0–13.8E-0
Truck shipments		1,050	1,350	0	0–243,000	0–8,520	620	11,420-18,400	120-257,000	55,000–65,000	6,270	420	33,000	3,570	330	20–68,000	6,620	84,000–257,000[c]

[a] DOE prefers to further narrow its configuration of disposing sites to 2-3 sites from these 6 sites. DOE has no site preferences pending further deliberations with regulators and stakeholders.

[b] Total costs for the alternative as presented in Table 7.16-2 are calculated by adding additional treatment costs for non-major DOE sites (estimated at $1.4 billion) and truck transportation costs (which vary from $0.2 billion for R3 to $2.5 billion for C1) to the costs presented here. The total cost for the alternative could therefore vary between $11.4 billion and $15.4 billion. For the preferred disposal alternative, disposal volumes would range between zero and those quantities disposed of in the Regionalized Alternative 3, at INEL, LANL, ORR, and SRS. At Hanford volumes would range between zero and those evaluated for Centralized Alternative 1. At NTS volumes would range between zero and those evaluated for Centralized Alternative 2.

[c] Total one-way shipments between two sites, as defined for shipments in Table 7.16–2, range between values for Regionalized Alternative 3 and Centralized Alternative 2.

Chapter 7

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Low-Level Waste Alternatives

Alternatives	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	10[a]	6				TD	TD	D	T	D	TD	T			T		TD	
Decentralized		16	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Regionalized 1		12			D	D	D	D	D	D	D	D	D	D	D		D	
Regionalized 2	11	12			TD	TD	TD	TD	TD	D	TD	TD	TD	TD	TD		TD	
Regionalized 3		6				D	D	D		D	D						D	
Regionalized 4	7	6				TD	TD	TD		D	TD			T	T		TD	
Regionalized 5	4	6				TD	TD	D		D	TD						TD	
Regionalized 6		2				D											D	
Regionalized 7		2								D							D	
Centralized 1		1				D												
Centralized 2		1								D								
Centralized 3	7	1				TD	T	T			T			T	T		T	
Centralized 4	7	1				T	T	T		D	T			T	T		T	
Centralized 5	1	1				TD												

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. D = dispose. Each of the 6-site disposal cases uses the same sites; each of the 12-site disposal cases uses the same 12 sites. Blanks indicate that no treatment or disposal takes place at these sites under the specified alternative.

[a] Ten sites use existing facilities for volume reduction. Three sites not listed as major sites above (LBL, RMI, and Mound) include volume reduction facilities.

CHAPTER 8
Impacts of the Management of Transuranic Waste

Chapter 8 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for transuranic waste (TRUW). This chapter provides information on existing and anticipated TRUW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to TRUW characteristics, the treatment and technologies considered, and the rationale for selecting the specific sites analyzed under each alternative. This chapter discusses the health risk, environmental impacts, and costs of the alternatives and provides a comparison of the alternatives.

The methods used to evaluate impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the TRUW analysis are contained in the technical report entitled "Transuranic Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports provided in Chapter 15.

8.1 Background

- *TRUW is material produced during research and development, nuclear weapons production and dismantlement, and fuel reprocessing. It contains elements with atomic numbers greater than that of uranium, which has an atomic number of 92.*
- *TRUW is managed, or may be managed in the future, at 16 waste generator/storage sites, a number of other small generator sites, and a planned disposal site, the Waste Isolation Pilot Plant (WIPP).*
- *DOE's Waste Management Program will manage approximately 132,000 cubic meters of TRUW over the next 20 years.*
- *Although approximately 60% of TRUW contains both radioactive and hazardous components, DOE assumes that all TRUW is mixed waste for purposes of the WM PEIS analysis.*
- *DOE must select sites for the treatment and storage of TRUW.*

8.1.1 DEFINITION AND ORIGIN

Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for (a) high-level radioactive waste, (b) waste that the Secretary has determined, with the concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations, or (c) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by case basis in accordance with Part 61 of Title 10, Code of Federal Regulations (10 CFR 61) (WIPP Land Withdrawal Act, Public Law

102-579).[1] The radioactive nuclides in transuranic waste emit alpha radiation, which requires minimal shielding when outside the body but can severely damage human tissue if taken into the body by inhalation, ingestion, or other means (such as through cuts). Transuranic waste requires long-term isolation from the environment. It is produced during reactor fuel assembly, research and development, nuclear weapons production, and spent nuclear fuel reprocessing. Transuranic waste contains traces of plutonium, with lesser amounts of neptunium, americium, curium, and californium. Other alpha-contaminated waste peculiar to a specific site may be managed as TRUW. For example, waste managed as TRUW at WVDP includes radioactive waste with concentrations of transuranic radionuclides as low as 10 nanocuries per gram, pursuant to the West Valley Demonstration Project Act.

Approximately 60% of TRUW is mixed waste, with both radioactive and hazardous components. However, for purposes of the WM PEIS analysis, DOE analyzes all TRUW as if it were mixed waste.

Because of its radioactive characteristics, TRUW falls under the jurisdiction of the Atomic Energy Act. In addition, TRUW's hazardous constituents are regulated under the Resource Conservation and Recovery Act (RCRA) (42 USC 6901 *et seq.*). The hazardous components, such as solvents and heavy metals, can be subject to RCRA land disposal restrictions (LDRs) (40 CFR 268) promulgated by the U.S. Environmental Protection Agency (EPA). The amendments to the Waste Isolation Pilot Plant Land Withdrawal Act contained in the 1997 Defense Authorization Act, however, exempt waste to be disposed of at WIPP from RCRA's provisions regarding LDRs.[2]

DOE plans to dispose of TRUW generated from defense activities and retrievably stored since 1970 at a geologic repository called the Waste Isolation Pilot Plant (WIPP), located near Carlsbad, New Mexico. In 1980, DOE issued a final environmental impact statement (EIS) on the proposed development of WIPP (DOE, 1980). DOE's record of decision (ROD), issued in 1981, called for the phased development of the repository. DOE prepared a Supplemental EIS (WIPP SEIS-I) in 1990 to analyze changes in environmental impacts since the 1980 EIS (DOE, 1990). In a 1990 ROD, DOE decided to continue with phased

[1]LLW and LLMW may also contain these transuranic isotopes, but with concentrations less than 100 nanocuries per gram of waste.

[2]The Waste Isolation Pilot Plant Land Withdrawal Act of 1992 provides for the disposal of 175,600 cubic meters (6.2 million cubic feet) of "defense TRUW" at WIPP provided all regulatory requirements are met. WVDP and other DOE sites have small amounts of "nondefense" TRUW. For purposes of analysis in this WM PEIS, DOE has assumed that all TRUW is defense TRUW and will be disposed of at WIPP. The impacts of treating and disposing of nondefense TRUW are evaluated in some of the alternatives analyzed in the second supplemental EIS for WIPP (WIPP SEIS-II) (DOE 1996e).

development of the WIPP. DOE is examining whether or not to dispose of TRUW in WIPP in a second supplemental EIS (WIPP SEIS-II) (DOE, 1996e).

However, disposal of TRUW cannot begin until DOE meets a series of regulatory requirements imposed under the Waste Isolation Pilot Plant Land Withdrawal Act, as well as other applicable regulatory and permitting requirements. Before shipment for disposal, all TRUW will be required to meet the Waste Isolation Pilot Plant Waste Acceptance Criteria (WIPP-WAC) that will be established by DOE in consultation with EPA and the State of New Mexico (DOE, 1991). However, this consultation process has not been completed yet, and additional treatment could be required to reduce the potential for gas generation at WIPP.[3] Since the Draft WM PEIS was prepared, DOE has revised the WIPP-WAC that it uses for planning purposes (DOE, 1996a). Revision 5 eliminated WAC that applied only to waste that would have been used in underground-test-phase experiments at WIPP, which were canceled, and revised the remaining requirements to make the document easier to use. Some additional requirements were added, including limits on volatile organic compounds and polychlorinated biphenyls. In general, the changes to the WIPP-WAC were minor, and the revised WIPP-WAC are slightly more restrictive than the previous version. Under the circumstances, the analysis in the Draft WM PEIS, which was based on Revision 4 of WIPP-WAC, is assumed to be adequate for the purposes of bounding the impacts that might be expected from packaging and treating waste to meet Revision 5 of WIPP-WAC.[4]

8.1.2 Volumes and Locations

Table 8.1–1 presents the estimated total volume of TRUW from waste management activities at the 16 sites where the largest amounts of TRUW are currently present or projected. (Details on the amounts and characteristics of TRUW are provided in ANL [1996].) Of these 16 sites, 10 (ANL-E, Hanford, INEL, LANL, LLNL, NTS, ORR, PGDP, RFETS, and SRS) and the WIPP site, which currently does not contain TRUW, were fully evaluated for environmental impacts and costs for each alternative considered in the WM PEIS. For the remaining six (ETEC, LBL, Mound, SNL-NM, UofMO, and WVDP) and for Pantex, the

[3] Treatment to reduce gas generation is considered in this PEIS. For TRUW, gas could be generated by the corrosion of metals in the waste, the metal containers themselves, and by microbial decomposition of the waste. DOE is evaluating in the WIPP SEIS-II (DOE, 1996e) an alternative for disposal of TRUW after treatment to reduce gas generation. Recent studies suggest that gas generation will not affect WIPP's ability to contain hazardous and radioactive constituents of TRUW.

[4] The WIPP SEIS-II (DOE, 1996e) evaluated Revision 5 of the WIPP-WAC.

Table 8.1-1. Transuranic Waste Volumes (cubic meters)

Site[a]	Contact-Handled TRUW			Remote-Handled TRUW			Total
	Inventory[b]	20-Year Projected Generation	Estimated Inventory + 20 Year Generation	Inventory[b]	20-Year Projected Generation	Estimated Inventory + 20 Year Generation	
ANL-E	15 (25)	940	960	0	340	340	1,300
ETEC	0.02 (2)	0	0.02	0 (6)	0	0	0.02
Hanford	12,000 (12,000)	24,000	36,000	200 (200)	15,400	16,000	52,000
INEL	38,000 (28,000)	280	38,000	110 (220)	500	610	39,000
LANL	8,200 (11,000)	2,500	11,000	79 (94)	10	89	11,000
LBL	0.8 (0)	0.2	1	0 (0)	0	0	1
LLNL	200 (230)	1,500	1,700	0 (0)	0	0	1,700
Mound	274 (300)	1,200	1,500	0 (0)	0	0	1,500
NTS	610 (620)	0	610	0 (0)	0	0	610
ORR	670 (1,300)	360	1,000	1,300 (2,500)	360	1,700	2,700
PGDP	14 (0)	0	14	0 (0)	0	0	14
RFETS[c]	1,500 (4,900)	4,800	6,200	0 (0)	0	0	6,200
SNL-NM	1 (7)	0	1	0 (0)	0	0	1
SRS	5,100 (2,900)	11,500	16,600	1 (0)	20	21	16,600
UofMO	0 (1)	2	2	0 (0)	0	0	2
WVDP	0.5 (0)	0	0.5	0 (0)	0	0	1
Total[d]	67,000 (61,000)	47,000	114,000	1,700 (3,000)	17,000	18,000	132,000
Other Sites Reporting TRUW Inventories:[e]							
Ames	(0)			(0)			
BCL	(0)			(580)			
Bettis	(0)			(0)			
Pantex	(1)			(0)			
TBE[f]	(1)			(0)			
USAMC[f]	(3)			(0)			

[a] WIPP, the seventeenth site, does not currently have any TRUW.
[b] Amount shown parenthetically indicates volume reported in BIR-2 (DOE, 1995c) and the WIPP SEIS-II (DOE, 1996e). Comparison of values is not necessarily appropriate because the BIR-2 estimates of volume reflect some level of treatment.
[c] Includes volume estimate of plutonium process residues.
[d] Volume data are rounded from field estimates and columns and rows do not add. Waste volume projections contained in this and other WM PEIS tables were based on 1993 or earlier data and may vary from the latest site estimates at the time of publication. Updated inventories and waste generation rates are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW."
[e] These sites are additional small quantity generators reported in the BIR-2 (DOE, 1995c) and the WIPP SEIS-II (DOE, 1996e) that constitute less than 1% of the total TRUW inventory.
[f] TBE = Teledyne Brown Engineering; USAMC = U.S. Army Material Command.

Sources: DOE (1992, 1993, 1995b,c).

TRUW volumes were very low (2 cubic meters or less) and did not warrant analysis of impacts because of the minimal amount of handling and packaging that would be required. However, the volumes for these six sites were included with waste that would be treated or stored at Regionalized or Centralized facilities. Waste volume managed at the 16 TRUW sites considered in the WM PEIS accounts for more than 99% of the Department's current and projected TRUW inventory.

TRUW is categorized as either contact-handled (CH) or remote-handled (RH) based on the level and type of radioactivity emitted. CH-TRUW consists primarily of alpha particles and low energy radionuclides with little penetrating power. CH waste containers can be handled directly by humans. As illustrated in Table 8.1-1, more than 85% of the total volume of TRUW is CH-TRUW. RH-TRUW typically contains a greater proportion of radionuclides that produce highly penetrating radiation (gamma radiation) and thus must receive special shielding in treatment, storage, and disposal facilities.

Since the initial preparation of the WM PEIS, DOE has issued updated information on TRUW volumes in the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report*, Revision 2 [WIPP BIR-2] (DOE, 1995c) and the *Mixed Waste Inventory Summary Report* [MWIR 95] (DOE, 1995b). Appendix I discusses how newly available data on TRUW may impact the analyses of alternatives in the WM PEIS. This more recent information revealed additional "small-quantity" generator or storage sites, which have or are expected to manage TRUW. The TRUW volumes at these small-quantity sites constitute less than 1% of the total TRUW inventory and are not expected to affect the TRUW analysis in the WM PEIS because sites with small amounts of TRUW are not well-suited for treatment facilities, as quantities of offsite TRUW greater than that stored onsite would have to be transported to such sites if they were proposed for treating TRUW in the various alternatives. Table 8.1-1 has been updated to identify these sites. Waste inventories from the BIR-2 for these sites, as well as for other sites, are expressed parenthetically because most of these data were not analyzed in the WM PEIS. The WIPP SEIS-II inventory is based on BIR-2.

Table 8.1-1 provides estimates of volumes of TRUW currently in inventory and estimates of the volumes DOE anticipates generating during the next 20 years; these estimates do not include wastes that may be generated as a result of environmental restoration activities.[5] The largest volumes of TRUW are located at

[5] The waste volumes also do not include TRUW generated before 1970. TRUW generated before 1970 is known as "buried TRUW." This waste is considered environmental restoration waste and will be managed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Section 8.15 of this chapter contains information regarding TRUW generated as a result of environmental restoration activities

10 sites, with 95% of the waste located at six of these sites: Hanford, INEL, LANL, ORR, RFETS, and SRS. Figure 8.1-1 presents the total TRUW volumes at the major sites. The data shown in Table 8.1-1 were obtained primarily from the *Interim Mixed Waste Inventory Report* (DOE, 1993) and *Integrated Data Base for 1992* (DOE, 1992),[6] with updated information on waste volumes used for two sites. As described in Appendix I, more recent data for TRUW were taken primarily from two sources: the *Mixed Waste Inventory Summary Report* [MWIR 95] (DOE, 1995b) and the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report, Revision 2* [WIPP BIR-2] (DOE, 1995c), with most of the new information taken from MWIR 95. MWIR 95 contains information on waste as it currently exists, and specifies treatability groups, and therefore is used in the WM PEIS analyses for calculating impacts from consolidating or decentralizing the treatment of TRUW throughout the DOE complex. Such information on as-generated waste forms is readily available from MWIR 95 but is not readily extracted from the WIPP BIR-2 data. A portion of the WIPP BIR-2 waste loads reflect some level of treatment because they are intended to represent the volume of wastes in the forms they might be disposed of at WIPP. The WIPP BIR-2 was also used for its radiological profiles and for more definitive waste volumes estimates for the years that are not covered by MWIR 95.[7]

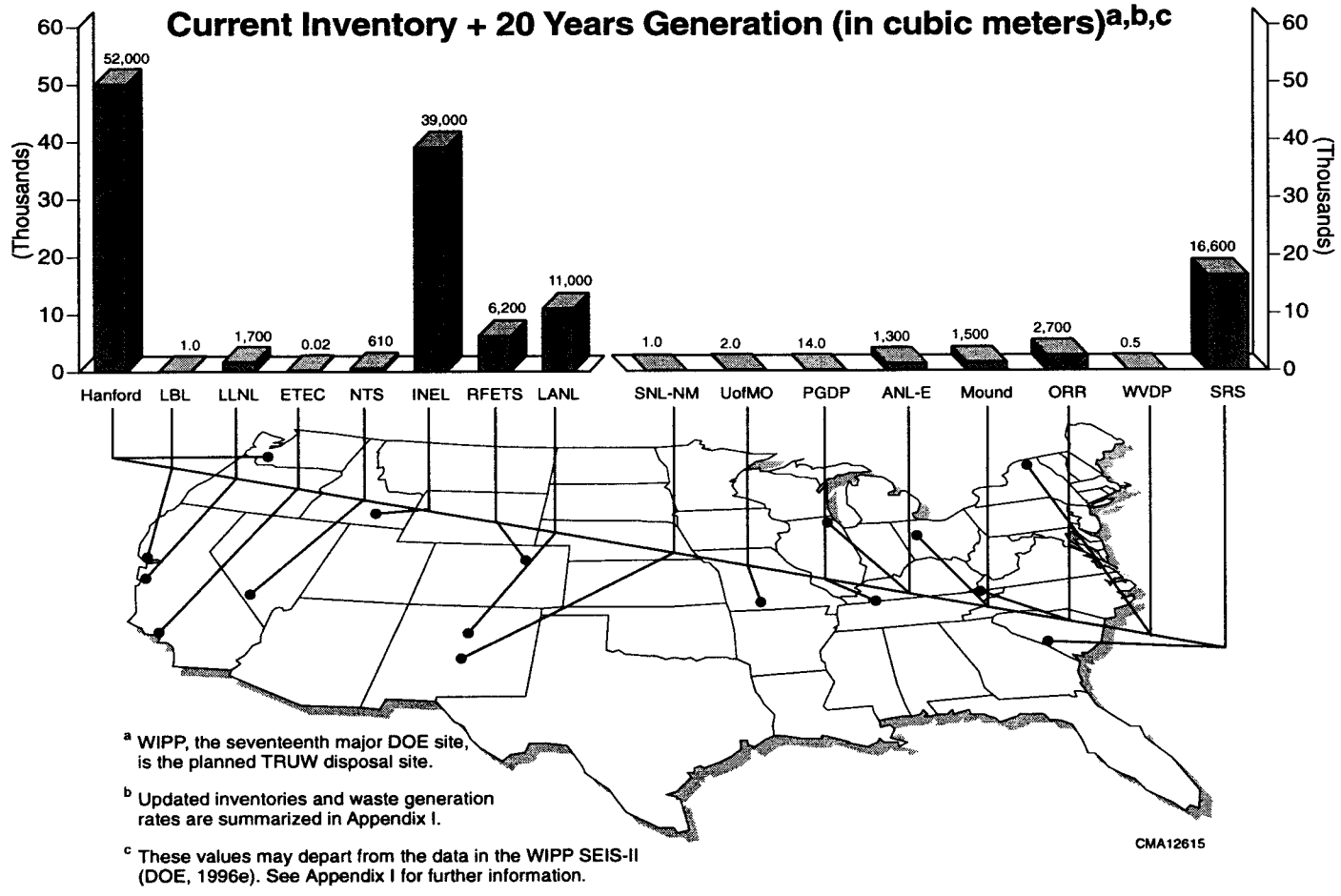
DOE also reviewed a third version of the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report* [WIPP BIR-3] (DOE, 1996d), which was published in June 1996, and the *Integrated Data Base Report-1994* (DOE, 1995d), published September 1995. Although the radionuclide inventories at some sites are changed slightly, the waste volumes and hazardous constituent inventories in WIPP BIR-3 are unchanged from WIPP BIR-2. The WIPP BIR-3 and IDB Report-1994 databases were not available at the time of the WM PEIS analysis; however, the changes in WIPP BIR-3 and IDB Report-1994 are minor, and, therefore, WIPP BIR-2 data were considered to be sufficient for analytical purposes.

A comparison of MWIR 95 with more recent site information at Hanford (22,000 m^3 in WIPP BIR-2 as compared to 160 m^3 in MWIR 95) showed that it would be more appropriate to use data in the WIPP BIR-2

(including retrieval of buried TRUW) and the extent to which these waste volumes may affect the analyses in the WM PEIS.

[6] These data were modified slightly because the TRUW reported at LLNL as remote-handled (RH) is actually contact-handled (CH) on the basis of information included in the 1994 Mixed Waste Inventory Report (DOE, 1994). For the rest of the sites, the waste volumes reported in the 1994 report do not vary significantly from the waste volumes reported in the 1993 interim report.

[7] For impacts at potential treatment site, the Draft WIPP SEIS-II (DOE, 1996e) scaled or adjusted the analysis in the Draft WM PEIS to reflect BIR-2 and other updated information as explained in the Draft WIPP SEIS-II. (See Section 8.2.5.)



[a] WIPP, the seventeenth major DOE site, is the planned TRUW disposal site.

[b] Updated inventories and waste generation rates are summarized in Appendix I.

[c] These values may depart from the data in the WIPP SEIS-II (DOE, 1996e). See Appendix I for further information.

Figure 8.1–1. TRUW Total Inventory and Generation.

for Hanford, as the largest waste streams at Hanford would not be generated until after the 5-year period covered by MWIR 95 and thus do not appear in MWIR 95.

The analysis presented in the WM PEIS has been updated based on this newer information for Hanford and SRS in alternatives where these sites treat their own wastes. Additionally, WIPP waste loads have been updated in the Centralized Alternative. A more complete discussion of the criteria for selecting sites for reanalysis using the newer information is presented in Appendix I. This appendix also identifies the criteria for reanalyzing using the more recent data, compares the waste load data used in the Draft WM PEIS with the more recent data, and describes DOE's conclusions about the need to analyze the more recent data for specified sites.

8.1.3 Existing and Planned Facilities Available at DOE Sites

To establish the baseline capacities for TRUW treatment and to identify the need for new or expanded facilities, DOE compiled a list of existing and planned TRUW facilities. Total capacities of these identified facilities are presented in Table 8.1-2. Some facilities that are not currently operating were considered to be in existence for the analysis, based on the assumption that they could become operational if required. Planned facilities include only those facilities for which a Title II design has been initiated.

Analysis in the PEIS assumes use of existing and planned facilities until their capacities are met. If additional capacity is needed, use of new conceptual facilities is assumed. These conceptual facilities constitute the difference in treatment and storage capacity between the baseline reported in Table 8.1-2 and what is necessary to manage the waste that a given site would receive under an alternative. Conceptual facilities are based on generic designs with specified impacts (e.g., cost, performance, and efficiency). Where necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of conceptual facilities.

Six sites have either existing or planned treatment facilities: Hanford, INEL, LANL, ORR, RFETS, and SRS (see Table 8.1-2). These facilities are each capable of performing different aspects of treatment including aqueous treatment, shredding, solidification, thermal treatment, and repackaging. DOE also assumed that the basic capabilities to package and store TRUW are available at every site that would

Table 8.1-2. Capacities of Existing and Planned TRUW Facilities

Site	Treatment (m^3/yr)					Storage (m^3)
	Aqueous Treatment	Shredding	Solidification	Thermal Treatment	Repackaging	
Hanford					1,400	
INEL					200	20,000
LANL	200		7.7	680[a]		
ORR			189			
RFETS	149,000	3,683	497		949	
SRS					200	15,300

Note: Blanks indicate that the treatment process or storage does not take place at the site.
[a] Thermal treatment unit at LANL is currently shut down and is being dismantled.

Source: DOE (1996b).

generate TRUW in the future. This includes 11 sites projected to generate CH TRUW and 5 sites with projected RH TRUW, as shown in Table 8.1-1.

8.2 Analytical Methods and Assumptions

To evaluate the TRUW alternatives, DOE first examined total waste volumes and the capability of existing or planned facilities. DOE then identified the chemical and radiological characteristics of TRUW in order to evaluate the effects of treatment. The specific assumptions used in the analysis related to TRUW facilities, treatment technologies, and transportation are discussed below.

8.2.1 CHARACTERISTICS

8.2.1.1 Physical/Chemical

Although TRUW contains hundreds of waste streams, these streams can be grouped by physical and chemical properties into a limited number of waste treatment categories. In doing this, DOE was able to analyze a relatively broad range of TRUW by applying appropriate technologies dictated by the common

physical and chemical treatment categories. Similar to low-level mixed waste (LLMW), the WM PEIS analysis of TRUW evaluated five treatment categories (or groupings): aqueous liquids, solid process residues, soils, organic liquids, and debris.

For the evaluation of impacts in the WM PEIS, DOE assumed that all TRUW is mixed waste. This assumption is conservative and consistent with practice in the field, where TRUW is managed as mixed waste unless definitive characterization has been performed to establish that there are no hazardous constituents present. The assumption that all TRUW contains hazardous constituents is conservative because it tends to overestimate the impacts of treating TRUW. DOE estimated the hazardous constituents in TRUW based on the TRUW present at RFETS, which has the most detailed process knowledge information on hazardous constituents available in the DOE system.

8.2.1.2 Radiological Profiles

Radionuclide concentrations for the 10 largest generators of TRUW were obtained from process knowledge, supplemented by limited sampling and analysis of stored TRUW. The radiological profiles at each site were derived from the estimated radionuclide concentrations in TRUW at the site. Insufficient data exist to assign unique radiological profiles to each individual waste stream at each site. Thus, a uniform radiological profile was assigned to all waste streams of a similar treatment category at each site (ANL, 1996). Updated information on radiological profiles was used in the Final WM PEIS for Hanford and SRS (DOE 1995b,c). Smaller generators were assumed to have the same concentrations as LLNL's TRUW (DOE, 1991). These radiological profiles identify the radionuclides likely to be encountered in TRUW and ultimately determine risk and impacts. DOE analyzed CH and RH TRUW separately in the WM PEIS to account for their different handling and treatment requirements.

8.2.2 Technologies and Treatment Processes

TRUW is treated by one or more treatment processes (or "modules"). Individual modules were linked together to form a complete treatment process for each treatability group. The emissions and impacts were calculated for each module and then added to determine the overall impacts from each treatment process at a site. Figures 8.2-1 through 8.2-3 represent simplified TRUW "treatment trains." These treatment trains are based on more detailed diagrams contained in the report, "Analysis of Waste Treatment

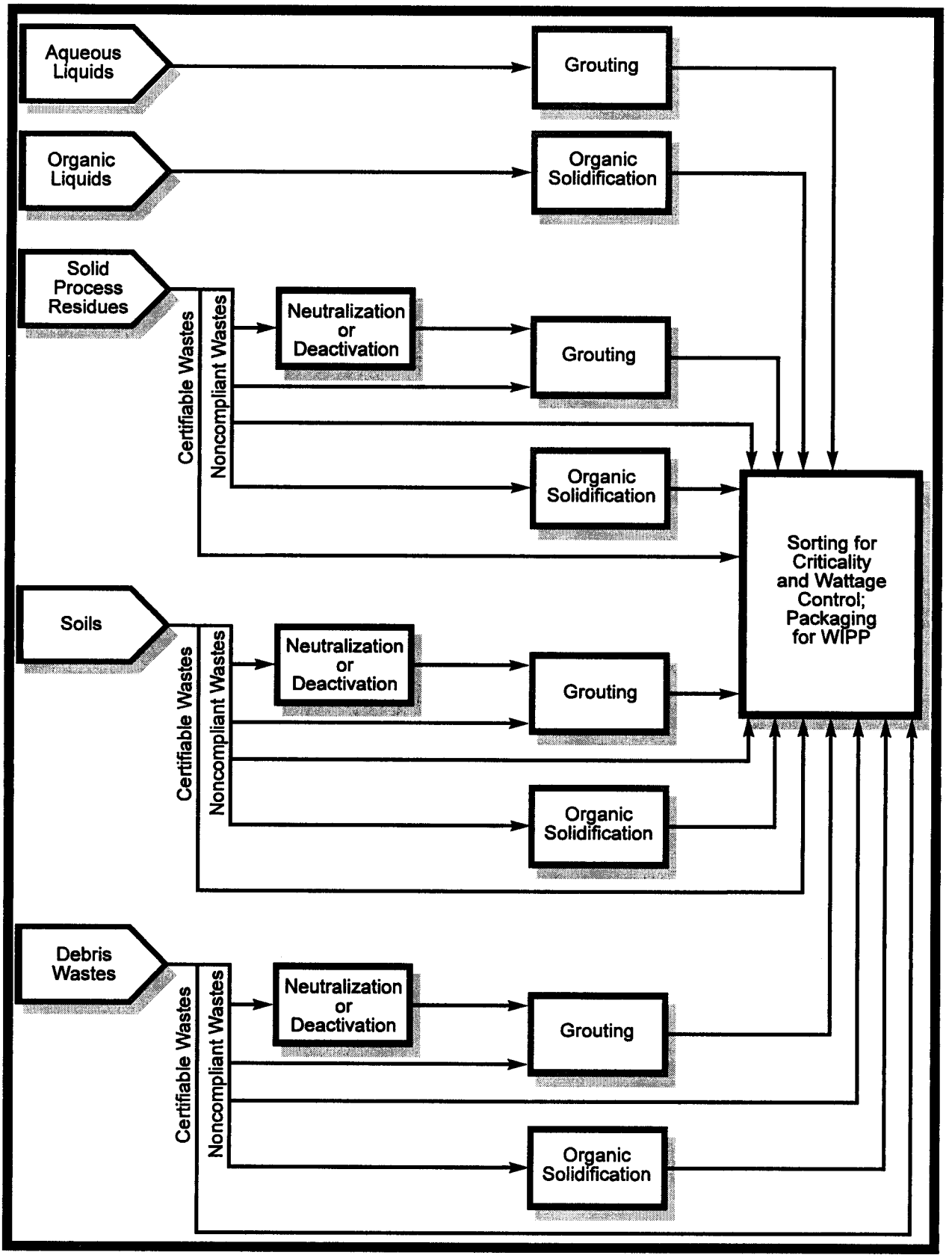


Figure 8.2–1. Treatment Trains for Meeting Current WIPP Waste Acceptance Criteria.

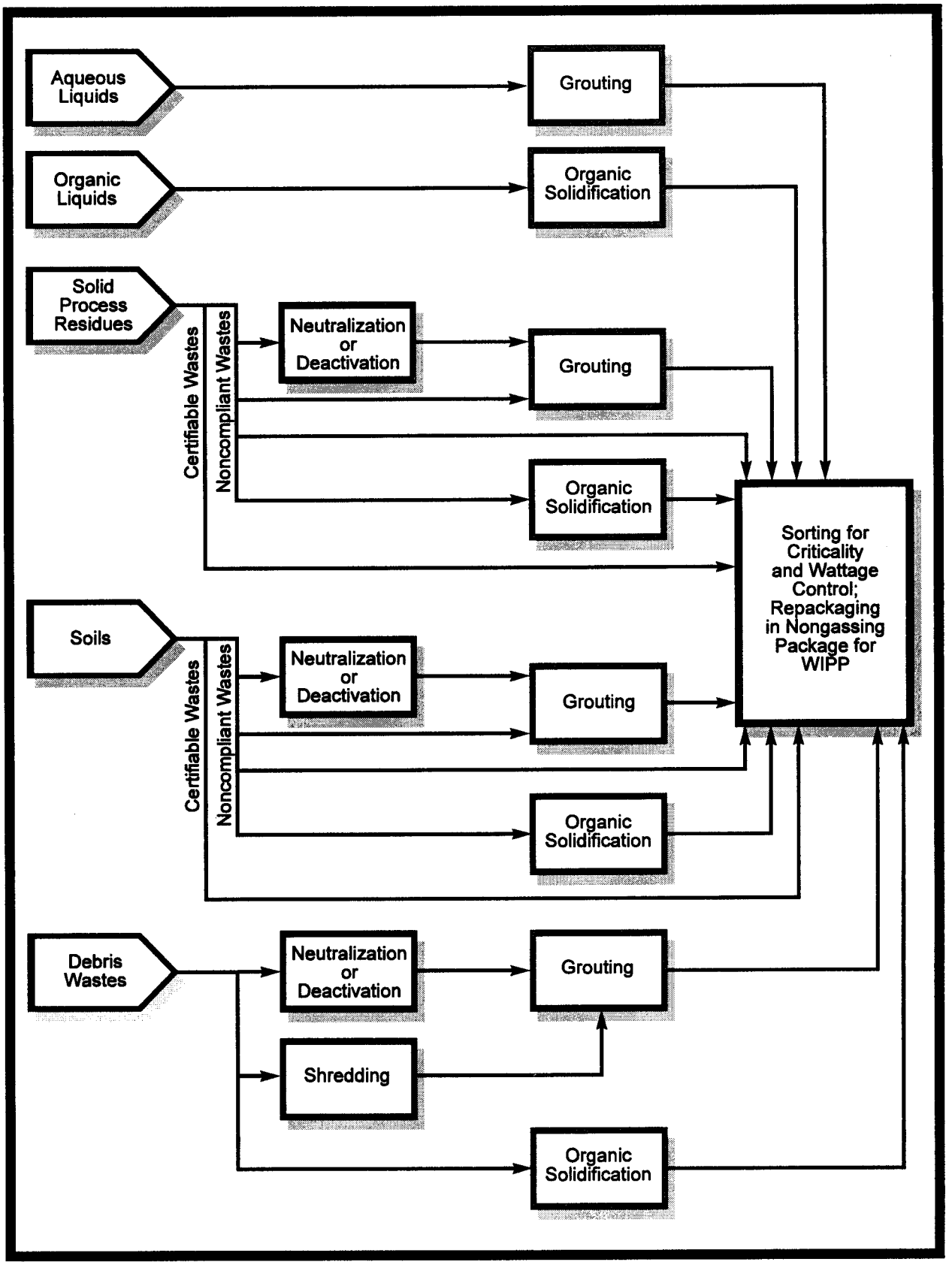


Figure 8.2–2. Treatment Trains for Reducing the Potential for Gas Generation in the WIPP.

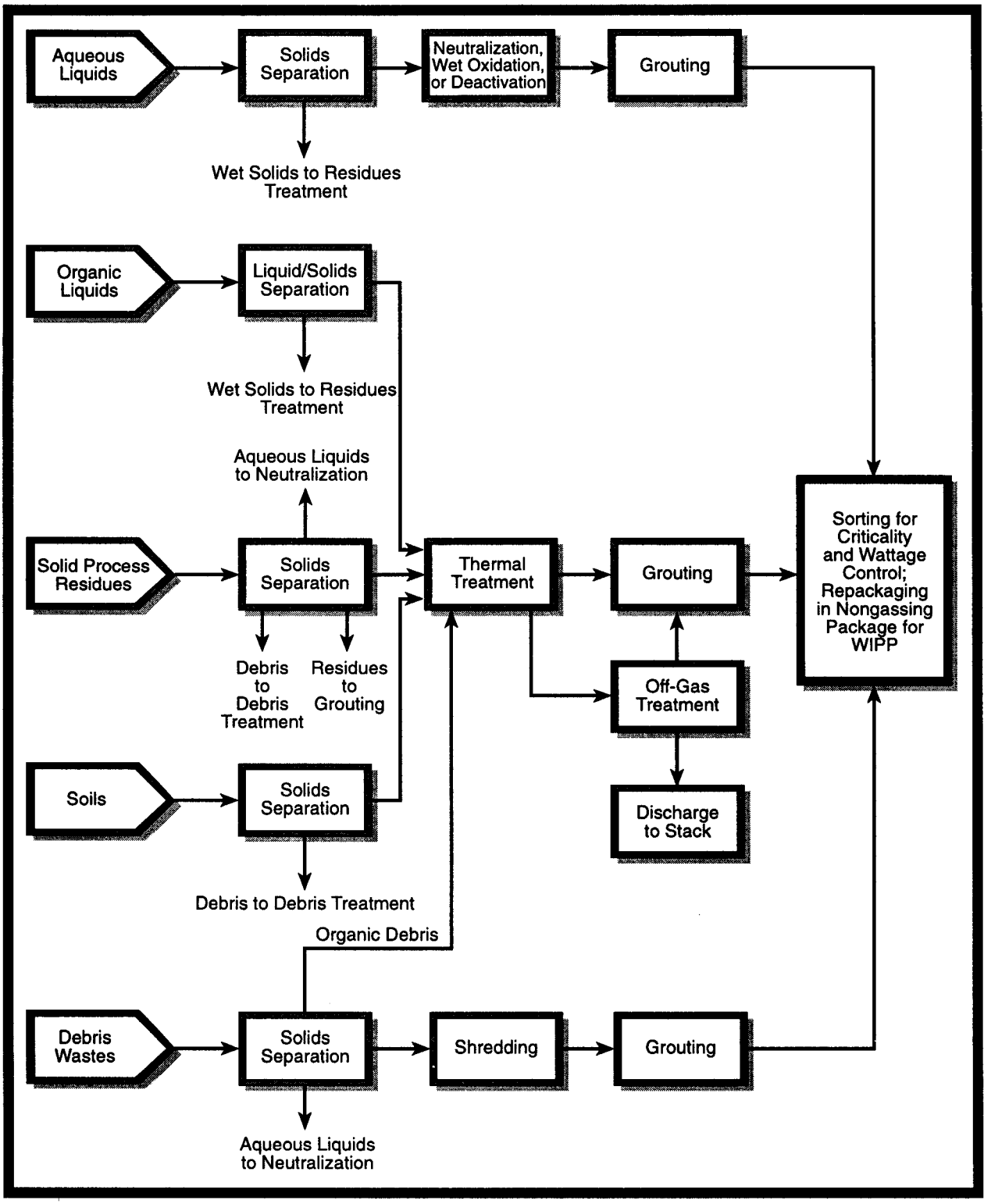


Figure 8.2–3. Treatment Trains for Meeting RCRA Land Disposal Restrictions.

Requirements for DOE Mixed Wastes: Technical Basis" (Musgrave, 1995). The waste volumes in Table 8.1-1 contain a small amount of TRUW (< 1% of the total) that requires extensive characterization prior to treatment. Such TRUW is not evaluated in the WM PEIS since its characteristics are unknown and therefore impacts cannot be quantified. This small amount of TRUW would not affect comparisons among TRUW alternatives evaluated in the WM PEIS.

The conceptual process for managing TRUW is similar to that for LLMW and includes (1) retrieving from storage and transporting; (2) sorting, characterizing, treating as appropriate, packaging, and certifying as acceptable under WIPP-WAC; (3) storing certified waste; and (4) transporting to WIPP for disposal. To ensure that the full range of impacts were assessed, DOE considered minimal treatment to meet current WIPP-WAC, intermediate treatment to reduce gas generation potential, and a more extensive treatment process including thermal treatment to meet LDRs. The estimated risks, impacts, and costs of characterization are also included in the WM PEIS analysis. When selecting specific technologies for waste treatment facilities at specific sites, DOE will consider the results of existing sitewide or project-level NEPA analyses, as there are several different technologies that could be used to treat TRUW to the levels required for WIPP or other disposition alternatives.

DOE's current strategy is to process TRUW when it is necessary to meet safety and health requirements for transport and handling and to meet Revision 5 of the WIPP-WAC. Minimum processing to meet current (but not yet final) WIPP-WAC was the least stringent treatment analyzed. More extensive treatment to reduce gas generation or to meet LDRs was analyzed as an intermediate and an upper range of treatment should more extensive treatment become necessary.

8.2.3 WM PEIS Assumptions: Facilities, Treatment, and Storage

Although DOE used data on TRUW volumes and existing facilities from well-documented sources, the analysis of alternatives required DOE to make additional assumptions. In addition to estimating and extrapolating techniques used to identify the radiological and chemical characteristics of TRUW, DOE made additional general assumptions related to facilities, treatment, storage, and special requirements, to further define specific actions and operating parameters for each alternative.

Facilities

- Any new treatment facilities required for an alternative would be in operation after a 10-year design and construction period.
- TRUW currently in inventory (sometimes referred to as "legacy waste") plus 20 years of newly generated waste would be treated during the 10-year period after construction (called a "work-off" period). After the designated work-off period, TRUW is assumed to be treated as it is generated on an annual basis; although it was not analyzed, the amount of waste annually generated after the work-off period is expected to be small, and the impacts from treatment and storage are expected to be bounded by those analyzed in the WM PEIS.
- In the TRUW analysis, each site was assumed to build and operate facilities with capacities sufficient to handle only TRUW. This avoids linking the results of one waste type to decisions not yet made in another and results in conservative estimates of risk, impacts, and cost. Chapter 11 discusses the cumulative effects for sites hosting more than one waste-type facility.
- DOE assumed that either fixed or mobile characterization facilities would be operated at sites that would need to retrieve, treat, repackage, and ship TRUW. Characterization and repackaging of TRUW is often necessary to meet Department of Transportation (DOT) or RCRA regulations for transport, and to meet State shipping and receiving requirements.

Treatment and Storage

- Processing to meet current WIPP-WAC is practical at all sites with TRUW.
- More extensive treatment to reduce gas generation is practical at only the six sites with the largest volumes of TRUW because of the economies of scale associated with larger facilities. Treatment to meet LDRs is only practical at the same six sites or at a central location. In this analysis, WIPP was evaluated as the central treatment location.
- Impacts and costs were evaluated for retrieval of stored TRUW and for characterization and are included in the analysis results as a component of treatment.

8.2.4 Transportation Analysis and Assumptions

DOE analyzed transportation impacts associated with each TRUW alternative. In general, offsite transportation for treatment was minimized. Both truck and rail transportation were analyzed using computerized routing models following the general principle of minimizing distance and transportation time. The routes were selected to be consistent with existing practices and with all applicable regulations and

guidelines; however, because the routes were developed for the purpose of risk assessment, they do not necessarily represent actual routes that would be used to transport waste in the future.

In general, the radiological risks from routine transportation of radioactive materials are directly proportional to the external dose rate, which is a measure of the external radiation (principally gamma radiation) from the shipment. The average external dose rates were assumed to be 3 millirem per hour for CH-TRUW and 7 millirem per hour for RH-TRUW at 1 meter from the shipping container. These values were derived from site-specific information contained in the WIPP SEIS-I (DOE, 1990) and are less than the DOT regulatory limit of 10 millirem per hour at 2 meters from the container.[8]

The following assumptions were used in the analysis:

- For purpose of analysis, this PEIS assumed that all CH-TRUW would be shipped in the TRUPACT-II Type B container.
- Waste package requirements for transportation of RH-TRUW would be based on the RH-72B cask described in a Safety Analysis Report for Packaging, which is being reviewed by the Nuclear Regulatory Commission (NRC) prior to issuance of a Certificate of Approval.

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, NRC, and EPA regulations, and by the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

8.2.5 Comparison of Treatment Impacts with the WIPP SEIS-II

Both the WIPP SEIS-II (DOE, 1996e) and WM PEIS consider TRUW treatment. In addition to exploring TRUW disposal impacts, the WIPP SEIS-II will lead to a determination of minimum levels of TRUW treatment preparatory to final disposition; the WM PEIS will lead to a decision *where* to treat TRUW. Both the WM PEIS and the WIPP SEIS-II report the human health impacts from treatment of TRUW. The WIPP SEIS-II recognizes that treatment may be a major contributor to the overall impacts of disposing of TRUW and preparing TRUW for disposal, while the WM PEIS presents treatment impacts in order to assist decision makers in determining whether to centralize, regionalize, or decentralize actual treatment activities.

[8] The WIPP SEIS-II (DOE, 1996e) assumes an average extreme dose rate of 4 millirem per hour for CH-TRUW, and 10 millirem per hour for RH-TRUW at 1 meter from the shipping container.

The approaches applied in the Final WM PEIS and the WIPP SEIS-II for estimating human health impacts from TRUW treatment are in general the same. The Draft WM PEIS analyses formed the basis of the WIPP SEIS-II analysis of treatment impacts. The impacts as a result of routine operations from the Draft WM PEIS were adjusted in the WIPP SEIS-II to account for the differences between the two documents in TRUW waste volumes and radionuclide inventories due to different periods of TRUW generation and site operation (28 years in the WIPP SEIS-II versus 20 years in the WM PEIS) and the addition of commercial and buried waste in the WIPP SEIS-II, number of sites producing waste, and the manner of waste consolidation as defined in the WIPP SEIS-II alternatives.

It should be noted that the Final WM PEIS provides updates and makes corrections to the analysis presented in the Draft WM PEIS. The preparers of the Final WIPP SEIS-II will review these WM PEIS changes to determine whether the Final WIPP SEIS-II should be similarly modified.

Comparison between the Final WM PEIS and the WIPP SEIS-II analyses of human health impacts from postulated accident scenarios is provided in Section 8.4.3.2.

8.3 Transuranic Waste Alternatives

The WM PEIS considered six alternatives for both CH-TRUW and RH-TRUW. Treatment and storage activities vary by alternative and by site. The foldout table at the end of this chapter shows the major sites at which TRUW would be treated and stored under each alternative. This table is designed to be used as a quick reference when reading the sections on TRUW impacts.

Each alternative was developed to evaluate the human health risk, environmental impacts, and costs associated with the range of treatment and storage activities available to DOE and to inform decisions about where to locate TRUW treatment and storage facilities.

The analysis includes alternatives in which TRUW would be treated to LDR levels. Although the WIPP LWA amendments contained in the 1997 Defense Authorization Act exempt waste destined for WIPP from the provisions in RCRA regarding LDRs, LDR treatment is a reasonable alternative for management activities and practices other than disposal at WIPP.

8.3.1 No Action Alternative

Under the No Action Alternative, DOE would continue to characterize, process, and package newly generated TRUW to meet current WIPP-WAC for storage at sites where existing or planned facilities are available. DOE would continue to store TRUW in existing storage facilities indefinitely. The impacts of these storage activities are analyzed for 20 years based on the scope of this PEIS. The impacts of storage beyond 20 years are analyzed as part of the No Action Alternatives in the WIPP SEIS-II (DOE, 1996e). As analyzed in the WIPP SEIS-II, if DOE continues to provide effective monitoring and maintenance of storage facilities, adverse health effects for the general public would be quite small, and the principal adverse effects, also small, would be related to occupational activity at the facilities. These health effects would continue at such levels for the indefinite future under the hypothesis of DOE control.

The analysis in the WIPP SEIS-II also considered, however, impacts if DOE were to lose institutional control of storage facilities. Considering the long-lived nature of the radionuclides in TRUW, this analysis was conducted for timeframes ranging up to 10,000 years after loss of institutional control. The WIPP SEIS-II analysis of intrusion for waste stored underground considered impacts of directly drilling into the wastes and gardening over the exhumed waste cuttings. Analysis of intrusion for waste stored above-ground considered impacts of an individual scavenging into the wastes and a farm family living over the wastes. The analyses showed that intruders could receive substantial radiation doses and that a potentially large number of non-intruders could die from exposure to stored waste that may be dispersed into the general environment.

Under the No Action Alternative, DOE would not ship TRUW for offsite, long-term storage or disposal. All sites are assumed to have adequate capabilities to package and store TRUW generated in the future. Eleven sites anticipate TRUW generation, including six sites that will generate both CH and RH TRUW. The potential impacts of TRUW management under the No Action Alternative are smaller than under the other alternatives because the No Action Alternative (1) evaluates treatment to WIPP-WAC only for future TRUW (existing retrievably stored TRUW would not be processed to meet current WIPP-WAC), (2) does not assess the impacts of removing TRUW from retrievable storage, and (3) does not include shipment of TRUW.

Figure 8.3–1 and Table 8.3–1 illustrate the sites at which TRUW would be processed and stored under the No Action Alternative.

TRUW No Action Alternative—(11 Sites Process to Current WIPP Criteria; Storage at Existing Facilities at 16 Sites)

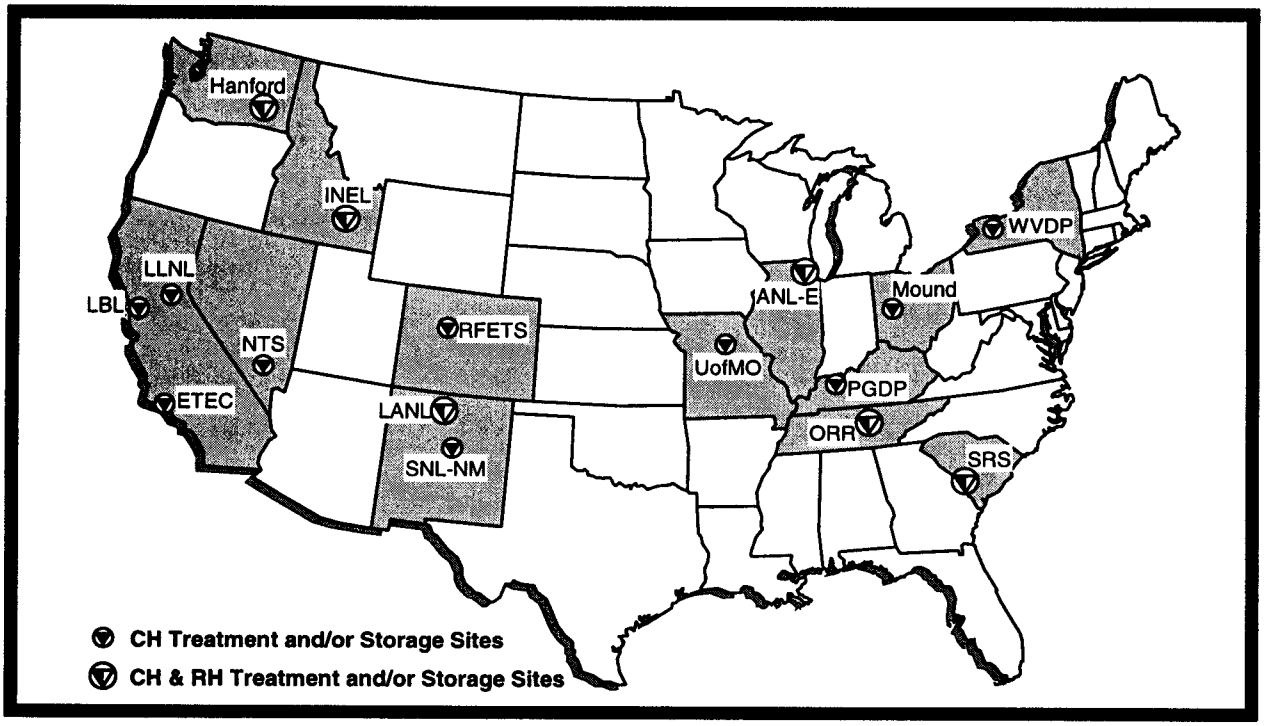


Figure 8.3–1. TRUW No Action Alternative.

	Generating Sites								
	ANL–E ANL-E^{RH}	ETEC	Hanford Hanford^{RH}	INEL INEL^{RH}	LANL LANL^{RH}	LBL	LLNL	Mound	NTS
Treat/Package (% Rec'd from Offsite)	ANL–E (0)		Hanford (0)	INEL (0)	LANL (0)	LBL (0)	LLNL (0)	Mound (0)	
Store	Store Onsite								

	Generating Sites						
	ORR ORR^{RH}	PGDP	RFETS	SNL-NM	SRS SRS^{RH}	UofMO	WVDP
Treat/Package (% Rec'd from Offsite)	ORR (0)		RFETS (0)		SRS (0)	UofMO (0)	
Store	Store Onsite						

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses; blank cells indicate sites store TRUW only.

Table 8.3–1. TRUW No Action Alternative

8.3.2 DECENTRALIZED ALTERNATIVE

Under the Decentralized Alternative, DOE would process and package TRUW to meet the current WIPP-WAC at 16 sites where TRUW is currently located. The CH-TRUW would then be shipped from sites with smaller amounts to the nearest of the 10 sites with the largest amount of TRUW for storage prior to disposal. All TRUW would be shipped to WIPP for disposal.[9] An important change from the No Action Alternative is that retrievably stored TRUW would be treated under this alternative, whereas it would not be treated under the No Action Alternative.

Figure 8.3–2 and Table 8.3–2 illustrate the sites at which TRUW would be processed and stored under the Decentralized Alternative.

8.3.3 REGIONALIZED ALTERNATIVES

The Regionalized Alternatives consider the consolidation of TRUW for treatment and storage prior to disposal at WIPP. Three Regionalized Alternatives were analyzed, with treatment (to reduce gas generation potential or to meet LDRs) at six and four sites, and storage at those sites prior to disposal at WIPP.

Under Regionalized Alternative 1, CH-TRUW would be shipped from the smallest generators to the four sites with the largest volumes of CH-TRUW (the Hanford Site, INEL, LANL, and SRS). In addition, RFETS would continue to treat its own waste, but would not receive waste from offsite. RH-TRUW would be shipped from ANL-E, INEL, and LANL to Hanford or ORR for treatment. At all six treatment sites, TRUW would be treated to reduce gas generation potential (referred to as intermediate treatment) and shipped from those sites to WIPP for disposal. The six treatment sites proposed under this alternative have 95% of current and anticipated TRUW inventories. Figure 8.3–3 shows the sites at which TRUW would be treated and stored under Regionalized Alternative 1. Table 8.3–3 lists the sites from which TRUW would be shipped and the six sites at which TRUW would be consolidated and treated.

[9] The Waste Isolation Pilot Plant Land Withdrawal Act of 1992 provides for the disposal of 175,600 cubic meters (6.2 million cubic feet) of "defense TRUW" at WIPP provided all regulatory requirements are met. WVDP and other DOE sites have small amounts of "nondefense" TRUW. For purposes of analysis in this WM PEIS, DOE has assumed that all TRUW is defense TRUW and will be disposed of at WIPP. The impacts of treating and disposing of nondefense TRUW are evaluated in some of the alternatives analyzed in the second supplemental EIS for WIPP (WIPP SEIS-II) (DOE 1996e).

TRUW Decentralized Alternative—(16 Sites Process to Current WIPP Criteria; Interim Storage at 10; Disposal at WIPP)

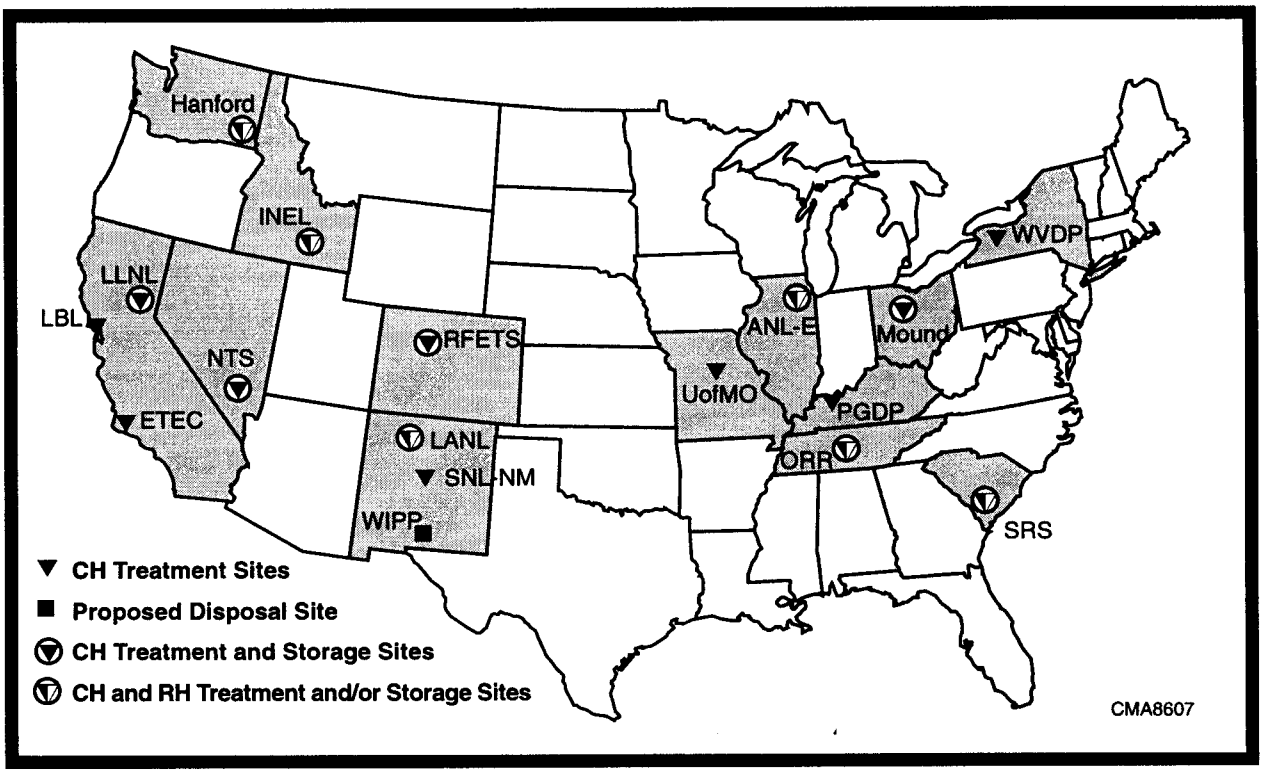


Figure 8.3–2. TRUW Decentralized Alternative.

	Generating Sites								
	ANL-E ANL-E^{RH}	ETEC	Hanford Hanford^{RH}	INEL INEL^{RH}	LANL LANL^{RH}	LBL	LLNL	Mound	NTS
Treat (% Rec'd from Offsite)	ANL–E (0)	ETEC (0)	Hanford (0)	INEL (0)	LANL (0)	LBL (0)	LLNL (0)	Mound (0)	NTS (0)
Store	ANL-E	NTS	Hanford	INEL	LANL	Hanford	LLNL	Mound	NTS
Dispose	All Sites Ship to WIPP								

	Generating Sites						
	ORR ORR^{RH}	PGDP	RFETS	SNL–NM	SRS SRS^{RH}	UofMO	WVDP
Treat (% Rec'd from Offsite)	ORR (0)	PGDP (0)	RFETS (0)	SNL–NM (0)	SRS (0)	UofMO (0)	WVDP (0)
Store	ORR	ORR	RFETS	LANL	SRS	ORR	Mound
Dispose	All Sites Ship to WIPP						

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3–2. TRUW Decentralized Alternative

Regionalized Alternative 1—(Treatment to Reduce Gas at 6 Sites; Disposal at WIPP)

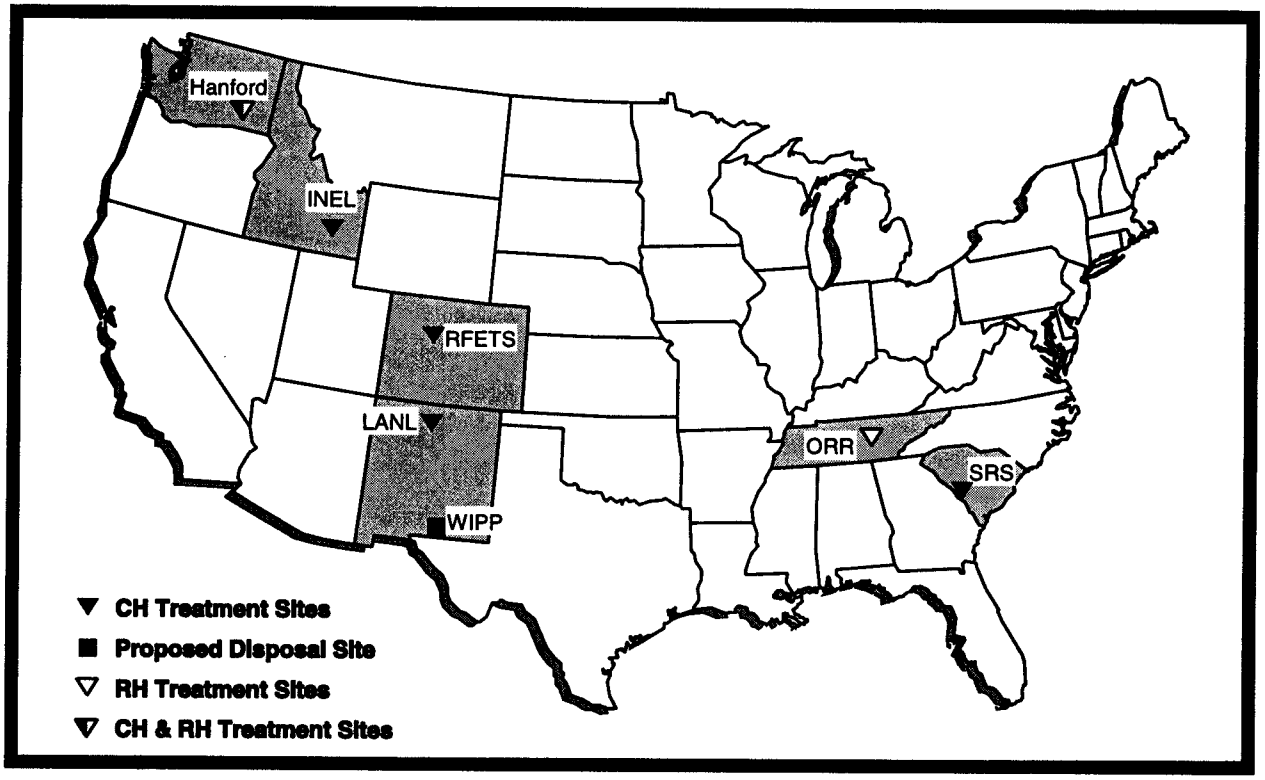


Figure 8.3–3. TRUW Regionalized Alternative 1.

	Generating Sites					
	Hanford Hanford^{RH} LBL LLNL INEL^{RH} LANL^{RH}	ETEC INEL NTS	LANL SNL-NM	SRS^{RH} ANL-E^{RH} ORR^{RH}	RFETS	ANL-E Mound ORR PGDP SRS UofMO WVDP
Treat (% Rec'd from Offsite)	Hanford (5)	INEL (1.5)	LANL (<1)	ORR (18)	RFETS (0)	SRS (17)
Dispose	All Sites Ship to WIPP					

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3–3. TRUW Regionalized Alternative 1

Under Regionalized Alternative 2, DOE would use the same configuration as in Regionalized Alternative 1, except that TRUW would be treated to meet LDRs and then shipped to WIPP for disposal. With this alternative, DOE can compare the impacts of intermediate treatment in Regionalized Alternative 1 to the impacts of LDR treatment in Regionalized Alternative 2; the impacts of both Regionalized Alternatives 1 and 2 can be compared to the impacts of meeting current WIPP-WAC in the Decentralized Alternative (where 98% of the waste would be processed at the same six sites). Figure 8.3–4 shows the sites at which TRUW would be processed and stored under Regionalized Alternative 2; Table 8.3–4 lists the sites from which TRUW would be shipped and the six sites at which TRUW would be consolidated and treated.

Regionalized Alternative 3 considers the consolidation of waste for treatment at four sites (Hanford, INEL, ORR, and SRS) where approximately 80% of TRUW is already located or is expected to be generated. CH-TRUW would be treated at Hanford, INEL, and SRS; RH-TRUW would be treated at Hanford and ORR. Under this alternative, TRUW would be treated to meet LDRs and shipped to WIPP for disposal. Figure 8.3–5 shows the four sites at which TRUW would be treated and stored under Regionalized Alternative 3; Table 8.3–5 lists the sites from which TRUW would be shipped and the four sites at which TRUW would be consolidated and treated.

8.3.4 Centralized Alternative

Under the Centralized Alternative, DOE would ship all CH-TRUW to WIPP for treatment to meet LDRs and for disposal. RH-TRUW would be shipped to the Hanford Site and ORR for treatment to meet LDRs and then shipped to WIPP for disposal. Figure 8.3–6 illustrates the Centralized Alternative. Table 8.3–6 shows the sites from which all TRUW would be shipped and the two sites at which RH-TRUW would be consolidated and treated.

8.3.5 Rationale for Selecting Treatment Sites

Treatment configurations for TRUW were developed to cover the range of reasonable alternatives. Thus, the Decentralized Alternative considers treatment of TRUW at 16 sites where TRUW is currently located, and the Centralized Alternative considers treatment of all CH-TRUW at one site and all RH-TRUW (which needs special handling) at two sites. For the regionalized alternatives, which are intermediate between the Decentralized and Centralized Alternatives, DOE focused on the six sites where 95% of the waste is located

Regionalized Alternative 2—(Treatment to LDRs at 6 Sites; Disposal at WIPP)

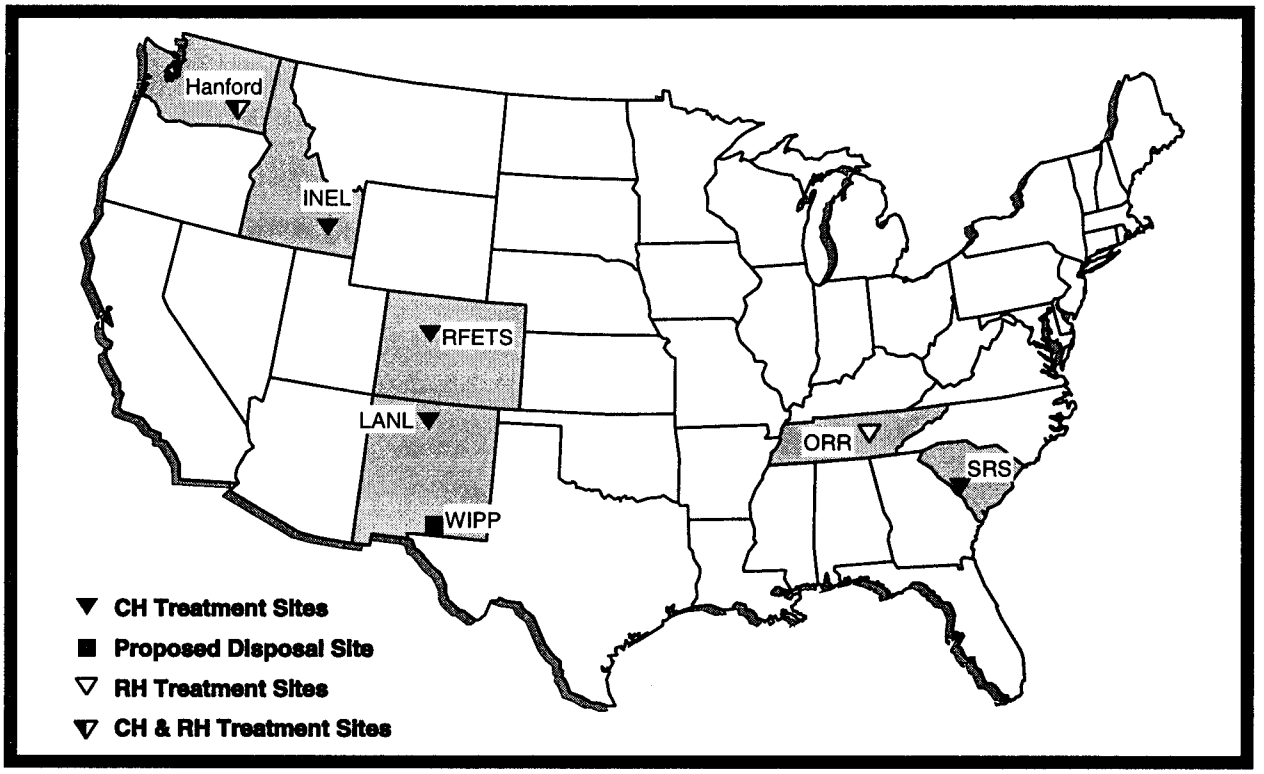


Figure 8.3–4. TRUW Regionalized Alternative 2.

	Generating Sites					
	Hanford Hanford^{RH} INEL^{RH} LANL^{RH} LBL LLNL	ETEC INEL NTS	LANL SNL-NM	SRS^{RH} ANL-E^{RH} ORR^{RH}	RFETS	ANL-E Mound ORR PGDP SRS UofMO WVDP
Treat (% Rec'd From Offsite)	Hanford (5)	INEL (1.5)	LANL (<1)	ORR (18)	RFETS (0)	SRS (17)
Dispose	All Sites Ship to WIPP					

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3–4. TRUW Regionalized Alternative 2

Regionalized Alternative 3—(4 Sites to Meet Treatment LDRs; Disposal at WIPP)

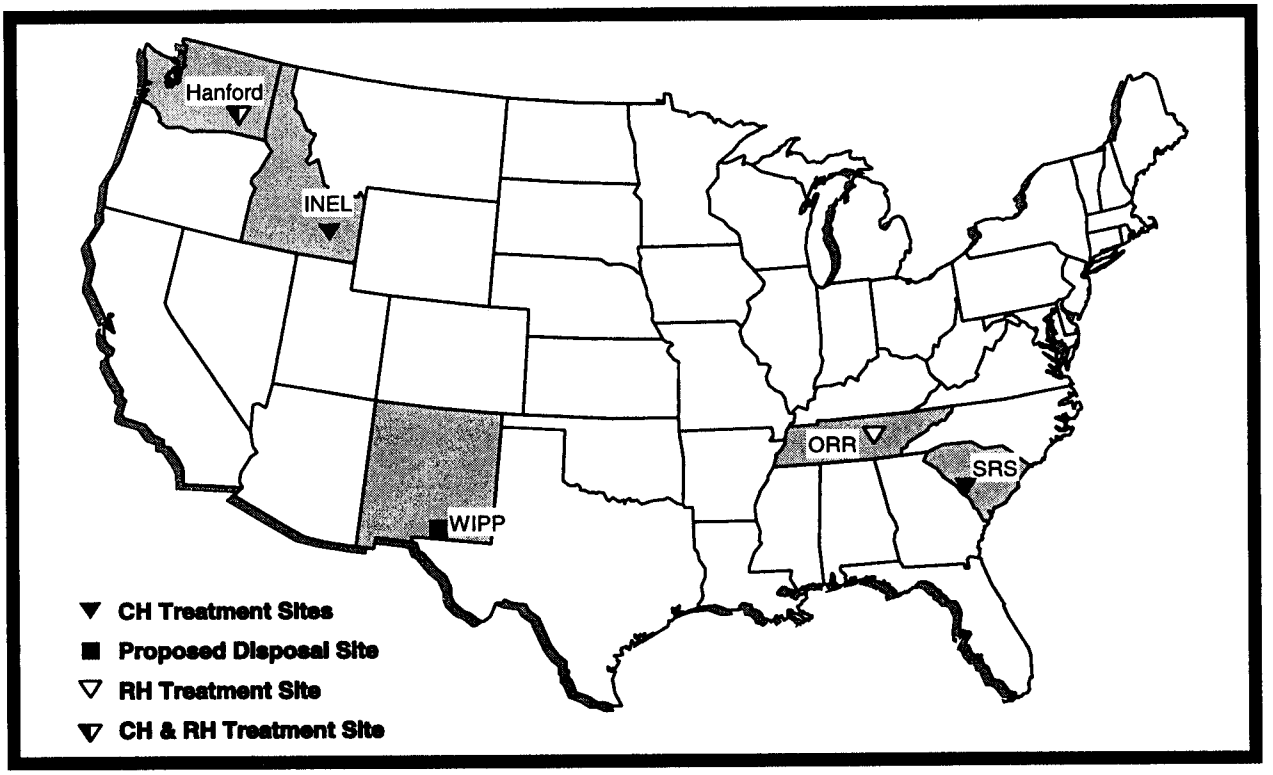


Figure 8.3–5. TRUW Regionalized Alternative 3.

	Generating Sites			
	Hanford Hanford^{RH} INEL^{RH} LANL^{RH} LBL LLNL	ETEC INEL LANL NTS RFETS SNL-NM	SRS^{RH} ANL-E^{RH} ORR^{RH}	ANL-E Mound ORR PGDP SRS UofMO WVDP
Treat (% Rec'd From Offsite)	Hanford (5)	INEL (31)	ORR (18)	SRS (17)
Dispose	All Sites Ship to WIPP			

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3–5. TRUW Regionalized Alternative 3

Centralized Alternative—(Treatment of CH at 1 Site and RH at 2 Sites to Meet LDRs; Disposal at WIPP)

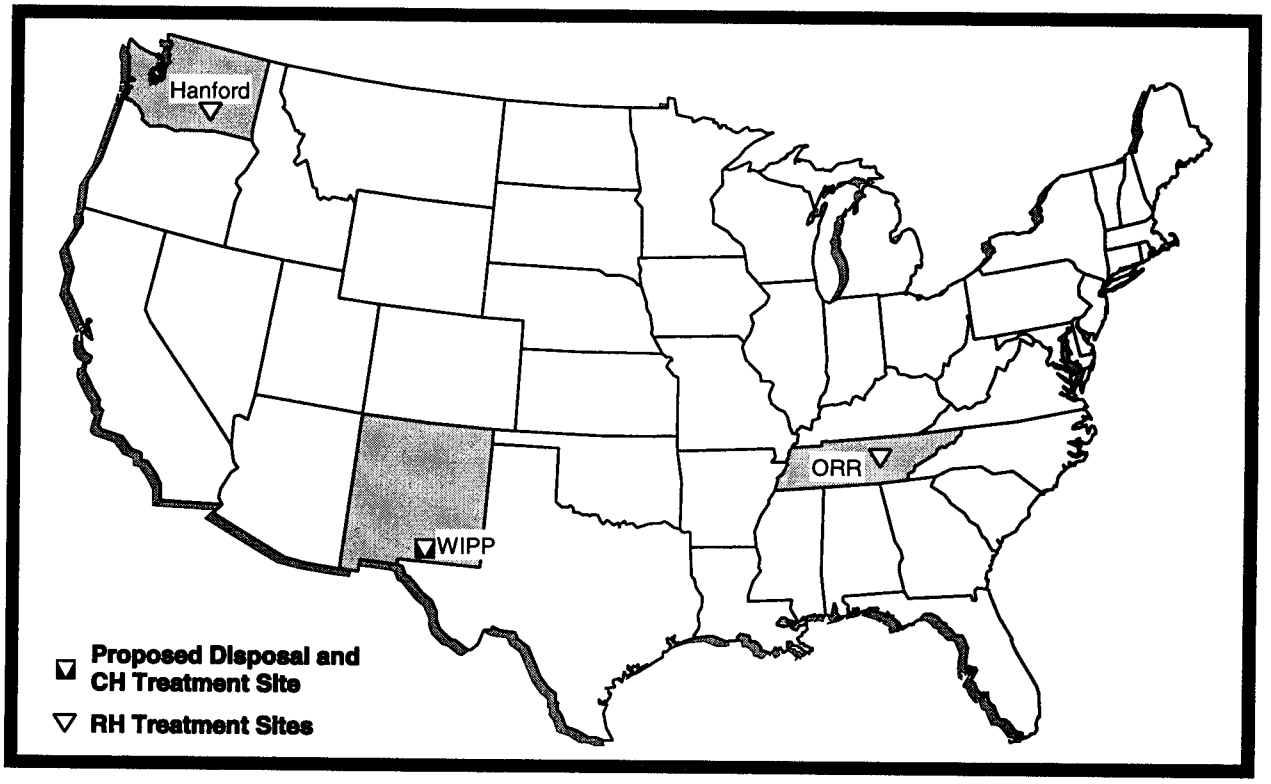


Figure 8.3–6. TRUW Centralized Alternative.

	Generating Sites			
	Hanford^{RH} INEL^{RH} LANL^{RH}	SRS^{RH} ANL–E^{RH} ORR^{RH}	ANL–E ETEC Hanford INEL LANL LBL LLNL Mound	NTS ORR PGDP RFETS SNL–NM SRS UofMO WVDP
Treat (% Rec'd From Offsite)	Hanford (5)	ORR (18)	WIPP (100)	
Dispose	All Sites Ship to WIPP			

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3–6. TRUW Centralized Alternative

or expected to be generated, and on the four sites where approximately 80% of the waste is located or expected. Under these regionalized alternatives, DOE assumed that the waste from other sites with TRUW would be shipped to the closest site for treatment and storage.

In addition, DOE assumed that it would not be practical or reasonable for sites with small volumes of TRUW (less than 15 cubic meters) to treat TRUW onsite to either reduce gas generation potential or to meet LDRs. Thus, waste at the small-volume sites (e.g., ETEC, LBL, PGDP, SNL-NM, UofMo, and WVDP) was shipped to another site for treatment to either of these levels under the Regionalized and Centralized Alternatives. Onsite processing to meet current WIPP-WAC was considered for all 16 sites, including the small-volume sites, under the Decentralized Alternative.

Consolidation of RH-TRUW at one site for treatment was not considered because a large number of cross-country trips would be required, and because most RH-TRUW requires extensive treatment (not necessarily to meet LDRs) before it can be shipped. Thus, under the Centralized Alternative, DOE would treat RH-TRUW at the two sites—the Hanford Site and ORR—where approximately 90% of current and projected inventory would be located.

8.4 Health Risks

The most adverse health risks occur under alternatives where TRUW is treated to meet LDRs—in Regionalized Alternatives 2 and 3 and the Centralized Alternative. These alternatives require the thermal treatment of organic wastes, which results in emissions of radionuclides (Pu-238, Am-241) that have the greatest contribution to offsite cancer risks and increase the probability of cancer to the maximally exposed individual (MEI). Fatalities among workers result primarily from physical trauma and are lower when TRUW is processed to WIPP-WAC or treated to reduce gas generation potential rather than treated to meet LDRs. Estimated transportation fatalities are low in all alternatives.

Health risk impacts result from exposure to radiation and chemicals and from physical trauma during the construction and operation of TRUW treatment facilities and transportation of waste. Health effects resulting from radiation and chemical exposure, whether from sources external or internal to the body, can affect either the exposed individual's body (known as a "somatic" effect, i.e., cancer) or descendants of the exposed individual (known as a "genetic" effect). This section discusses the estimated adverse health impacts resulting from radiation and chemical exposures as well as the physical hazards for each TRUW

treatment alternative. Details of the TRUW results are contained in Appendices D, E, and F. Methodology details are contained in Section 5.4.1 of Chapter 5 and in ORNL technical reports (ORNL, 1995a-d).

Potential health risks to a number of receptor populations and individuals are presented including:

- The offsite population—individuals living within a 50-mile radius of the site as well as along transportation routes.
- Noninvolved worker population—workers at DOE sites who are not involved directly in waste management.
- Waste management worker population (or "waste management workers")—employees working at a site's waste management facilities, including workers who manage waste, construction workers who build the waste management facilities, and workers who operate the trucks and trains that transport the waste.
- MEIs for the offsite population—hypothetical individuals in the offsite population who are assumed to receive the highest total lifetime dose from all media.
- MEIs for the noninvolved worker population— hypothetical individuals in the noninvolved worker population who are assumed to receive the highest total lifetime dose from all media.

The following sections present the impacts for the TRUW Alternatives:

8.4 Health Risks
8.5 Air Quality Impacts
8.6 Water Resources Impacts
8.7 Ecological Resources Impacts
8.8 Economic Impacts
8.9 Population Impacts
8.10 Environmental Justice Concerns
8.11 Land Use Impacts
8.12 Infrastructure Impacts
8.13 Cultural Resources Impacts
8.14 Costs
8.15 Environmental Restoration Analysis
8.16 Comparison of Alternatives Summary

The impacts evaluated were:

- Fatalities from physical hazards (e.g., vehicle accidents)
- Cancer fatalities from radiation exposure
- Cancer incidences from radiation or chemical exposure
- Genetic effects from radiation exposure
- Noncancer effects from chemical exposure (e.g., headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

Maximally Exposed Individual

In keeping with standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual" (MEI). The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of treatment operations analyzed in the PEIS.

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for a further discussion of these issues.

8.4.1 ROUTINE OPERATION IMPACTS

For operations involving TRUW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in TRUW treatment ("noninvolved workers"), and waste management workers directly involved in TRUW treatment. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative were implemented. Table 8.4-1 provides the estimated number of individuals in the offsite populations at the proposed TRUW treatment and storage sites and the number of waste management workers for each alternative. The numbers of waste management workers are derived from generic baselines that established the number of personnel required to operate treatment facilities needed to manage a given amount of waste (INEL, 1995b).

Individual impacts focus on the *probability* that the MEI within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk is presented as a probability (e.g., one-in-one million, or 1E–06) of that individual experiencing an adverse health impact, rather than a total number of impacts for a selected population.

DOE analyzed effects of both radionuclides and chemicals on individuals and populations. The pathways of exposure analyzed were inhalation, ingestion of plants and animals, direct gamma radiation, and absorption of tritium through the skin.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment facilities, and a subsequent 10-year period of operation. However, worker and public risks from radionuclide or chemical exposure (received during the 10-year operation period) were evaluated for an entire lifetime (70 years), because health impacts from airborne contaminants or direct radiation could occur throughout the lifetime of the exposed individual.

Table 8.4–1. Offsite Populations and Waste Management Treatment Worker Populations

Site	Offsite Population*	WM Treatment Worker Population by Alternative[a]					
		No Action	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Centralized
ANL-E	7,939,785	136	337	150	150	150	150
Hanford	377,645	899	1,519	2,312	3,621	3,621	1,993
INEL	153,061	132	2,471	3,205	5,469	6,382	1,691
LANL	159,152	262	1,115	1,537	2,807	748	748
LLNL	6,324,234	148	354	186	186	186	186
NTS	14,266	0[b]	204	137	137	137	137
ORR	881,652	41	272	314	682	682	682
PGDP	500,502	0[b]	15	8	8	8	8
RFETS	2,171,877	353	664	989	1,852	420	420
SRS	620,618	324	556	948	1,412	1,412	368
WIPP	99,889	--	--	--	--	--	4,132

Notes: -- = no waste treatment occurs at the site under this alternative; * = within 50 mile radius of sites. Waste management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation periods.
[a] Because ETEC, LBL, Mound, and UofMo are not "major" waste management sites analyzed in the WM PEIS (see Section 1.6) and because it was assumed that it would not be practical or reasonable to treat the small volume of TRUW at SNL-NM or WVDP, values are not provided for these sites.
[b] Sites reporting zero workers are sites where no TRUW was generated as reported in the 1992 Integrated Data Base (DOE, 1992). There would be no treatment of newly generated TRUW under the No Action Alternative.

Table 8.4–2 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for TRUW treatment.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases. Note that both the *total cancer incidence* and the *nonfatal cancer incidence* values are overestimated by a factor of about two because the estimates contain a relatively large component of skin cancers. The internal exposure pathways evaluated in the WM PEIS (e.g., inhalation or ingestion of radionuclides) are not likely to induce large numbers of skin cancer cases. However, the International Commission on Radiological Protection (ICRP) dose conversion factors used in the WM PEIS to estimate total cancer incidence includes incidences of skin cancer (ICRP, 1990).

Table 8.4-2. TRUW Health Risk Analysis Components

TRUW Treatment					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20 years	8.4-3
Number of cancer fatalities	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4-3
	Noninvolved workers		Inhalation, direct radiation		
	WM workers		Inhalation, direct radiation		
Number of cancer incidences	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4-4
		Chemicals	Inhalation, ingestion		
	Noninvolved workers	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
	WM workers	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
Number of genetic effects	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4-4
	Noninvolved workers		Inhalation, direct radiation		
	WM workers		Inhalation, direct radiation		
Probability of cancer fatality	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4-5 8.4-6
	Noninvolved worker MEI		Inhalation, direct radiation		
Probability of cancer incidence	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4-7
		Chemicals	Inhalation, ingestion		
	Noninvolved worker MEI	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
Probability of genetic effects	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4-7
	Noninvolved worker MEI		Inhalation, direct radiation		

Understanding Scientific Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10
$10^1 = 10 \times 1 = 10$
$10^2 = 10 \times 10 = 100$
and so on; therefore,
$10^6 = 1{,}000{,}000$ *(or 1 million)*
etc.

Negative Powers of 10
$10^{-1} = 1/10 = 0.1$
$10^{-2} = 1/100 = 0.01$
and so on; therefore,
$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^5 *can also be written as 3E+05, and* 3×10^{-5} *is equivalent to 3E–05. Therefore, 3E+05 = 300,000 and 3E–05 = 0.00003.*

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3E–06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated results (e.g., fatal cancer) will occur in the period covered by the analysis.

8.4.1.1 Estimated Number of Fatalities

Table 8.4–3 presents an overview, by alternative, of the total estimated programwide fatalities associated with TRUW treatment. This table presents the estimated number of fatalities to the offsite population, noninvolved workers, and waste management workers caused by radiological exposure. In addition, the table shows the estimated number of waste management worker deaths resulting from physical hazards during facility construction and operation.

For each alternative except No Action, there is at least one estimated fatality associated with treatment operations. Most of these fatalities occur within the waste management worker population, and result from physical hazards involved in construction and operation of TRUW treatment facilities. Only waste management workers are exposed to these physical hazards, and therefore, have more estimated fatalities than other receptor groups. Overall the estimated number of waste management worker fatalities due to

Table 8.4-3. TRUW Treatment: Estimated Number of Fatalities Programwide[c]

Alternative	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Worker Radiation Exposure
	CH Treat	RH Treat		Physical Hazards	Radiation Exposure		
No Action[a]	11	5	WIPP-WAC	*	*	*	*
Decentralized[b]	16	5	WIPP-WAC	2	1	*	*
Regionalized 1	5	2	Reduce gas	3	1	*	*
Regionalized 2	5	2	LDRs	4	1	1	*
Regionalized 3	3	2	LDRs	3	1	*	*
Centralized	WIPP	2	LDRs	2	1	*	*

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; * = greater than 0 but less than 0.5.
[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.

physical hazards exceeds the number of estimated fatalities to the offsite and the noninvolved worker populations for all alternatives. In general, risk to waste management workers appears to decrease when TRUW is treated to less stringent standards. That is, estimated fatalities are less when TRUW is processed to meet current waste acceptance criteria or to reduce gas generation potential than when it is treated to meet LDRs. A single latent cancer fatality is estimated for the waste management worker population under each alternative except No Action. It should, however, be noted that potential radiological impacts provided in the WM PEIS are based on analyses that include prudently conservative release, exposure, and risk factor estimates. DOE would use ALARA ("As Low As Reasonably Achievable") procedures and monitoring to reduce the actual doses received by the workforce.

Regionalized Alternative 2 also produces an estimated single latent cancer fatality in the offsite population at LANL from the thermal treatment of waste that contains americium-241. DOE may mitigate this potential effect by reducing emissions by means of special oxidation or other treatment or offgas control techniques that would be examined in sitewide or project-specific NEPA reviews. Site-specific estimated latent cancer fatalities for TRUW can be found in the site data tables in Volume II.

8.4.1.2 Estimated Number of Cancer Incidences and Genetic Effects

Table 8.4–4 presents an overview, by alternative, of the total programwide incidences of cancer and genetic effects associated with treatment of TRUW. These impacts result from exposures of the offsite, noninvolved worker, and waste management worker populations to chemicals and radiation. In addition, dose estimates are included for the offsite, noninvolved worker, and waste management worker populations.

Each of the alternatives has estimates of one or more cancer incidences resulting from radiation exposure. The greatest numbers of estimated cancer incidences resulting from treatment of TRUW to meet LDRs occur in the offsite populations at LANL and Hanford under Regionalized Alternative 2 and Hanford under Regionalized Alternative 3. This result reflects thermal treatment of waste that contains americium-241 at LANL and plutonium-238 at Hanford, which, as previously mentioned, would require special mitigation measures. There is a reduction in offsite population cancer incidences from treatment to meet LDRs under the Regionalized 3 and Centralized Alternatives. Estimated cancer incidences and genetic effects for TRUW can be found in the site data tables in Volume II.

LANL, Hanford, and WIPP are the only sites that have an estimated incidence of at least one cancer in the offsite population as a result of radiation exposure. Treatment to meet LDRs is forecast to cause this at Hanford and WIPP predominantly because of plutonium-238, whereas americium-241 accounts for most of the risk at LANL. Mitigation of the emissions from thermal treatment of these radionuclides may be accomplished through application of alternative treatment concepts when these become available, or by enhancing off-gas treatment systems, if these alternatives are selected. Specific mitigation measures would be evaluated in sitewide or project-specific NEPA reviews. Cancer incidences resulting from chemical exposure and genetic effects resulting from radionuclide and radiation exposure were not estimated to exceed one for any receptor group under any alternative.

8.4.1.3 Probability of MEI Cancer Fatalities

Table 8.4–5 summarizes, by alternative, the highest estimated *probability* at any site of latent fatal cancer from radiation exposure. This table presents the risk of cancer fatality to the MEI within the offsite and noninvolved worker populations. The numbers in this table are the estimated *probabilities* that the MEI will die of cancer from radiation exposure.

Table 8.4–4. TRUW Treatment: Estimated Number of Cancer Incidences and Genetic Effects Programwide[c]

Alternative	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Radiation Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action [a]	11	5	WIPP-WAC	0.08	*	*	*	0.007	*	*	*	400	1	*	*
Decentralized [b]	16	5	WIPP-WAC	0.3	*	*	*	0.03	*	*	*	1,510	2	*	*
Regionalized 1	5	2	Reduce gas	0.5	*	*	*	0.05	*	*	*	1,620	2	*	*
Regionalized 2	5	2	LDRs	1,990	3	*	*	3	*	*	*	1,640	2	*	*
Regionalized 3	3	2	LDRs	469	1	*	*	40	*	*	*	1,740	3	*	*
Centralized	WIPP	2	LDRs	609	1	*	*	4	*	*	*	2,040	3	*	*

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; * = values greater than 0 but less than 0.5.

[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.

Table 8.4–5. TRUW Treatment: Greatest Probability of Cancer Fatality at Any TRUW Site[c]

Alternative	Number of Sites		Treatment Standard	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
	CH Treat	RH Treat			
No Action [a]	11	5	WIPP-WAC	4E–10	2E–09
Decentralized [b]	16	5	WIPP-WAC	6E–09	7E–09
Regionalized 1	5	2	Reduce gas	7E–09	1E–08
Regionalized 2	5	2	LDRs	7E–05	5E–05
Regionalized 3	3	2	LDRs	5E–06	2E–05
Centralized	WIPP	2	LDRs	7E–05	9E–05

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.

The probability of a cancer fatality to the MEI was calculated for each site, and the highest values under each alternative are presented in Table 8.4–5. The MEI risk is not a combined total of risks across all of the sites in an alternative. This table indicates that the TRUW alternatives with treatment to meet LDRs have the highest cancer fatality probabilities for the MEI of the offsite and noninvolved worker populations. The other alternatives, which process TRUW to WIPP-WAC or treat it to reduce the potential of gas generation, have probabilities of cancer fatalities that are less by three orders of magnitude or more.

Table 8.4–6 presents the probability of a fatal cancer from radiological exposure for the offsite MEIs for all sites by treatment alternative. The data in Table 8.4–6 are graphically presented in Figure 8.4–1. Essentially, all sites that conduct treatment to meet LDRs have relatively higher cancer fatality probabilities than those that do not treat to meet LDRs. Air emissions of plutonium-238 are responsible for the relatively higher risk estimates at Hanford and WIPP, whereas americium-241 accounts for most of the risk at INEL, LANL, and RFETS.

Estimates of the potential release of alpha radionuclides to the air based on more recent waste loads at INEL and RFETS result in increases in the offsite MEI cancer fatality probabilities, and produce risk estimates in excess of one in one million for these sites for the Regionalized Alternative 2. Other risks (e.g., noninvolved worker MEI cancer fatality probability, offsite MEI cancer incidence probability) posed by the release of alpha radionuclides could increase as well (see Appendix I).

Table 8.4-6. TRUW Treatment: Offsite MEI Cancer Fatality Probabilities[c]

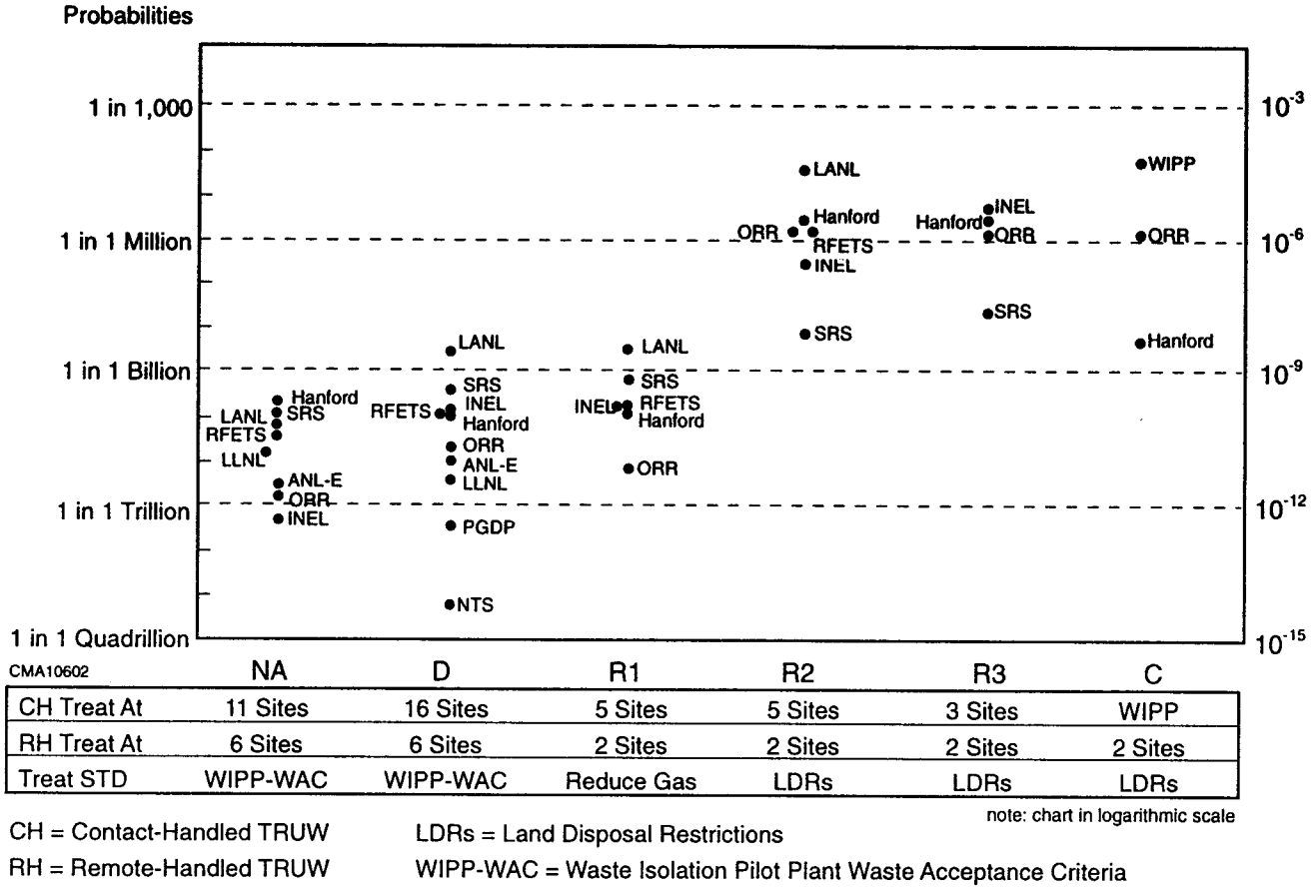
Alternative	Number of Sites		Treatment Standard	ANL-E	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	RFETS	SRS	WIPP
	CH Treat	RH Treat												
No Action [a]	11	5	WIPP-WAC	3E-12	2E-10	8E-13	4E-10	2E-11	--	2E-12	--	4E-11	2E-10	--
Decentralized [b]	16	5	WIPP-WAC	1E-11	5E-10	1E-10	6E-09	6E-11	3E-14	2E-11	4E-13	1E-10	7E-10	--
Regionalized 1	5	2	Reduce gas	1E-11	9E-10	2E-10	7E-09	6E-11	4E-14	3E-11	6E-13	2E-10	1E-09	--
Regionalized 2	5	2	LDRs	1E-11	3E-06	9E-07	7E-05	6E-11	4E-14	1E-06	6E-13	1E-06	2E-08	--
Regionalized 3	3	2	LDRs	1E-11	3E-06	5E-06	7E-09	6E-11	4E-14	1E-06	6E-13	2E-10	2E-08	--
Centralized	WIPP	2	LDRs	1E-11	1E-08	2E-10	7E-09	6E-11	4E-14	1E-06	6E-13	2E-10	3E-10	7E-05

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant Waste Acceptance Criteria. Analysis was not conducted for Offsite MEI Cancer Fatality Probabilities at SNL-NM and WVDP due to low TRUW inventory. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.



	NA	D	R1	R2	R3	C
CH Treat At	11 Sites	16 Sites	5 Sites	5 Sites	3 Sites	WIPP
RH Treat At	6 Sites	6 Sites	2 Sites	2 Sites	2 Sites	2 Sites
Treat STD	WIPP-WAC	WIPP-WAC	Reduce Gas	LDRs	LDRs	LDRs

note: chart in logarithmic scale

CH = Contact-Handled TRUW
RH = Remote-Handled TRUW
LDRs = Land Disposal Restrictions
WIPP-WAC = Waste Isolation Pilot Plant Waste Acceptance Criteria

Figure 8.4–1. Probability of Cancer Fatality to Offsite MEI—TRUW.

8.4.1.4 Probability of MEI Cancer Incidence and Genetic Effects

Table 8.4–7 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidence and genetic effects resulting from chemical and radiation exposure. This table presents these estimated risks for the MEI within the offsite and noninvolved worker populations.

Each of the TRUW alternatives involving treatment to meet LDRs has estimated probabilities of cancer incidence and genetic effects relatively greater than alternatives that do not involve treatment to meet LDRs. This includes the MEI in both the offsite and noninvolved worker populations.

All seven sites that would conduct treatment to meet LDRs (the Hanford Site, INEL, LANL, ORR, RFETS, SRS, WIPP) have relatively higher estimated probabilities of cancer or genetic effects than sites that would not treat to LDRs. Probabilities of cancer from chemical exposure were lower than probabilities of cancer from exposure to radiation. Estimated cancer incidences and genetic effects for TRUW can be found in Volume II in the site data tables.

8.4.1.5 MEI Noncancer Risks

The "Hazard Index" is the EPA's standard indicator of potential noncancer toxicity caused by exposure to hazardous chemicals. It is derived by comparing estimated exposure to concentrations of noncarcinogenic chemicals to concentrations presumed to be protective of human health over an entire lifetime, assuming continuous low-level exposure. If the Hazard Index exceeds one, the estimated exposure concentrations exceed the concentrations presumed to be without adverse health effects. In the WM PEIS, the Hazard Index was estimated for the offsite population MEI and noninvolved worker MEI.

For waste management workers, an "Exposure Index" rather than a Hazard Index was estimated. The Exposure Index is derived by comparing the estimated exposure concentrations to appropriate occupational exposure limits. The Exposure Index was considered to be a better measure for waste management workers because the Hazard Index uses standards designed to protect the health of the general population, including sensitive subgroups, such as children. Workers are generally assumed to be healthier than the general population, and worker populations contain fewer sensitive subgroups. Therefore, the concentrations of noncarcinogenic chemicals presumed to be protective of human health are different for these two groups

Table 8.4–7. TRUW Treatment: Estimated Greatest Probability of Cancer Incidence and Genetic Effects at Any Site[c]

Alternative	Number of Sites		Treatment Standard	Offsite MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Radiation Dose (rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Radiation Dose (rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action [a]	11	5	WIPP-WAC	0.000001	2E–09	7E–13	1E–10	0.000005	8E–09	3E–10	5E–10
Decentralized [b]	16	5	WIPP-WAC	0.00001	2E–08	1E–11	1E–09	0.00002	6E–08	6E–11	2E–09
Regionalized 1	5	2	Reduce gas	0.00001	2E–08	1E–11	1E–09	0.00003	5E–08	7E–11	3E–09
Regionalized 2	5	2	LDRs	0.1	2E–04	1E–11	1E–05	0.03	2E–04	5E–11	9E–06
Regionalized 3	3	2	LDRs	0.01	2E–05	1E–11	1E–06	0.03	5E–05	5E–11	3E–06
Centralized	WIPP	2	LDRs	0.1	2E–04	6E–12	1E–05	0.2	3E–04	4E–11	2E–05

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria;
* = greater than 0 but less than 0.0005 rem. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.

of receptors. If the Exposure Index exceeds one, the estimated concentrations exceed the concentrations presumed to be without adverse health effects.

None of the Hazard or Exposure Indices estimated for the alternatives evaluated exceeded one; therefore, no noncancer risks are expected as a result of TRUW treatment.

8.4.2 TRANSPORTATION-RELATED IMPACTS

Transporting TRUW for treatment and storage may affect the health of the truck drivers, rail crew, and the public along the transportation route. These impacts are the result of physical injury from vehicle accidents, radiation-induced latent cancers from normal operations, accidents where the waste containers are assumed to open, chemical exposure during accidents, and exposure to vehicle exhaust. For all alternatives except No Action, shipments were assumed to occur uniformly over a 10-year period, assuming a 10-year period to build treatment and storage facilities. There would be no transportation in the No Action Alternative.

The methods used to estimate transportation risks as well as relevant information concerning the types of shipping casks assumed are described in Appendix E. Tables 8.4–8 and 8.4–9 present the total number of estimated fatalities associated with truck and rail transportation of TRUW, respectively. Table 8.4–8 shows that if DOE shipped TRUW by truck, there is one additional fatality estimated for truck drivers under the Decentralized Alternative than under the other alternatives. Otherwise, the estimated number of latent cancer and traffic accident fatalities are approximately the same for all alternatives. Risks from rail transport are estimated to be slightly less than risks estimated for truck transport (Table 8.4–9).

The health impacts associated with exposure to the hazardous chemical components of TRUW that might be released during accidents are presented in Appendix E. No incidences of cancer or noncancer health effects associated with transportation were estimated for any alternative.

Table 8.4–8. Estimated Fatalities for TRUW Truck Transportation From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Treatment Standard	Estimated Number of Radiological Fatalities[a]		Estimated Number of Nonradiological Fatalities	
	CH Treat	RH Treat		Normal Operations Public	Normal Operations Crew	Fuel Emissions	Injury From Traffic Accidents
No Action [b]	11	5	WIPP-WAC	0	0	0	0
Decentralized [c]	16	5	WIPP-WAC	2	2	*	3
Regionalized 1	5	2	Reduce gas	2	1	*	3
Regionalized 2	5	2	LDRs	2	1	*	2
Regionalized 3	3	2	LDRs	2	1	*	3
Centralized	WIPP	2	LDRs	2	1	*	3

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria.
* Greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced cancer.
[b] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; for all other alternatives, disposal at WIPP is assumed.
[c] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table 8.4–9. Estimated Fatalities for TRUW Rail Transportation From Rail Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Treatment Standard	Estimated Number of Radiological Fatalities[a]		Estimated Number of Nonradiological Fatalities	
	CH Treat	RH Treat		Normal Operations Public	Normal Operations Crew	Fuel Emissions	Injury From Traffic Accidents
No Action [b]	11	5	WIPP-WAC	0	0	0	0
Decentralized [c]	16	5	WIPP-WAC	1	*	*	*
Regionalized 1	5	2	Reduce gas	*	*	*	*
Regionalized 2	5	2	LDRs	*	*	*	*
Regionalized 3	3	2	LDRs	*	*	*	*
Centralized	WIPP	2	LDRs	1	*	*	*

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria.
* Greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced latent cancer.
[b] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; for all other alternatives, disposal at WIPP is assumed.
[c] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

8.4.3 FACILITY ACCIDENT IMPACTS

8.4.3.1 Storage Facility Accidents

Accidents and source terms for current storage were not analyzed explicitly. Unlike treatment, which will chiefly use new facilities that have common characteristics, current (pretreatment) storage uses a variety of preexisting facilities that vary greatly with regard to the amounts and types of waste inventories they store, the arrangements in which the inventories are stored, and the containment characteristics of the storage enclosures. However, recent DOE safety analysis reports (SARs) and NEPA reviews provide guidance on the potential impacts of accidents in existing LLMW and TRUW storage facilities.

These current SARs and EISs are valid indicators of the potential consequences of a range of storage accidents with various probabilities of occurring. A brief summary of some of the accidents and assumptions used by sites in preparing the analyses, and the related release or health effects-related results, are shown in Appendix F. Examples of existing analyses applicable to TRUW storage accidents include accidents ranging from breaches of single drums due to drum rupture and lid failure to the total collapse of a storage facility due to a beyond-design-basis earthquake.

The most relevant recent analyses dealing with postulated accidents for TRUW waste storage facilities were reviewed, including the *Waste Isolation Pilot Plant Disposal Phase Draft Supplemental Environmental Impact Statement* (WIPP SEIS-II) (DOE, 1996e). The WIPP SEIS-II considers accidents associated with storage of TRUW after treatment and before further disposition. Accidents during current storage of TRUW are not considered in the WIPP SEIS-II. To allow comparison with other safety analysis of current TRUW storage, it was assumed that the TRUW treated to the planning-basis WAC in the WIPP SEIS-II would be similar in form to that currently stored at the generator sites. The accident scenarios considered in the WIPP SEIS-II include a multiple drum spill, an internally induced drum rupture and fire, and a beyond-design-basis earthquake that results in collapse of the storage facility. Accident consequences were calculated for six sites (Hanford, INEL, LANL, RFETS, ORNL, and SRS). The radionuclide content of each TRUW drum for the first two postulated accidents was assumed to be at the WIPP WAC limit of 80 plutonium equivalent curies (PE-Ci), while the average radionuclide content was applied to the accident involving a beyond-design-basis earthquake.

For the multiple drum spill accident (annual frequency of occurrence of about 0.01) considered in the WIPP SEIS-II, the probability of a latent cancer fatality (LCF) to the offsite MEI ranged from 2E-09 at SRS to 3E-07 at ORNL, with offsite population impacts estimated at less than 1E-03 fatalities. Similarly, the internally induced drum rupture and fire accident considered in the WIPP SEIS-II (annual frequency of occurrence of about 1E-04) also resulted in offsite population impacts of less than 1E-02 fatalities and probabilities of a LCF to the offsite MEI of from 8E-09 at SRS to 1E-06 at ORNL.

Much higher consequences were predicted for the earthquake accident (annual frequency of occurrence of less than 1E-05) considered in the WIPP SEIS-II. The probability of a LCF to the offsite MEI ranged from 2E-03 at SRS to 7E-02 at LANL. The number of latent cancer fatalities in the offsite population ranged from 6 at ORNL and INEL to 200 at Hanford and 300 at RFETS. The high number of fatalities may be attributable to the assumption of a beyond-design-basis earthquake that results in total collapse of the storage structure upon the site's entire inventory of TRUW treated to WIPP-WAC, which produces a significant airborne release of TRUW. In light of the stable nature of treated TRUW, this set of assumptions may be conservative. Consideration of the probability of such an accident results in an offsite MEI cancer risk of less than one in one million.

It should be noted that explicitly analyzing risks from storage would not help to discriminate among most alternatives because of the assumptions used in the WM PEIS. Except for the No-Action Alternative, the WM PEIS assumes that all sites will increase (or at least maintain) their inventories of TRUW for 10 years, until treatment begins. Thus, all sites will have their largest inventories (leading to maximum potential releases during a storage facility accident) regardless of the alternative, with the exception of the No Action Alternative. In that alternative, inventories of TRUW would continue to increase indefinitely.

8.4.3.2 Treatment Facility Accidents

Although there are many possible ways to treat TRUW, technologies using thermal treatment have been the most effective to date (in terms of volume reduction and destruction of organic hazardous constituents). A significant amount of incineration data are available and incineration represents and bounds other thermal

treatment processes. Thus, this risk analysis focuses on incineration.[10] Like other TRUW treatment processes, incineration operations and accidents can result in airborne releases of radionuclides. Potential treatment facility accidents identified for all TRUW alternatives include: (1) incineration facility fires or explosions initiated by internal causes; (2) an earthquake or tornado that causes damage and fires in the facility; and (3) the crash of a large or small aircraft into the facility, resulting in fire and explosion. All of these types of accidents can release the radioactive contents from the kiln of the incinerator, the stored ash byproduct from the incineration process, or the trapped contents of the filtration systems in the facility. The accident with the highest potential consequence at each site was evaluated.

The radiological health effects from treatment facility accidents were calculated on the basis of conservative assumptions. Table 8.4–10 summarizes the estimated cancer fatalities resulting from radiation exposures produced by potential treatment facility accidents. This table contains estimates of the cancer fatalities for maximum consequence accidents at each site and of the annual frequency of those accidents. The doses indicated are a function of the severity of the accident and the size of the population affected. The indicated probabilities of an excess cancer are calculated on the basis of the assumption that the accident occurs. Consistent with standard practice in radiological safety analysis, the fatalities are derived only from the cancers associated with radiation. In general, local worker fatalities from trauma in severe accidents would primarily result from the physical effects of the accident (e.g., the initial impact and fire of an airplane crash). These trauma fatalities would tend to be independent of the inventory or process used at a particular site under a given alternative and, therefore, would not tend to be a significant discriminator among the alternatives. Trauma fatalities to the offsite populations from severe accidents would be almost totally independent of the alternative, and therefore would not vary among alternatives.

Assuming that the accident occurs, each of the alternatives poses a cancer fatality probability equal to or greater than one in one million for the offsite MEI at most sites. However, when the frequencies of the accidents are considered, none of the alternatives pose an offsite MEI cancer risk greater than one in one million.

The Centralized Alternative is estimated to produce the highest number of cancer fatalities if an accident occurs affecting the offsite population (seven individuals at the WIPP site). Under Regionalized

[10] This focus gives DOE sufficient information to decide on the location of proposed TRUW treatment and storage facilities. Accident scenarios for all three TRUW treatment trains are assessed in the WIPP SEIS-II (DOE, 1996e). DOE will base its decision on which treatment process it will use to meet the performance standards for WIPP or storage requirements on the analysis in the WIPP SEIS-II.

Table 8.4-10. TRUW Facility Accidents—Radiation-Induced Cancer Fatalities From Maximum Reasonably Foreseeable Potential Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Radiation Dose (rem)	Offsite MEI Cancer Fatality Probability	Offsite Population Radiation Dose (person-rem)	Offsite Population Number of Cancer Fatalities	Worker Radiation Dose (person-rem	WM Workers Number of Cancer Fatalities
Regionalized 2								
Hanford	Incineration, natural phenomena	1.0E-06 to 1.0E-04	2E-03	9E-07	8E+01	*	1E+04	5
Hanford	Incineration explosion	1.0E-06 to 1.0E-04	1E-02	5E-05	4E+03	2	8E+02	*
INEL	Incineration, natural phenomena	1.0E-06 to 1.0E-04	9E-03	5E-06	8E+01	*	4E+02	*
LANL	Incineration, natural phenomena	1.0E-06 to 1.0E-04	1E+00	7E-04	3E+03	1	2E+03	1
RFETS	Incineration, natural phenomena	1.0E-06 to 1.0E-04	2E-02	1E-05	6E+02	*	5E+01	*
SRS	Incineration, natural phenomena	1.0E-06 to 1.0E-04	9E-06	5E-09	3E-01	*	4E+01	*
SRS	Incineration explosion	1.0E-06 to 1.0E-04	5E-04	2E-07	2E+01	*	2E+00	*
Regionalized 3								
Hanford	Incineration, natural phenomena	1.0E-06 to 1.0E-04	2E-03	9E-07	8E+01	*	1E+04	5
Hanford	Incineration explosion	1.0E-06 to 1.0E-04	1E-01	5E-05	4E+03	2	8E+02	*
INEL	Incineration, natural phenomena	1.0E-06 to 1.0E-04	5E-02	3E-05	4E+02	*	2E+03	1
SRS	Incineration, natural phenomena	1.0E-06 to 1.0E-04	9E-06	5E-09	3E-01	*	4E+01	*
SRS	Incineration explosion	1.0E-06 to 1.0E-04	5E-04	3E-07	2E+01	*	2	*
Centralized								
WIPP	Incineration, natural phenomena	1.0E-06 to 1.0E-04	2E+00	1E-03	3E+02	*	2E+05	14
WIPP	Incineration explosion	1.0E-06 to 1.0E-04	1E+02	6E-02	1E+04	7	1E+04	4
Centralized (RH)								
Hanford	Incineration, natural phenomena	1.0E-06 to 1.0E-04	8E-06	4E-09	4E-01	*	6E+00	*
ORNL	Incineration, natural phenomena	1.0E-06 to 1.0E-04	7E-02	3E-05	8E+02	*	3E+01	*

Notes: Natural phenomena refer to accidents initiated either by earthquake or by high wind or tornado, depending on the site and the associated recurrence frequencies. Incineration was the thermal treatment analyzed. * = greater than 0 but less than 0.5. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

Alternative 2, treatment accidents would result in two cancer fatalities in the offsite population at Hanford and one cancer fatality in the offsite population at LANL if the accidents were to occur. Under Regionalized Alternative 3, treatment accidents are estimated to result in two cancer fatalities in the offsite population at Hanford, assuming they occur. No cancer risk fatalities exceeding one within the offsite population would result from accidents under the Centralized Alternative for RH TRUW. The overall risks from accidents for all alternatives, derived by multiplying the health risk value by the frequencies of the accidents, are small.

The highest estimate of cancer fatalities resulting from the maximum reasonably foreseeable accidents affecting waste management workers is 14 at the WIPP site under the Centralized Alternative. Under Regionalized Alternative 2, five cancer fatalities are estimated in the WM worker population at Hanford, and one cancer fatality is estimated at LANL. Under Regionalized Alternative 3, five cancer fatalities are estimated in the WM worker population at Hanford, and one cancer fatality is estimated at INEL. No cancer fatalities within the WM worker population are estimated to result from accidents under the Centralized Alternative for RH TRUW. The overall risks from accidents, taking into account the probability of these accidents, are small.

The results of the WM PEIS analysis are consistent with those in the WIPP SEIS-II (DOE, 1996e). The WIPP SEIS-II examines three levels of treatment: treating to WIPP WAC, thermal treatment using vitrification, and shred and grout. Although the generic treatment train evaluated in the WM PEIS for meeting RCRA land disposal restrictions (Figure 8.2-3) does not include vitrification as a treatment technology, comparison of the accident analyses impacts in the WM PEIS with those estimated in the WIPP SEIS-II indicates that the largest potential impacts from accidents are associated with thermal treatment. The accident analysis for thermal treatment to LDRs in the WIPP SEIS-II considers three scenarios: failure of a drum containing vitrified treated waste, a steam explosion in a vitrification glass melter, and a beyond-design-basis earthquake with resultant collapse of the waste treatment facility. The accident associated with TRUW treatment with the highest potential consequence to the offsite population for both the WM PEIS and WIPP SEIS-II is a seismic event. For this event, the WM PEIS predicts up to 7 latent cancer fatalities in the offsite public, depending upon the alternative and site; the WIPP SEIS-II predicts up to 30 LCFs in the offsite population. The difference in consequences for this seismic event between the WIPP SEIS-II and the WM PEIS can be attributed to the use of different analytical methods and assumptions and their attendant uncertainties. As an example, the WIPP SEIS-II very conservatively assumes that the entire process inventory would be affected by this accident, while the WM PEIS assumes 24% of the process

inventory, based upon recent safety literature. Therefore it may be expected that the WIPP SEIS-II would predict generally higher consequences for a seismic-initiated treatment facility accident. The maximum probability of a LCF to the offsite MEI is on the order of 0.06 for the Centralized Alternative at WIPP in the WM PEIS and 0.02 for ORNL in the WIPP SEIS-II.

The health risk consequences presented in Table 8.4–10 are conservative. They assume no mitigation of the accidents and take no credit for emergency response actions. The reduction in impacts due to these mitigation actions would be significant.

8.5 Air Quality Impacts

The management of TRUW would not appreciably affect the air quality at most sites. No criteria air pollutant emissions would exceed standards at any site. Emissions of radionuclides were estimated to be below the applicable standards at all sites, except for LANL and WIPP when these sites treat TRUW to meet LDRs. The exceedances at these sites would require mitigation measures to reduce emissions to acceptable levels. Emissions of other hazardous air pollutants were estimated to be below the applicable standards at all sites.

As illustrated in Table 8.5–1, DOE evaluated air quality impacts at each proposed TRUW treatment site on the basis of estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (which include radionuclides), and toxic air pollutants. Emissions from TRUW facility construction and operation and maintenance activities were estimated.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new emissions from both "stationary" (e.g., treatment and storage facilities) and "mobile" (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule" (GCR). In this rule, EPA has established limits for each criteria air pollutant in nonattainment areas. An entity which would engage in an activity that would result in emissions that equals or exceeds those limits in a nonattainment area must first obtain a permit.

Table 8.5-1. Air Quality Impacts Evaluated for TRUW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Were Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Table 8.5-2
	Operations	Estimated for thermal treatment units, for fuel use by all other TRUW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 8.5-3
Radionuclide emissions	Operations	For all TRUW treatment facilities	Percent of standard	Table 8.5-4
Hazardous and toxic air pollutant emissions	Operations	For all TRUW treatment facilities	Percent of standard	Text discussion only

In "attainment areas" (where air pollution standards are met), only new emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. However, a permit is required for a new stationary source if it equals or exceeds the allowable increase. Permits are not required for criteria pollutant emissions from mobile sources.

8.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers drive to the construction site—"mobile sources."

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities under the TRUW alternatives would result in emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. Table 8.5-2 lists those sites. DOE chose the 10%

Major Types of Air Pollutants

- ***Criteria Air Pollutants:*** *carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*
- ***Hazardous Air Pollutants:*** *189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*
- ***Toxic Air Pollutants:*** *Other toxic compounds regulated by EPA and state or local governments*

Table 8.5-2. TRUW Sites Equaling or Exceeding 10% of Standard for Criteria Air Pollutants During Construction[a]

Alternative	Number of Sites		Treatment Standard[b]	ANL-E		RFETS	
	CH Treat	RH Treat		NO_2	VOC	CO	NO_2
No Action[c]	11	5	WIPP-WAC				
Decentralized[d]	16	5	WIPP-WAC	49(23/26)	17(2/15)	19(3/16)	11(8/3)
Regionalized 1	5	2	Reduce gas	40(16/24)	16(2/14)	20(3/17)	11(8/3)
Regionalized 2	5	2	LDRs	34(25/9)		29(4/25)	15(10/5)
Regionalized 3	3	2	LDRs	34(25/9)			
Centralized	WIPP	2	LDRs	34(25/9)			

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; NO_2 = nitrogen dioxide; VOC = volatile organic compounds; CO = carbon monoxide.
[a] Sites that exceed 10% of the limit specified by the GCR; total % of limit (% equipment/% worker vehicles). Blanks indicate that a site does not exceed 10% of the standard under the specified alternative.
[b] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce volatile gas generation; LDRs = Land Disposal Restrictions criteria.
[c] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[d] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

threshold to identify those sites where criteria air pollutant emissions could result in adverse air quality impacts.

As indicated in Table 8.5-2, two of the 13 major TRUW sites are located in nonattainment areas and, as a result of construction of TRUW facilities, would release emissions that exceed 10% of the allowable limit for a particular criteria air pollutant. Both sites would exceed the 10% threshold in the Decentralized and Regionalized Alternatives 1 and 2. However, DOE estimates that emissions from construction activities would not exceed the allowable levels at any site under any alternative.

8.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operations and maintenance (O&M) of TRUW facilities (stationary sources) and by vehicles driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rule in nonattainment areas or PSD increments in attainment areas).

As shown in Table 8.5-3, three of the 13 major TRUW sites would exceed 10% of applicable air pollutant emission standards. Of these, one site is located in a nonattainment area, and two sites are in attainment areas. Two sites would have pollutant emissions that exceed 10% of the levels under any alternative. No site is estimated to exceed applicable standards, and therefore, no site would need to obtain a Clean Air Act permit.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 kilometers of a PSD Class I area. Eight

Table 8.5-3. Percent of Sites' Allowable Air Emissions Discharged During Operations—TRUW Sites Equaling or Exceeding 10% of Standard [a]

Alternative	Number of Sites		Treatment Standard [b]	Criteria Pollutants			
				Operation and Maintenance			
				INEL	RFETS	WIPP	
	CH Treat	RH Treat		PM_{10} [c]	CO [d]	NO_2 [c]	PM_{10} [c]
No Action [e]	11	5	WIPP-WAC				
Decentralized [f]	16	5	WIPP-WAC		17(0/17)		
Regionalized 1	5	2	Reduce gas		20(0/20)		
Regionalized 2	5	2	LDRs	10	24(0/24)		
Regionalized 3	3	2	LDRs	17			
Centralized	WIPP	2	LDRs			15	25

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; CO = carbon monoxide; NO_2 = nitrogen dioxide; PM_{10} = particulate matter less than or equal to 10 micrometers in diameter. Blanks indicate that a site does not exceed 10% of the standard under the specified alternative.

[a] Sites equaling or exceeding 10% of the PSD increment or the standard specified by the General Conformity Rule, as indicated.

[b] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce gas generation potential; LDRs = Land Disposal Restrictions criteria.

[c] Attainment area for this pollutant; PSD regulations are applied; total % represents stationary-source emissions only.

[d] Nonattainment area for this pollutant; General Conformity regulations are applied; total % (% stationary-source/% mobile-source).

[e] For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[f] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

sites proposed for TRUW activities under various alternatives are located within 100 km of a PSD area: INEL, LANL, LLNL, NTS, ORR, RFETS, SNL-NM, and WIPP. None of the proposed TRUW activities would emit enough criteria pollutants to affect a PSD Class I area.

8.5.3 Hazardous and Toxic Air Pollutant Emissions

Thermal treatment of TRUW will result in emission of small quantities of hazardous (including radionuclides) and toxic air pollutants. Nonradiological hazardous air pollutants and toxic air pollutants were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits (AALs) for each site. Radionuclides were evaluated by comparing the annual MEI radiation dose to the National Emissions Standards for Hazardous Air Pollutants (NESHAP)—10 millirem per year (40 CFR 61).

As shown in Table 8.5–4, doses from airborne radionuclides were estimated not to equal or exceed 10% of the dose standard at any site, except at INEL, LANL, and WIPP. The dose standard was exceeded at LANL and WIPP. These results are from the assumed thermal treatment with generic technology of waste containing plutonium-238 at WIPP and americium-241 at INEL and LANL. The treatment of TRUW with these radionuclides would require special design and other considerations, including additional control measures to reduce emissions to acceptable levels. Nonradiological hazardous or toxic air pollutant concentrations at the proposed treatment sites were not estimated to equal or exceed 10% of the applicable guidelines or standards.

8.6 Water Resources Impacts

Major impacts to water resources at the sites are unlikely for treatment of TRUW under any of the alternatives.

As illustrated in Table 8.6–1, DOE analyzed the impacts on water resources of treatment activities. DOE evaluated the effects on water availability from building and operating treatment facilities.

Table 8.5-4. TRUW Sites Equaling or Exceeding 10% of Standard for Radionuclides During Operation

Alternative	Number of Sites		Treatment Standard[a]	Radionuclides		
	CH Treat	RH Treat		INEL	LANL	WIPP
No Action[b]	11	5	WIPP-WAC			
Decentralized[c]	16	5	WIPP-WAC			
Regionalized 1	5	2	Reduce gas			
Regionalized 2	5	2	LDRs		134	
Regionalized 3	3	2	LDRs	10		
Centralized	WIPP	2	LDRs			137

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW. Blanks indicate that a site does not exceed 10% of the standard under the specified alternative.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce gas generation potential; and LDRs = Land Disposal Restrictions criteria.
[b] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

Table 8.6-1. Water Resource Impacts Evaluated for TRUW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Table 8.6-2
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by treatment processes	Percent increase in current water use	Table 8.6-2
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

8.6.1 WATER AVAILABILITY

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of TRUW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 8.6–2 identifies sites where projected water usage under any alternative would increase by more than 1%. This 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Five of the 13 major sites are predicted to exceed the 1% threshold. Most exceedances are due largely to water used during the 2- to 3-year period for construction of treatment facilities. Although projected water requirements exceed current water use by more than 1% at INEL, LLNL, RFETS and SRS, these sites are not likely to experience adverse impacts because of sufficient capacities and the relatively small amount of additional water needed (DOE, 1996b).

Adverse impacts could be experienced at WIPP. As shown in the site data tables in Volume II, additional water use for the Centralized Alternative would be approximately 290% of current use of 15,000 gallons per day during the 2- to 3-year construction period and 110% of current use during operations. This appears high, but the capacity of the water supply system at WIPP was designed to allow for increased water demand if TRUW is disposed of there. Water use under the Centralized Alternative would require an additional 8% of the 540,000 gallons per day capacity of the water supply distribution system during

Table 8.6-2. TRUW Sites Predicted to Exceed 1% of Current Water Use for Construction or Operations

Alternative	Number of Sites		Treatment Standard[a]	INEL	LLNL	RFETS	SRS	WIPP
	CH Treat	RH Treat						
No Action[b]	11	5	WIPP-WAC					
Decentralized[c]	16	5	WIPP-WAC	1.2	2.8	2.1		
Regionalized 1	5	2	Reduce gas	1.2	2.8	2.2	1.2	
Regionalized 2	5	2	LDRs	1.3	2.8	3.0	1.4	
Regionalized 3	3	2	LDRs	1.4	2.8		1.4	
Centralized	WIPP	2	LDRs		2.8			290

Notes: CH = contact-handled TRUW; RH = remote-handled. Blank cells are less than or equal to 1%. Water sources are as follows: groundwater for INEL, LLNL, SRS; municipal water supply for RFETS and WIPP.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce gas generation potential; and LDRs = Land Disposal Restrictions criteria.
[b] For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, impacts are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

construction and 3% during operations. WIPP does not withdraw water from any onsite surface water or groundwater body. Instead, water is supplied by municipal water via a pipeline from the city of Carlsbad, New Mexico. Because water for WIPP is supplied by an offsite municipal system, onsite water resources would not be affected.

As shown in the site data tables in Volume II, water use would be less than 1% of the average flow in the surface water body for DOE sites that withdraw water directly from a surface water source (Hanford, ORR, PGDP, and WVDP). In addition, it was assumed for this analysis that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, ORR, PGDP, RFETS, SRS, and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These negligible changes in flow should not affect surface water availability.

8.6.2 WATER QUALITY

Impacts to groundwater quality from disposal of TRUW were not evaluated because disposal of TRUW is not within the scope of the WM PEIS.

8.7 Ecological Resources Impacts

Loss of limited acreage of habitat at some sites from construction site clearing for TRUW facilities should not affect populations of nonsensitive plant and animal species because these species' habitats are well established regionally. DOE should be able to locate new TRUW facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction sites are small compared to the total acreage at each site suitable for waste operations. A screening level risk assessment of TRUW facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. Transportation accidents leading to spills of TRUW into aquatic environments are not expected to have serious short- or long-term consequences under any alternative.

DOE analyzed the effects of construction site clearing to build TRUW treatment and storage facilities at the 10 major TRUW sites and the operation of treatment facilities on terrestrial ecological resources at proposed TRUW management sites (Table 8.7–1). Accidental releases during transportation of TRUW between DOE sites that could affect aquatic resources offsite were also evaluated.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the WM PEIS will not be the basis for selecting specific locations for facilities at the sites. When selecting locations for facilities at sites, DOE will consider the results of relevant existing or new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

8.7.1 GENERAL IMPACTS OF SITE CLEARING

None of the TRUW alternatives would require extensive clearing for construction of TRUW facilities. No more than 29 acres would be disturbed at any site under any alternative. These acreage requirements are small compared to the regional extent of habitat for nonsensitive species on or near the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small

Table 8.7-1. Ecological Resources Impacts Evaluated for TRUW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at TRUW construction sites to general habitat range	Text discussion
Terrestrial species exposures	Terrestrial animal species	Comparison of estimated radiation dose of representative species with toxicity standard	Text discussion
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats by comparing construction acreage to available acreage of nonsensitive habitats	Text discussion
Sensitive species concerns	Federally- and State-listed endangered and threatened species	Numbers of Federally- and State-listed species displayed by site/alternative	Table 8.7-2
Effects of transportation accidents	Aquatic species in streams crossing transportation corridors	Results of scenario-based modeling analysis of accidental spill effects on fish in various size streams	Text discussion

mammals and song birds with limited home ranges), no effects on populations of these species are expected from proposed TRUW actions because nonsensitive species habitats are well established regionally.

8.7.2 Site Clearing Effects on Sensitive Habitats

WIPP has no sensitive habitats on or adjacent to the site; the other TRUW sites do contain sensitive habitats. The degree to which the habitats may be affected by noise or vibration, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby construction activities at any site depends on DOE's ability to avoid siting facilities near these habitats. A measure of this ability is the percentage of available land required for facility construction under an alternative. Available acreage was estimated from site development plans, either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage required for the TRUW facilities ranged from 0.003% at SRS under the Centralized Alternative to 0.41% at the Hanford Site under Regionalized Alternatives 2 and 3. Considering the small amounts of available land required for TRUW facilities, DOE should have a great degree of flexibility in siting these facilities and should be able to employ a range of mitigative measures so that site clearing to implement any of the alternatives for TRUW management should not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices should minimize these effects. Direct discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

8.7.3 Effects of TRUW Treatment Facility Emissions

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of radionuclides from treatment facilities. This analysis used the same atmospheric emissions estimates as the human health risk assessment and provided estimates of radionuclides deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Potential toxicity to terrestrial wildlife was analyzed for selected sites under the Decentralized Alternative, Regionalized Alternatives 2 and 3, and the Centralized Alternative. The radionuclides Cs-137, H-3, Ni-63, Co-60, Sr-90, U-238, Pu-238, Pu-239, Pu-241, Y-90, Am-241, Pm-147, and Ba-137 were selected for the analysis. These radionuclides constitute 80% of the total activity of all radionuclides expected to be emitted. The remaining 20% of the radioactivity comes from smaller emissions of a large number of radionuclides. The conservative assumptions used to characterize the exposure scenario for wildlife (e.g., accumulation of contaminants for 10-year period with no loss due to decay or transport) compensate for limiting the analyses to 80% of the released activity. The concentrations of radionuclides were used in calculating Hazard Indexes for each selected combination of sites and alternatives as composite ratios between the estimated exposures of species to each contaminant and the estimated contaminant-specific toxic levels. A Hazard Index greater than 1 indicates a potential for the combined exposures to adversely affect the health of terrestrial species. For all Alternatives at all sites, the Hazard Index was determined to be less than 0.01, except at WIPP under the Centralized Alternative, where the maximum estimated dose produces a maximum estimated Hazard Index of 0.11. Therefore, impacts to terrestrial receptor populations as a result of emissions of radionuclides from treatment facilities are expected to be minimal. Additional information on the methods used to assess potential toxicity to terrestrial animals and on the results of the analysis is presented in Section C.4.4 of Volume III and the impacts technical report (DOE, 1996b).

8.7.4 CONSIDERATION OF SENSITIVE SPECIES

For comparison of the TRUW management program's potential to affect sensitive species, Table 8.7–2 lists the numbers of Federally and State-listed sensitive species occurring or potentially occurring at the 10 largest TRUW sites under each alternative. DOE anticipates that, in the majority of cases, any such impacts found significant in sitewide or project-specific NEPA reviews can be mitigated or eliminated by alteration of a proposed facility's location or other measures.

8.7.5 EFFECTS OF TRUW TRANSPORTATION ACCIDENTS

The ecological impacts of a transportation accident involving shipment of TRUW were analyzed on the basis of an assumed accident involving a release of TRUW from a vehicle into a stream. Analysis of such an accident requires an estimate of the spill release rate and assumed stream characteristics. The impacts of waste transportation accidents were evaluated as consequence assessments that did not include estimates of the probability of occurrence of these events. The transportation accident scenario involved spilling the

Table 8.7–2. Numbers of Federally Listed and State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the TRUW Sites (Federal/State)

Alternative	Number of Sites		Treatment Standard[a]	ANL-E	Hanford	INEL	LANL	LLNL	NTS	ORR	RFETS	SRS	WIPP
	CH Treat	RH Treat											
No Action[b]	11	5	WIPP-WAC	2/5	3/11	2/2	2/4	6/5	2/2	1/11	2/2	8/8	--
Decentralized[c]	16	5	WIPP-WAC	--	3/11	--	2/4	--	2/2	1/11	--	--	--
Regionalized 1	5	2	Reduce gas	--	3/11	2/2	2/4	--	--	1/11	--	8/8	--
Regionalized 2	5	2	LDRs	--	3/11	2/2	2/4	--	--	1/11	2/2	8/8	--
Regionalized 3	3	2	LDRs	--	3/11	2/2	--	--	--	1/11	2/2	8/8	--
Centralized	WIPP	2	LDRs	--	3/11	--	--	--	--	1/11	--	--	2/5

Notes: CH = contact-handled TRUW; RH = remote-handled; -- = no major action proposed at a site under the specified alternative.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce volatile gas generation; and LDRs = Land Disposal Restrictions criteria.
[b] For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

contents of a TRUW shipment being transported by rail to the Hanford Site or LANL into streams of different sizes. As a result of the packaging used to transport TRUW, it was assumed that only a small fraction of the total inventory of TRUW (approximately 6 kg [14 lb.] out of a single shipment weight of 28,000 kg [61,000 lb.] of RH-TRUW, or 0.02%) would be released into the streams in an accident, as a result of small cracks and potential seal failures in the packaging containers (see Section 8.2.4).

The results of this analysis indicate that even if the entire release were concentrated in 1 cubic meter (m^3) of surface water, the dose to aquatic organisms would be at least five orders of magnitude below the National Council on Radiation Protection and Measurements recommended safe level. If spills were deposited in stream sediments, a few kilograms of sediment, at most, would be significantly contaminated. Since the total estimated release of radioactivity is less than 0.5 curie in the scenarios evaluated, it is unlikely that the released material would be detected above background radiation levels after its initial dispersal. In addition, impacts from the release of hazardous constituents are expected to be minor due to the small fraction of waste released. Additional information on the methods used to assess the potential consequences of a TRUW transportation accident on aquatic environments and on the results of the analysis is presented in Section C.4.4 of Volume III and the impacts technical report (DOE, 1996b).

8.8 Economic Impacts

Nationwide, the largest economic effects of TRUW management would occur under Regionalized Alternative 2 and would generally decrease as the alternatives become more centralized. The greatest benefit at any site occurs when TRUW is managed at that site. The greatest increase in jobs as a percent of regional employment would occur at INEL and WIPP under Regionalized Alternative 3 and the Centralized Alternative, respectively. None of the TRUW alternatives would substantially affect the national economy, although some 1,850 to 11,900 jobs would be directly or indirectly created.

DOE estimated the effects of expenditures for TRUW management on the local and national economies (see Table 8.8-1). Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of treatment facilities. The socioeconomic region of influence (ROI), where local effects were evaluated, consists of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data for the ROI counties. Local jobs and personal income were considered to be substantial benefits when they were

Table 8.8-1. Economic Impacts Evaluated for TRUW Alternatives

Economic Impact Analyzed	Affected Economic Resource	Analysis Method	Presentation of Results
Increased regional employment	Regional employment	Proposed site expenditures multiplied by regional employment multiplier at each TRUW site	Table 8.8-2
Increased regional incomes	Regional per capita income	Proposed site expenditures multiplied by regional income multiplier at each TRUW site	Text discussion
National economic effects	National economy	Proposed site plus total transportation expenditures multiplied by national employment and income multipliers	Text discussion

1% or greater than the 1990 baseline. Transportation expenditures were considered at the national level only.

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined to estimate total project effects at each site over 24 years. For all alternatives (except No Action), the construction phase at any site was assumed to take 4 years; the operations phase was assumed to take 15 years (a 10-year operations and maintenance period and a 5-year decontamination period); and 5 years was assumed to account for the continued effects on employment and income after each project phase ended. Job and personal income increases are shown for each site in the site tables in Volume II.

Across the alternatives, only regions surrounding the Hanford Site, INEL, LANL, and WIPP would experience a 1% or greater change in the number of jobs as a result of expenditures for TRUW management (Table 8.8-2). The Hanford Site would experience an increase in the number of direct, indirect, and induced jobs of 1% under Regionalized Alternatives 2 and 3, and LANL would experience a 1% change under the Decentralized and Regionalized 1 and 2 Alternatives. The increases in the number of new direct, indirect, and induced jobs were greatest at INEL and WIPP under the Regionalized 3 and Centralized Alternatives, respectively, showing a 2.1% change in the number of jobs. No sites would experience a 1% or greater increase in personal income under any of the alternatives.

Table 8.8–2. Employment Resulting From the Management of TRUW as a Percent of Regional Employment (sites where jobs were estimated to be 1% or more of the regional baseline)

Alternative	Number of Sites		Treatment Standard[a]	Hanford	INEL	LANL	WIPP
	CH Treat	RH Treat					
No Action[b]	11	5	WIPP-WAC				
Decentralized[c]	16	5	WIPP-WAC		1.4	1.0	
Regionalized 1	5	2	Reduce gas		1.6	1.0	
Regionalized 2	5	2	LDRs	1.0	1.8	1.1	
Regionalized 3	3	2	LDRs	1.0	2.1		
Centralized	WIPP	2	LDRs				2.1

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW. Blanks indicate sites where jobs were estimated to be less than 1% of the regional baseline.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce gas generation potential; and LDRs = Land Disposal Restrictions criteria.
[b] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

The sum of the new direct, indirect, and induced jobs across the alternatives at 10 sites' ROIs range from approximately 1,250 (under the No Action Alternative) to 7,700 (under Regionalized Alternative 2). At the four sites listed in Table 8.8–2, job increases are in line with increases in the volume of TRUW managed at each site under the alternatives. These employment increases of up to 2.1% could be considered important benefits of TRUW management at those sites.

Under the No Action Alternative, in place of distinct construction and operations phases, all costs were assumed to occur in 25 years (20 years of storage operations plus 5 years for decontamination and decommissioning).

In addition to analyzing the effects on regional economies, DOE analyzed these effects on the national economy. None of the TRUW Alternatives would have substantial impacts on the national economy. The No Action Alternative has no construction activities, and therefore no construction impacts. The total number of jobs generated in the national economy from combined weighted construction and operations activities ranges from approximately 1,850 (under the No Action Alternative) to 11,900 jobs (under

Regionalized Alternative 2). In absolute terms, the number of jobs appears large, but 11,900 jobs represents only 0.009% of the 137 million jobs in the national economy. Similarly, the change in personal income due to the implementation of any of the alternatives ranges from $42 million (under the No Action Alternative) to $270 million (under Regional Alternative 2). This $270 million represents only 0.006% of the $4.7 trillion total personal income in the U.S. economy. The changes would likely represent a shift in the source of income from previous employment to employment in TRUW projects rather than a net increase in national personal income.

8.9 Population Impacts

No major population increases are expected to occur at any site under any alternatives; thus, community characteristics and the provision of services would not be affected.

Potential population changes in ROIs were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that associated effects, such as changes in community size and diversity, and the provision of necessary services, would be caused by such population changes.

No regions around any TRUW site would experience population increases greater than 1% of the current ROI population. Three sites are in regions that would experience an estimated population increase of more than 0.5%, which DOE believes would have a potential for minor social impacts—for INEL under the Decentralized and Regionalized Alternatives 1, 2, and 3, and WIPP under the Centralized Alternative.

8.10 Environmental Justice Concerns

Assessment of potential concerns regarding environmental justice associated with TRUW management indicated potential concerns about disproportionately high and adverse health risks or environmental impacts to minority and low-income groups at the INEL and WIPP sites. These potential impacts could be mitigated by selection of an alternative facility location or treatment technology, or the use of more efficient emissions controls.

The analysis of environmental justice concerns related to the management of TRUW was based on a review of the impacts reported in this chapter. This analysis was performed to reveal the potential for disproportionately high and adverse human health or environmental impacts on minority or low-income populations near each of the 13 major sites that might treat TRUW. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done. Appendix C also provides maps illustrating the distribution of minority and low-income populations within 50 miles of each of the 13 sites.

8.10.1 RESULTS

From the standpoint of environmental justice, the potential for disproportionately high adverse human health effects from exposures to radionuclide emissions from TRUW treatment facility operations is low for most TRUW management alternatives and for all TRUW sites except INEL and WIPP. Incident-free TRUW storage and treatment facility operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the surrounding population of any site.

For the offsite population MEI during incident-free facility operations, screening criteria indicated a cancer fatality probability equal to or greater than 1.0E–06 at Hanford, INEL, LANL, ORR, RFETS, and WIPP for treatment to LDRs. Demographic analysis of the ROIs of these six sites indicated potential disproportionate effects at INEL under the Regionalized 3 Alternatives and at WIPP under the Centralized Alternative. The MEI would be located in a census tract at INEL that contains a low-income population proportion (20.3%) greater than the national average of 13.1%. The MEI at WIPP would be located in a census tract with a minority population proportion (69.7%) that exceeds the national average (24.4%) and a low-income population proportion (23.6%) that also exceeds the national average (13.1%).

It should be noted that use of an alternative treatment technology or employment of more efficient emissions controls than the controls assumed in the conceptual thermal treatment analyzed in the WM PEIS would enable DOE to treat TRUW with lower health risks to the nonworker MEI.

A more detailed analysis of potential concerns regarding environmental justice impacts would be conducted in NEPA reviews on site-specific activities involved in treating and storing TRUW.

8.10.1.1 Transportation

Incident-free TRUW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects on minority or low-income populations. As Section 8.4.2 indicates, the estimated total number of cancer fatalities resulting from incident-free transportation is zero under the No Action Alternatives and two under all other TRUW alternatives. These estimates of collective population fatalities are for the total of all shipments. Disproportionate shares of minority and low-income populations reside near interstate highways and railroads; however, the major routine risk to the public from truck transportation is from exposure during rest stops to travelers who are using the same rest stops. Minority and low-income populations are found to be disproportionately lower in use of highway rest stops (DOT, 1992). For rail shipments, the primary risks to the public would be from radiological exposure during railcar classification in railyards, primarily at the start and end of each shipment, and from the emission of diesel exhaust from the trains in urban areas. Therefore, disproportionately high and adverse health effects to minority or low-income populations from incident-free TRUW transportation are not expected to occur.

The expected number of cancer fatalities due to radiation exposure resulting from transportation accidents, taking into account both the consequences of such a release and the probability that an accident causing such a release will occur, is less than 0.5 under all alternatives. The expected number of transportation accident fatalities from trauma is approximately three under all TRUW alternatives except No Action, which would have none. Consequently, disproportionately high and adverse impacts on minority and low-income populations are not expected.

8.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 8.10.1 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Air quality impacts are possible at three sites but no disproportionately high and adverse impacts are expected for any segment of the population.

8.11 Land Use Impacts

Because land requirements for TRUW facilities are relatively small, no impacts on current onsite land uses are expected. Site development plans indicate no potential conflicts between proposed treatment or storage facilities and other plans for the sites.

DOE examined the impacts of the alternatives on land use by comparing the acreage required for new treatment and storage facilities to the acreage either designated for waste operations or suitable for development (see Table 8.11-1). Suitable land is the total site acreage, minus the acreage of known cultural resources, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Site development plans were also used to identify potential conflicts between the facilities proposed under each alternative and plans for future uses of the site.

None of the site development plans indicated any conflicts between TRUW management and other uses. Because the analysis showed that TRUW facilities would require less than 1% of the land available for waste operations at any site, DOE would have considerable flexibility in locating those facilities, and impacts on land use would probably be minimal. (See the site data tables in Volume II for percentage of waste operations area.) For the same reason, conflicts with adjacent offsite land use plans are considered unlikely.

Table 8.11-1. Land Use Impacts Evaluated for TRUW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each TRUW site	Land use shown in site development plans	Comparison of waste management required land acreage with amount designated (or estimated) for waste management in site development plan	Text discussion
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed waste management uses and nearby land uses	Text discussion

Although DOE intends to select sites for waste management on the basis of the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities at those sites. When selecting locations for facilities at sites, DOE will consider the results of relevant existing or new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations on a site.

8.12 Infrastructure Impacts

Although no offsite infrastructure impacts are expected, proposed TRUW activities would affect onsite infrastructure at Hanford, INEL, and WIPP. In addition, increases in site employment at the Hanford Site, INEL, LANL, and WIPP would lead to traffic increases that would be sufficient to affect onsite transportation infrastructure. The greatest infrastructure impacts are expected at WIPP under the Centralized Alternative.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and power under the alternative configurations for TRUW management (see Table 8.12–1). Water and power requirements were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because construction wastewater was assumed to be negligible.

Table 8.12–1. Infrastructure Impacts Evaluated for TRUW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support TRUW facilities	Capacity of onsite water, power, and wastewater systems	Add increased TRUW facility use to current use—compare to current capacities	Table 8.12–2
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Table 8.12–3
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater treatment, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment (Table 8.12-2) was used as an indicator of potential impacts to onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population through in-migration of workers as an indicator of increased demand on community infrastructure.

Table 8.12–3 shows the increase in onsite demand for water, wastewater treatment, and power at sites where the increase exceeds 5%. The potential for a major impact is assumed to exist where an increase of 5% or greater causes total demand to exceed 90% of capacity. A moderate impact is assumed where total demand remains below 90% of capacity.

As shown in Table 8.12–3, with the single exception of WIPP under the Centralized Alternative, all of the onsite infrastructure impacts relate to demand for wastewater treatment or power. Wastewater treatment impacts would occur at Hanford under the Decentralized and all Regionalized Alternatives. Electrical power impacts would occur at INEL under all Regionalized Alternatives and the Centralized Alternative. The

Table 8.12–2. Percent Increase in Site Employment From Construction of TRUW Facilities (sites with employment increases equal to or greater than 5%)

Alternative	Number of Sites		Treatment Standard[a]	Hanford	INEL	LANL	WIPP
	CH Treat	RH Treat					
No Action[b]	11	5	WIPP-WAC				
Decentralized[c]	16	5	WIPP-WAC	6	6	7	
Regionalized 1	5	2	Reduce gas	7	7	8	
Regionalized 2	5	2	LDRs	9	9	7	
Regionalized 3	3	2	LDRs	9	11		
Centralized	WIPP	2	LDRs	6			**162**

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW. Bold indicates potential for major effects on transportation infrastructure onsite. Blank cells indicate an increase of less than 5%.

[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce volatile gas generation; and LDRs = Land Disposal Restrictions criteria.

[b] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, impacts are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP will occur, but the alternatives do not include disposal actions.

[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage.

Table 8.12-3. Increase in Demand for Water, Wastewater, or Power as a Percent of Current Capacity—TRUW (sites with increases exceeding 5%)

Alternative	Number of Sites		Treatment Standard[a]	Hanford	INEL	WIPP
	CH Treat	RH Treat				
No Action [b]	11	5	WIPP-WAC			
Decentralized [c]	16	5	WIPP-WAC	Wastewater (5.9)		
Regionalized 1	5	2	Reduce gas	Wastewater (7.0)	Power (6.4)	
Regionalized 2	5	2	LDRs	Wastewater (7.8)	Power (6.6)	
Regionalized 3	3	2	LDRs	Wastewater (7.8)	Power (6.6)	
Centralized	WIPP	2	LDRs		Power (6.6)	Water (7.7) Wastewater (82) Power (50.0)

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW. Blanks indicate increases of 5% or less.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce volatile gas generation; and LDRs = Land Disposal Restrictions criteria.
[b] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, impacts are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for storage, and then to WIPP for disposal.

greatest impacts on water demand, wastewater treatment, and power would occur at WIPP under the Centralized Alternative. A 7.7% increase in WIPP's demand for water is expected to have a moderate impact on water supply under this alternative. A moderate to major impact on wastewater treatment would also occur, increasing the current demand for treatment by 82%.

A further evaluation found that this increase might exceed the capacity of the current treatment system by 61%. Current power demand at WIPP would increase by 50%, although this increase would not cause total power demand to exceed 90% of current capacity. If new construction were needed to increase the power system's capacity, additional environmental impacts and costs might result.

Although DOE intends to select sites for waste management on the basis of the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities at the sites. When selecting locations for facilities at sites, DOE will consider the results of relevant existing or new sitewide or project-level NEPA analyses, which would evaluate potential impacts on infrastructure at specific sites.

8.13 Cultural Resources Impacts

Construction and operation of TRUW facilities could adversely affect cultural resources. Cultural resources surveys would be conducted at the site before construction would begin; however, protection measures would be identified and implemented.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where treatment and storage facilities for TRUW are proposed. Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys at the 16 proposed TRUW sites and the reported resources at those sites. However, the impacts of the construction of TRUW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends on identifying specific locations for proposed facilities at a site.

Although DOE intends to select sites for waste management on the basis of the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities at those sites. When selecting locations for facilities at sites, DOE will consider the results of relevant existing or new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources at particular locations on a site.

Land requirements for the construction of TRUW facilities are sufficiently small under all alternatives that DOE would probably have enough flexibility in siting them to avoid impacts on cultural resources. If not, measures would be taken to protect these resources.

8.14 Costs

Costs increase as the level of treatment increases. Treatment to meet WIPP-WAC costs about the same as treatment to reduce gas generation potential. Treatment to meet LDRs costs approximately 22% more than the two less intensive treatments. Transportation costs are lower than facility costs, making shipment to available facilities at other sites generally less expensive than building a new facility at a site.

As indicated in Table 8.14–1, DOE estimated costs for building and operating treatment and storage facilities, and for transportation (INEL, 1995a,b). DOE evaluated costs associated with TRUW management from both a life-cycle and process perspective using 1994 dollars.

8.14.1 LIFE-CYCLE COSTS

DOE evaluated facility costs for four phases of the life-cycle of facilities and their operations: pre-operations, construction, O&M, and decontamination and decommissioning. Life-cycle costs do not include speculative factors such as impacts to long-term land value.

- Costs for pre-operation activities consist of technology and site adaptation, including bench-scale tests and pilot plant demonstrations; permitting; plant startup and cold-run costs; and related conceptual design, safety analysis, project management, and contingencies.
- Construction costs consist of expenses for building construction, equipment purchase and installation, contractor overhead, design and inspection, construction management, project management, and contingencies. Mobilization and demobilization costs are included for portable treatment units.
- Operations and maintenance costs consist of expenses for annual operations labor and material; maintenance labor and equipment; utilities; contractor supervision and overhead; and related project management and contingencies.
- Decontamination and decommissioning costs consist of expenses for facility decontamination and demolition, closure, post-closure, and environmental monitoring activities.

8.14.2 PROCESS COSTS

DOE also analyzed costs based on treatment and storage. Treatment costs include costs to build and operate treatment facilities (such as thermal treatment) and common support facilities (such as maintenance, and certification/shipping facilities). DOE estimated costs for three treatment options: minimal treatment to current WIPP-WAC, an intermediate level of treatment to reduce gas generation potential, and treatment to meet LDRs. TRUW disposal is outside the WM PEIS scope; thus, life-cycle costs of disposal at WIPP were not included.

Table 8.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts are Assessed	Location of Impacts Assessment
Process costs	Treatment	Life-cycle costs for treatment including support facilities and retrieval/characterization facilities	Table 8.14–2
	Storage	Life-cycle costs for storage facilities for one-year of treatment production was included, assuming a moderate delay from treatment to shipment to disposal	Table 8.14–2
Transportation cost	Truck	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 8.14–2
	Rail	See above	Table 8.14–2

Note: No Action Alternative includes 20 years of storage and limited operations and maintenance.

For the purpose of the WM PEIS analysis, TRUW storage capacity for one year of treatment was included, assuming a moderate delay from the completion of treatment until the waste is transported for disposal.

Transportation costs include the costs associated with the physical movement of waste from one site to another, for treatment, storage, or disposal. Transportation costs are evaluated for both truck and rail shipments (INEL, 1995a).

A summary of costs is shown in Table 8.14–2 based on 20 years of treatment and storage (INEL, 1996). The total cost of treating to reduce gas generation is only slightly more (4%) than treating to WIPP-WAC. The total cost of treating to meet LDRs in a comparable regional configuration is approximately 22% more than treating to WIPP-WAC. As waste is consolidated at fewer sites, costs for treatment to meet LDRs decrease, illustrating the economy of scale of using larger and fewer facilities.

Under the No Action Alternative, DOE would treat only waste that required urgent repackaging to prevent leakage at the site. The No Action Alternative costs provide a baseline for comparison with the other alternatives. The relative proportion of truck transportation costs is small, varying from 0% to 8% of the total costs. Rail transportation costs vary from 0% to 20% of the total costs.

Table 8.14-2. Life-Cycle Costs (billions of 1994 dollars)

Alternative	Number of Sites		Treat Standard	Total Costs[a] (including truck transportation)	Life-Cycle Costs				Process Costs[b]			Transportation Costs	
	CH Treat	RH Treat			Pre-ops	Const	O&M	D&D	RC	T	S	Truck	Rail
No Action[c]	11	5	WIPP-WAC	1.7	0	0	1.47	0.24	0	1.48	0.23	0	0
Decentralized[d]	16	5	WIPP-WAC	7.4	0.4	1.72	3.40	1.35	2.15	4.42	0.31	0.56	1.44
Regionalized 1	5	2	Reduce gas	7.7	0.5	1.79	3.53	1.36	2.15	4.70	0.33	0.51	1.40
Regionalized 2	5	2	LDRs	9.0	0.6	2.42	4.13	1.38	2.15	6.09	0.29	0.45	1.24
Regionalized 3	3	2	LDRs	8.5	0.6	2.31	3.80	1.31	2.15	5.61	0.24	0.49	1.29
Centralized	WIPP	2	LDRs	7.9	0.5	2.21	3.49	1.18	2.15	5.17	0.06	0.51	1.33

Notes: Pre-ops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning; RC = retrieval and characterization; T = treatment; S = storage; CH = contact-handled; RH = remote-handled.

[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. In Total Costs, also in the table, truck transportation costs are added to the facility costs. Therefore, Total Costs equal the sum of life-cycle costs and truck transportation costs and also equal the sum of process costs and truck costs.

[b] The costs of current storage are included in the site infrastructure costs, which are not included in this PEIS. The cost of one-year's storage after treatment, but prior to shipment for disposal at WIPP, is included.

[c] For the No Action Alternative storage is indefinite, costs are only estimated for 20 years, and no disposal at WIPP is assumed. However, costs are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[d] In the Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to 10 sites for interim storage, and then sent to WIPP for disposal.

8.15 Environmental-Restoration-Transferred Waste

The total volume of TRUW generated by environmental restoration activities that would be transferred to the waste management program is currently estimated to be about 60% of the volume of waste management TRUW. Because the radiological and hazardous chemical profiles and physical characteristics of the environmental restoration (ER) transferred TRUW have not yet been determined to the extent necessary to allow a meaningful evaluation of the potential environmental and human health impacts, the potential effects resulting from the treatment of the ER transferred TRUW are discussed separately in the WM PEIS. When the radiological and physical characteristics of the ER transferred waste are better known, DOE may need to assess the impacts of managing the ER transferred TRUW on a site-specific basis.

DOE is responsible for the management of wastes currently in inventory and those generated by future operations (referred to as "waste management" wastes). As discussed in Chapter 1, DOE is also responsible for the management and remediation of contaminated media, such as soils, groundwater, and buildings. DOE expects that most of the contaminated media at its sites will be remediated under the Environmental Restoration Program. The extent to which media are "cleaned up" is site-specific and will depend largely on regulatory requirements and decisions regarding future land use. For analysis purposes, a standard "base case" scenario was developed that estimates remediation costs across the DOE complex (DOE, 1996c). Although most waste generated by cleanup activities will be managed within the Environmental Restoration Program, some of the waste generated by these activities will be transferred to waste management facilities. In the WM PEIS, these wastes are referred to as "environmental restoration (ER) transferred wastes." At present, only estimates of the volumes of ER transferred waste are available. These estimates were used to provide a qualitative assessment of how the addition of ER transferred waste might impact TRUW alternatives described in this chapter.

Appendix B provides more detail about how some of the wastes generated during environmental restoration activities will be transferred to the waste management program for final disposition, and provides estimates of the volumes of ER transferred TRUW. Appendix B also discusses the assumptions and uncertainties involved in assessing how the ER transferred TRUW may affect waste management alternatives.

To conduct a health risk impact analysis for the additional ER transferred TRUW similar to that conducted for waste management TRUW, additional information is needed on the ER transferred waste streams. In addition to the volume of ER transferred waste, information is needed on the treatability of the individual transferred TRU waste streams that would include data about the radiological profile, chemical constituents, and physical form of the transferred waste. Characterization of the ER transferred wastes into one of the treatment categories identified for TRUW is needed to estimate the degree of further treatment needed and, thereby, the waste management costs. Information about the timing of the transfer of ER wastes to the waste management program is needed to determine the capacities of treatment and disposal facilities. This information is also crucial to conduct transportation and socioeconomic analyses. However, in many cases, this information will not be available until site-specific cleanup is underway.

To identify how the addition of ER transferred TRUW could affect the comparisons among waste management alternatives evaluated in the WM PEIS, DOE compared the volumes of waste management TRUW with the expected volumes of ER transferred TRUW. This analysis reveals the potential for

exceeding the capacity of treatment facilities of those sites and for those alternatives where the volume of ER transferred TRUW equals or exceeds the volume of waste management TRUW. Strategies that might be used to manage the additional ER transferred waste at these sites include increasing facility operational capacity and operating a facility longer to "work off" the increased waste load. The WM PEIS treatment facilities are assumed to have an effective operational life of at least 30 years, which allows for an additional 20 years of operational capacity beyond the 10 years needed to work off the waste management wastes.

Increased radiation and chemical exposure risks to site workers, offsite populations, and the environment are a function of the chemical constituents and radiological activity in the ER transferred wastes, which, at present, cannot be reliably predicted. However, because radiological activities and chemical concentrations of ER transferred waste are, in general, expected to be lower than those of comparable waste management waste, risks from the addition of ER transferred wastes are expected to be lower than those from the treatment of equivalent volumes of waste management wastes. Site-specific performance assessments would be conducted, and appropriate treatment restrictions would be imposed to manage any potential increased risks. The risks from physical hazards associated with operating treatment facilities to manage the ER transferred waste are related to the volume relationship between the ER transferred and waste management wastes. Transportation risks and costs are also dependent on waste volume rather than the composition of the waste.

Overall, the volume of ER transferred TRUW is expected to be about 60% of the waste management TRUW load (80,000 cubic meters compared with 132,000 cubic meters, respectively) (see Table B.6–1 in Appendix B). The additional ER transferred waste would affect waste treatment at SRS under the Decentralized and Regionalized Alternatives (see Table B.7-3). The additional ER transferred TRUW at SRS is expected to be 380% of the waste management load. The additional ER transferred TRUW would have little impact on the Centralized Alternative.

8.16 Comparison of Alternatives Summary

Health Risks. The most adverse health risks would occur under alternatives where TRUW is treated to meet LDRs—in Regionalized Alternatives 2 and 3 and the Centralized Alternative. These alternatives require the thermal treatment of organic TRUW, which would result in emissions of radionuclides (Pu-238 and Am-241) that have the most significant impact on offsite cancer risks. Although waste management

worker fatalities would result primarily from physical trauma, fatalities are lower when TRUW is treated to meet WIPP-WAC or reduce gas generation than when it is treated to meet LDRs. Estimated transportation fatalities are low in all alternatives.

Air Quality Impacts. The management of TRUW would not affect the air quality at most sites; however, emissions of radionuclides were estimated to exceed the applicable standards at LANL and WIPP in the alternatives involving treatment to meet LDRs at these sites (Regionalized Alternative 2 at LANL and the Centralized Alternative at WIPP). The exceedances at these sites could require additional measures to reduce emissions to acceptable levels. Emissions of other hazardous air pollutants and criteria pollutants were estimated to be below the applicable standards at all sites.

Water, Ecological, Cultural, and Land Use Impacts. Major impacts to these resources at the sites are unlikely for treatment of TRUW under any of the alternatives. However, ecological and cultural impacts analysis would require that further site-specific studies be conducted before locations for specific facilities would be selected at sites.

Economic Impacts. Nationwide, the largest economic effects of TRUW management would occur under the Decentralized Alternative and would generally decrease as the alternatives become more centralized. The greatest benefit at any site occurs when TRUW is managed at that site. The greatest number of jobs attributable to management of TRUW, as a percentage of the regional baseline, would occur at INEL and WIPP under Regionalized Alternative 3 and the Centralized Alternative, respectively. None of the TRUW alternatives would substantially affect the national economy, although some 1,900 to 12,000 jobs would be directly or indirectly created.

Population Impacts. No major population increases are expected to occur at any site under any alternatives and thus, community characteristics and the provision of services would not be affected.

Environmental Justice Concerns. Assessment of potential environmental justice concerns associated with TRUW management indicated a potential for disproportionately high and adverse health risks or environmental impacts to minority and low-income groups at the INEL and WIPP sites. This potential would be mitigated by selection of an alternative treatment technology, employment of more efficient emissions controls, and other measures.

Infrastructure Impacts. Infrastructure impacts on water use, wastewater treatment, and power are comparable for the Decentralized and Regionalized Alternatives but are much greater at WIPP under the Centralized Alternative.

Costs. Costs increase as the level of treatment increases. Treatment to WIPP-WAC and treatment to reduce gas generation potential cost approximately the same in nondiscounted 1994 dollars. Treatment to meet LDRs costs approximately 22% more in nondiscounted 1994 dollars. Transportation costs are lower than facility costs, making shipment to available facilities at another site generally less expensive than building a new facility when one does not exist at a site. The details of cost estimating are covered in Section 5.3.3 of Chapter 5.

Summary of Impacts by Alternative. Table 8.16–1 summarizes the impacts of each alternative.

The Preferred Alternative. Most of the Department's sites with TRUW would treat and store it onsite. Five sites would ship TRUW to other sites for treatment under the preferred alternative: Pantex would ship its de minimis inventory of TRUW to LANL; RFETS would ship some of its TRUW to INEL for treatment; ORR would send its CH-TRUW to SRS for treatment; SRS would send its RH-TRUW to ORR for treatment; and SNL-NM would send its TRUW to LANL for treatment. This preference assumes that the Waste Isolation Pilot Plant (WIPP) will require treatment to the waste acceptance criteria the Department has proposed to the Environmental Protection Agency for this geologic repository. The Department's preference could change if WIPP requires a different level of treatment. The Department would store its TRUW where it is treated pending a decision on its disposal or other disposition.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several of the Regionalized Alternatives as shown in Table 3.7–1. It provides for cost-effective management of TRUW, poses low potential risks to the public, and has relatively small environmental impacts. DOE's preference is consistent with the preferred alternative identified in the Draft Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement (WIPP SEIS II) (DOE, 1996e).

Table 8.16–2 provides potential impacts for the preferred alternative by combining the impacts evaluated in the WM PEIS for the preferred alternative at each site. Treatment and storage impacts are taken from Volume II site data tables for the preferred alternative specified in the second row of Table 8.16–2.

Table 8.16-1. Comparison of TRUW Alternatives—Selected Impacts

Alternative	Number of Sites: CH Treat	Number of Sites: RH Treat	Treatment Standard	Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Truck Radiation Fatalities	Truck Non-Radiation Fatalities	Number of Sites With Air Pollutants That Exceed Standards	Highest Air Pollutant Percentages at Any Site	Truck Shipments	Cost ($ Billions)	Comment
No Action[a]	11	5	WIPP-WAC	*	*	*	0	0	0	8 (CO-RFETS)	0	1.7	Extended Storage not in compliance with RCRA
Decentralized[b]	16	5	WIPP-WAC	2	1	*	4	3	0	49 (NO_2-ANL-E)	24,000	7.4	10 sites provide interim storage, then ship to WIPP
Regionalized 1	5	2	Reduce gas	3	1	*	3	3	0	40 (NO_2-ANL-E)	22,000	7.7	4 western, 2 eastern sites shred and grout to reduce gas generation
Regionalized 2	5	2	LDRs	4	1	1	3	2	1	134 (Rad-LANL)	19,000	9.0	4 western, 2 eastern sites treat to meet LDRs
Regionalized 3	3	2	LDRs	3	1	*	3	3	0	34 (NO_2-ANL-E)	21,000	8.5	2 western, 2 eastern sites treat to meet LDRs
Centralized 5	WIPP	2	LDRs	2	1	*	3	3	1	137 (Rad-WIPP)	22,000	7.9	WIPP + 1 eastern, 1 western site treat to meet LDRs

CH = contact handled TRUW; RH = remote handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; * = greater than 0 but less than 0.5.
[a] For No Action Alternative, storage is indefinite, no disposal at Waste Isolation Pilot Plant is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table 8.16–2. The Preferred TRUW Alternative—Selected Impacts

Impact Area	Decision	ANL	Hanford	INEL[c]	LLNL	LANL	NTS	ORR	Pantex	PGDP	RFETS	SNL-NM[d]	SRS	WIPP	WVDP[d]	Total
Preferred alternative	T	D	D	R3	D	D	D	R1	*[e]	D	D	R1	R1	D	D	
Worker physical hazard fatalities	T	1.2E-01	2.6E-01	1.8E+00	1.1E-01	3.8E-01	6.8E-02	1.0E-01	--	1.3E-02	2.1E-01	--	1.5E-01	--	--	3.2E+00
Worker cancer fatalities	T	8.8E-03	1.3E-01	2.5E-01	5.6E-04	1.4E-01	2.1E-04	2.8E-03	--	4.6E-07	7.7E-03	--	7.7E-02	--	--	6.2E-01
Offsite population cancer fatalities	T	2.0E-06	2.3E-05	4.1E-02	3.5E-06	5.4E-05	1.1E-10	8.3E-07	--	3.5E-09	9.3E-06	--	1.4E-04	--	--	4.1E-02
Truck radiation fatalities	These numbers reflect intersite transportation results and are not attributable to individual sites.															≤4
Truck nonradiation fatalities																≤3
Highest air pollutant percentage		49% NO_2	2% NO_2	17% PM_{10}	0%	1% NO_2	6% CO	0%	--	1% NO_2	19% CO	--	1% NO_2/PM_{10}	--	--	No sites exceed
Cost (10^9 $)[a]		0.33	1.81	2.49	0.23	0.92	0.096	0.48	--	0.05	0.38	--	0.86	--	--	7.65
Truck shipments[b]		590	10,260	7,610	260	1,590	90	2,440	--	10	830	10	1,240	23,860	--	48,790

[a] Cost for truck transportation (estimated at $0.6 billion) were added to these site totals for a total alternative cost of $8.2 billion.
[b] Shipments include inbound shipments to INEL (2,060), ORR (390), and SRS (160). Total one-way shipments between two sites, as defined for shipment totals in Table 8.16–1, are 48,790 ÷ 2 = 24,395 shipments.
[c] Includes impacts of onsite treatment of RH-TRUW to meet current WIPP-WAC.
[d] SNL-NM and WVDP are included because they are major sites that would manage TRUW onsite under the Regionalized 1 and Decentralized Alternatives, respectively, noted here as the Preferred Alternatives at those sites. However, health risks and environmental impacts were not evaluated at SNL-NM and WVDP; they are expected to be minimal because the TRUW volumes are very small (less than 2 cubic meters).
[e] The current DOE plan is to ship the very small amount of CH-TRUW at Pantex to LANL for treatment and storage.

Chapter 8
References

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Transuranic Waste Alternatives

Alt.	CH Treat	RH Treat	Treat Stand	ANL-E	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	RFETS	SNL-NM[d]	SRS	WIPP	WVDP[d]
No Action	11	5	WIPP WAC	TS	TS	TS	TS	TS	S	TS	S	TS	S	TS		S
D	16	5	WIPP-WAC	TS	TS	TS	TS	TS	TS	TS	T	TS	T	TS		T
R-1	5	2	Reduced gas		TS[a]	TS	TS			TS[b]		TS		TS		
R-2	5	2	LDRs		TS[a]	TS	TS			TS[b]		TS		TS		
R-3	3	2	LDRs		TS[a]	TS				TS[b]				TS		
C	WIPP	2	LDRs		TS[c]					TS[b]					T	

Notes: T = treatment to one of three standards: process to current WIPP-WAC; shred and grout to reduce potential for gas generation in the repository (Reduced gas); and treat to meet LDRs using thermal organic destruction and complete treatment train. S = storage after treatment for one year, prior to transport for disposal, for all alternatives except No Action or store current inventory under No Action Alternative. Blanks indicate that TRUW is not treated or stored at a site under the specified alternative.

[a] The Hanford Site treats both CH and RH waste.

[b] ORR treats RH waste only.

[c] The Hanford Site treats RH waste only.

[d] SNL-NM and WVDP are included because they are major sites that would manage TRUW onsite under the Regionalized 1 and Decentralized Alternatives, respectively; noted here as the preferred alternatives at those sites. However, health risks and environmental impacts were not evaluated at SNL-NM and WVDP; they are expected to be minimal because the TRUW volumes are very small (less than 2 cubic meters).

CHAPTER 9
Impacts of the Management of High-Level Waste

Chapter 9 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for storing vitrified high-level waste (HLW). This chapter provides information on existing HLW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to HLW characteristics and the rationale for selecting the sites analyzed under each alternative. The chapter discusses the health risk, environmental impacts, and costs of the alternatives, and provides a comparison of alternatives.

The methods used to evaluate the impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the HLW analysis are contained in the technical report entitled "High-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports provided in Chapter 15.

- *HLW is highly radioactive waste material that results from the reprocessing of spent nuclear fuel and irradiated targets in nuclear defense, research, and production activities.*
- *The WM PEIS only analyzes the impacts of stored vitrified HLW.*
- *HLW has both radioactive and hazardous components and is considered mixed waste.*
- *HLW will be treated and packaged for disposal in a licensed geologic repository.*
- *HLW is currently stored at the Hanford Site, the Idaho National Engineering Laboratory (INEL), the Savannah River Site (SRS), and the West Valley Demonstration Project (WVDP).*
- *Approximately 378,000 cubic meters of HLW have been or will be generated. Treated (vitrified) HLW will require an estimated 21,600 canisters for packaging.*
- *DOE must decide where to store the vitrified HLW canisters.*

9.1 Background

9.1.1 Definition and Origin

The term HLW means (a) the highly radioactive waste material that results from the reprocessing of spent nuclear fuel (SNF), including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation, and (b) other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

HLW also contains toxic metal, organic materials, or corrosive characteristics that are considered hazardous under the Resource Conservation and Recovery Act (RCRA) (42 USC 6901). Because it is both radioactive and hazardous, HLW is considered mixed waste.

The WM PEIS analyzes only the impacts of stored vitrified HLW. DOE must decide where to store vitrified HLW canisters since the decision to immobilize the HLW prior to transport was made in the early 1980s. Just prior to the passage of the Nuclear Waste Policy Act (NWPA) in 1983, Congress directed the President to prepare a report that would describe plans for permanent disposal of HLW and TRUW resulting from atomic energy defense activities. The President's report (*The Defense Waste Management Plan*, DOE/DP-0015) was submitted to Congress in June 1983. The report describes reference plans for the immobilization of HLW resulting from defense activities at SRS, INEL, and Hanford. (The HLW at WVDP from commercial spent nuclear fuel reprocessing was not addressed in this report, but the West Valley Demonstration Project Act [Public Law 96-368] requires that DOE take similar actions with regard to West Valley's HLW.)

The goal of the HLW management was to end interim storage and to achieve permanent disposal by immobilizing and preparing HLW for shipment to a geologic repository. Each HLW site has taken steps to follow the President's plan regarding immobilizing HLW in a sequential manner. This approach is intended to permit the applicable operating experience gained at the first site to be applied to the other sites, thereby resulting in a more efficient use of resources, including funding.

The Nuclear Waste Policy Act (42 USC 10101–10270) enunciated the national policy that HLW be solidified and disposed of in a mined geologic repository. The U.S. Nuclear Regulatory Commission (NRC) has established requirements for the performance of a geologic repository. DOE must submit an application for a repository license and show that the mined geologic disposal system, including repository site natural barriers, engineered barriers, waste packages, and shaft seals will meet NRC requirements. The U.S. Environmental Protection Agency (EPA) will promulgate public health and safety standards for protection of the public from releases of radioactive materials disposed of in a candidate geologic repository as required by the Nuclear Waste Policy Act and the Energy Policy Act (42 USC 10101–10270).

For purposes of the WM PEIS, a geologic repository candidate site at Yucca Mountain, Nevada, was assumed to be the final disposal site for all HLW. Currently, Yucca Mountain is the only site being characterized as a geologic repository for HLW. If selected as the site for development, it would be ready to accept HLW no sooner than 2015. The potential environmental impacts at a geologic repository from

the disposal of HLW are not yet known and therefore not addressed in the WM PEIS. DOE is preparing another EIS to analyze site-specific environmental impacts from construction, operation, and eventual closure of a potential geologic repository for spent nuclear fuel (SNF) and HLW at Yucca Mountain.

9.1.2 VOLUMES AND LOCATIONS

Government operations from 1944 to the present have generated about 357,000 cubic meters (94 million gallons) of HLW, with approximately 21,000 cubic meters (5.6 million gallons) to be generated within the next 20 years (DOE, 1995e, 1996b). Only four sites either store or manage HLW: the Hanford Site, INEL, SRS, and WVDP. There is a discussion in Section 9.2.3 of the potential additional HLW canisters that may be generated if the Department proposes to chemically process SNF in the future, and a discussion of their potential impacts is in Section 9.4.4.

DOE is proceeding with plans to treat HLW by processing it into a glass form that would not be readily dispersible into air or leachable into ground or surface water. This process is called vitrification. If the existing inventory of HLW is vitrified, the vitrified material will fill an estimated 21,600 canisters. Canisters are assumed to vary in volume of vitrified HLW between 0.62 and 1.17 cubic meters.

Table 9.1–1 shows the projected HLW inventory at the Hanford Site, INEL, SRS, and WVDP; and the projected total vitrified HLW canisters that will be produced as a result of treating the entire HLW inventory.

Table 9.1–1. High-Level Waste Volumes and Projected Number of Estimated HLW Canisters

Site	HLW Volume (m^3)	Total Number of Estimated Canisters to Be Produced
Hanford	213,000	15,000
INEL	10,400	1,700
SRS	152,000	4,572
WVDP	2,200	340
Total	378,000	21,600

Sources: ANL (1996); DOE (1994a; 1995b, d-f; 1996a-c); WINCO (1994).

The estimated number of HLW canisters to be produced at each site shown in Table 9.1-1 is dependent on waste characteristics, volume prior to treatment, final waste loading and immobilized form, and canister size. These factors vary from site to site and result in a nonlinear relationship between the projected number of HLW canisters and the initial waste volume.

The WM PEIS analyses for SRS are based on a total HLW inventory of 4,572 canisters (DOE, 1994a, 1995d). The latest version of the *High-Level Waste System Plan* (1996) projects a total of approximately 6,000 canisters to be produced at SRS. Preliminary analysis indicates that the impacts associated with the higher total number of canisters (6,000) are similar to those for the canister inventory applied in the WM PEIS (4,572). The WM PEIS forecasts conservative results because although the number of canisters applied in the WM PEIS analyses is lower than the number projected in the *High-Level Waste System Plan* (WSRC, 1995), an individual canister has a greater radiological activity when compared with that in the *High-Level Waste System Plan*; thus, an accident associated with this canister would have greater impacts (as an example). Similarly, the occupational dose received by the workforce during interim storage of HLW canisters pending disposal at a national geologic repository appears to be greater when the WM PEIS canister inventory is used, again because of the higher radiological activity of a single canister. The overall risk of transportation would increase on the average by 11% and at most by 14% for the Centralized Alternative, Case 2, when the higher SRS canister number is used. The uncertainty in the total number of canisters at Savannah River does not significantly affect decisions made within the WM PEIS concerning HLW management.

The Hanford Tank Waste Remediation System EIS (DOE, 1996b) presents a total of approximately 12,200 canisters projected to be produced at Hanford. The WM PEIS analyses for the Hanford Site are based on a total HLW canister inventory of 15,000 canisters. Preliminary analysis indicates that the impacts associated with the lower total number of canisters (i.e., 12,200) are similar to those for the canister inventory applied in the WM PEIS (i.e., 15,000). The WM PEIS forecasts conservative results because the number of canisters applied in the WM PEIS analyses is greater than that in the Tank Waste Remediation System EIS (DOE 1996b), and an individual canister has a greater radiological activity (by approximately 50%) compared with the TWRS EIS. Thus, an accident associated with this canister would have greater impacts, and as an example, the occupational dose received by the workforce during interim storage of HLW canisters pending disposal at a national geologic repository appears to be greater using the WM PEIS canister inventory, again due to the higher radiological activity of a single canister. The overall risk of transportation would decrease on the average by 10% and at most by 12% for the No Action Alternative

using the lower Hanford canister number. In general, the final number of canisters at Hanford would depend on the decisions based on the TWRS EIS and performance of separations and treatment processes implemented to treat the HLW. The uncertainty in the total number of canisters at Hanford does not significantly affect decisions made within the WM PEIS concerning HLW management.

Changing the number of canisters at INEL results in comparatively more impacts. As an example, the transportation risk would increase on the average by 20% and at most by 36% for the Centralized Alternative, Case 2. The number of storage facilities would decrease from a total of four for the 8,500-canister total used in the Draft WM PEIS to one for the updated value of 1,700 canisters, with a resulting fourfold decrease in the facility construction and operations impacts. In this case, revision of the number of canisters at INEL could affect decisions made within the WM PEIS concerning HLW management, and it would appear reasonable to consider the more recent HLW canister totals for INEL. For this reason, the Final WM PEIS uses the more current estimate of canisters for INEL.

9.1.2.1 Hanford

HLW has been generated at the Hanford Site as a result of plutonium production, research and development for advanced reactors, renewable energy technologies, waste disposal technologies, and cleanup of contamination from past practices. The Hanford Site began storing liquid HLW in belowground tanks in 1944. Over the years, three substantially different separations processes have been used at the site. In all cases, the acidic wastes were neutralized for storage in carbon steel tanks. Further, in order to remove strontium and cesium from the less active materials at the Hanford Site, several precipitation procedures were employed. These resulted in the concentration of strontium and cesium, now stored in metal, double-walled capsules with an external diameter of approximately 6.7 cm (2.6 in.) and an overall length of about 53 cm (21 in.), and in the introduction of organic and ferrocyanide precipitating agents which have produced potentially dangerous conditions in some of the tanks.

In April 1988, the Hanford Defense Waste EIS Record of Decision was published in the *Federal Register* (53 FR 12449). However, important changes have occurred since the 1988 decision. The Tank Waste Remediation System Final EIS (DOE, 1996b), issued in August 1996, addresses actions to manage and dispose of approximately 213,000 cubic meters (56 million gallons) of radioactive, hazardous, and mixed waste within the Tank Waste Remediation System program at the Hanford Site (61 FR 45949). The EIS

also addresses actions to manage and dispose of the cesium and strontium contained in approximately 1,930 metal, double-walled capsules. The EIS identifies Phased Implementation as the preferred alternative for remediating Hanford's high-level tank waste. (The preferred alternative for the cesium and strontium capsules is to continue storage.) Under the Phased Implementation Alternative, the high-level tank waste would be remediated in a two-phase process. Phase 1 would involve design, construction, and operation of demonstration-scale treatment facilities. Phase 2 would be implemented following Phase 1 and would involve the design, construction, and operation of full-scale treatment facilities to remediate the remainder of the tank waste. Under both phases of the preferred alternative, the HLW would be vitrified and placed into canisters for interim storage pending offsite disposal at a geologic repository.

The tank waste is mainly in three forms — liquid, saltcake, and sludge — and is contained in 177 underground storage tanks (149 single-shell and 28 double-shell tanks) built between 1943 and 1986. Vitrification of all Hanford HLW is expected to be completed by the year 2028.

The estimated number of HLW canisters to be produced from vitrification of the Hanford Site tank waste depends on the performance of separations and treatment processes implemented to treat the HLW. For purposes of the WM PEIS, an estimated 15,000 canisters were assumed to be produced from treating existing HLW (Walters, 1995).

9.1.2.2 INEL

INEL's anticipated generation and management activities will result in approximately 7,600 cubic meters (2 million gallons) of liquid HLW and 3,800 cubic meters (1 million gallons) of calcined HLW in storage at the Idaho Chemical Processing Plant. Liquid HLW has been blended routinely with sodium-bearing liquid and calcinated at the New Waste Calcining Facility, which converts the waste into dry, noncorrosive granules. The calcinated waste is stored in stainless steel closed bins inside near-surface concrete vaults (DOE, 1995b).

Calcination of liquid HLW at INEL results in a solid that is safer to store than liquid waste but does not meet NRC requirements for disposal in a repository. The calcination process may be classified as an interim best demonstrated available technology by EPA under RCRA, pending development of a process to produce

a stable glass, ceramic or glass/ceramic that will meet both Atomic Energy Act and RCRA requirements. Characteristics of INEL waste suggest the waste form will be a borosilicate glass material.

INEL built the New Waste Calcining Facility to convert the liquid HLW at the INEL into dry, noncorrosive granules that are stored in stainless steel, closed bins inside near-surface concrete vaults. The Final Programmatic Spent Nuclear Fuel and INEL Environmental Restoration and Waste Management Programs EIS (DOE, 1995b) analyzed a Waste Immobilization Facility (WIF) Project to immobilize the Idaho Chemical Processing Plant radioactive wastes (sodium-bearing liquid and solid calcine) into forms suitable for permanent disposal. The SNF and INEL EIS, Volume 2, Part B, Section C.4.3.2, presents a project description for calcine treatment technology development. No decision has been made on the construction of the WIF, and no decision has yet been made on whether further treatment of the calcinated waste will occur before shipment to a geologic repository. The WM PEIS assumes that production of HLW canisters will begin in 2015 and be completed in 2035 (DOE, 1995d). An estimated 1,700 HLW canisters will be produced.

9.1.2.3 SRS

An inventory of approximately 131,000 cubic meters (34 million gallons) of HLW is stored in belowground tanks in the F- and H-Areas near the center of SRS. This waste was generated as a result of defense, research, and medical programs. Approximately 22,000 cubic meters (5.8 million gallons) are projected to be generated within the next 20 years.

SRS completed the Defense Waste Processing Facility (DWPF) Supplemental EIS in November 1994 (DOE, 1994a). The DWPF includes the HLW pretreatment process, the Vitrification Facility, saltstone manufacturing and disposal (LLW resulting from the pretreatment of HLW), radioactive glass waste storage facilities, and associated support facilities. The Record of Decision (March 28, 1995) describes the Department's decision to complete construction and begin operation of the DWPF. The DWPF became operational on March 12, 1996. Vitrified HLW canister production began in 1996 and is to be completed in 2020 (DOE, 1994a). For purposes of this EIS, the estimated total number of canisters is assumed to be 4,572, the total planned storage capacity of HLW canisters at SRS (DOE, 1995a).

9.1.2.4 WVDP

The WVDP is being conducted at the Western New York Nuclear Services Center near West Valley, New York. It is owned by the New York State Energy Research and Development Authority. Commercial operations generated HLW from reprocessing spent nuclear fuel at WVDP from 1966 to 1972. Under the West Valley Demonstration Project Act (42 USC 2021a *et seq.*), DOE is demonstrating the solidification for disposal of liquid HLW.

The WVDP HLW inventory is approximately 2,200 cubic meters (580,000 gallons). All the HLW will be blended together with glass-forming materials and vitrified into a borosilicate glass waste form. DOE and the New York State Energy Research and Development Authority (NYSERDA) completed a Final Environmental Impact Statement, *Long Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley* (DOE, 1982). The Record of Decision, issued in September 1982, identified that the liquid HLW would be vitrified and transported to a geologic repository for disposal. Vitrification at the WVDP began on July 2, 1996. Vitrification should result in the production of an estimated 340 canisters (ANL, 1996).

Analysis in the WM PEIS assumes use of existing storage facilities until their capacities are met. If additional capacity is needed, use of new conceptual facilities is assumed. These conceptual facilities provide the difference in storage capacity between existing storage capacity and what is necessary to manage the waste received under any given alternative. Conceptual facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). When necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of conceptual facilities.

9.1.3 Existing and Planned Facilities Available at DOE Sites

Each alternative considered in this PEIS for storage of HLW canisters involves three major facilities and features: the HLW canisters, the facilities for the storage of HLW canisters, and the packages for transporting HLW canisters. The following sections briefly describe each of these facilities and features.

9.1.3.1 High-Level Waste Canisters

HLW canisters are large stainless steel cylinders resembling those typically used to store gases (such as oxygen). In the vitrification process, a molten mixture of HLW and glass-forming materials is poured into the canisters. After each canister is filled, it is sealed with a welded plug. After sealing, each canister is tested for leaks and the surface is decontaminated. Following decontamination, the canisters are loaded into a shielded cask and transferred to storage. Table 9.1–2 lists the dimensions, weights, and activity levels of the HLW canisters assumed in this PEIS at the four HLW sites.

9.1.3.2 Storage Facilities for High-Level Waste Canisters

Storage facilities for HLW canisters are buildings containing underground plugged storage vaults within a concrete structure that is designed to withstand earthquakes and other natural disasters. When casks containing HLW canisters are received at a storage facility, the HLW canisters are unloaded. A concrete plug is lifted from the top of the storage vault, or from the floor of the building, and the canisters are lowered into tubes within the cavity. Each storage tube, or sleeve, is then sealed to prevent the canisters from coming into direct contact with cooling or ventilation system air. After the storage tubes are sealed, a concrete plug is lowered over the cavity. Radioactive decay heat from the canisters is transferred to the

Table 9.1–2. Dimensions, Weights, and Activity Content of HLW Canisters

Characteristics	Hanford	INEL	SRS	WVDP
Material	Stainless steel			
Outer diameter (cm)	61	N/A	61	61
Overall height (cm)	300	N/A	300	300
Nominal wall thickness (cm)	0.95	N/A	0.95	0.34
Total weight (kg)	2,150	N/A	2,182	2,152
Activity per canister (curies)	1,373	9,000	2,344	1,043
Decay heat per canister (watts)	389	26	709	311

Notes: The canister dimensions are assumed for this PEIS. Selection of a different size canister could result in a decrease or increase in the number of canisters produced and rate of acceptance at the repository.

Source: ANL (1996).

tubes and removed by a cooling or ventilation system. Although no radioactive emissions are expected during normal operation, a high-efficiency particulate air (HEPA) filtration system would be used to ensure minimal release of radioactivity to the atmosphere in the event a release occurred. Storage facilities for HLW canisters currently exist at SRS and WVDP. Storage facilities are planned for the Hanford Site and INEL.

The Glass Waste Storage Building at SRS has an estimated capacity of 2,286 canisters. The storage vault is designed as an earthquake- and tornado-resistant concrete structure. Radiation shielding protection for Glass Waste Storage Building workers is provided by concrete walls, earth embedment, and a concrete deck that forms the floor of the building and operating area. The building's forced air exhaust system would remove radioactive decay heat. The exhaust air would pass through the building's HEPA filter ventilation system and then be discharged into the atmosphere through the stack. No condensate is expected to accumulate in the ventilation system sump; however, if any does, it would be drummed, monitored for activity, and treated. Depending on activity levels, the condensate would be sent to the F- and H-Area Effluent Treatment Facility or incorporated into the Vitrification Facility wastewater stream for recycling to the SRS HLW tank farm. Although no activity is expected to occur in the condensate or exhaust air, provisions have been made for its management if activity is detected (DOE, 1994a). The construction of a second Glass Waste Storage Building has been approved in the Record of Decision for the Final Supplemental EIS for Defense Waste Processing Facility (DOE, 1995a). Upon completion of this building, total estimated storage capacity at SRS will be 4,572 canisters.

At WVDP, storage racks holding four canisters each would be used to transport HLW canisters to the Waste Canister Storage Facility, located in the existing Chemical Process Cell building which has been decontaminated and modified for storage of HLW canisters. The racks containing the HLW canisters would be stored on two levels to allow for a failed equipment storage area. The canister storage area would be equipped with two coolers to remove heat generated by the HLW canisters. Storage capacity is available for approximately 344 canisters (ANL, 1996).

DOE approved, as part of a previous EIS for the Hanford Site (DOE, 1987), a storage facility that would provide enough storage capacity for approximately 750 HLW canisters. It was assumed in the WM PEIS that the HLW canister storage facility would be operational by 2009.

9.1.3.3 Transportation Packages for High-Level Waste

Transportation of all DOE radioactive material must conform to the Hazardous Materials Transportation Act, Department of Transportation (DOT), and NRC regulations. HLW canisters would be transported in Type B packages, which provide a high degree of assurance that, even in severe accidents, package integrity will be maintained with essentially no loss of radioactive contents or serious impairment of the shielding capability provided by the package. DOE has prepared initial designs for a HLW waste cask for truck transportation based on SRS canister designs. As designed, the HLW waste cask uses a solid body concept to absorb energy during an accident and normal transportation. To minimize the exposure to gamma radiation, shielding would be provided by a depleted uranium liner inside the cask body. The WM PEIS assumed that the HLW truck cask would contain only a single HLW canister; however, it is likely that DOE will develop a multiple-canister truck cask, as well as a cask for transporting HLW canisters by rail. The WM PEIS assumed that five HLW canisters would be shipped per rail cask; therefore, rail transportation could reduce the number of shipments by at least 80%. Further details of the WM PEIS assumptions for transporting HLW canisters are contained in Appendix E. Currently, no casks for shipping HLW canisters by truck or rail have been certified by the NRC (ANL, 1996).

9.2 Analytical Methods and Assumptions

Reported HLW volumes, characteristics, and facilities were used to analyze human health risks, environmental and socioeconomic impacts, and costs associated with each of the HLW alternatives. To facilitate the analysis, DOE made numerous assumptions on HLW characteristics, facilities, and transportation. These assumptions are described below.

9.2.1 CHARACTERISTICS

High-level waste is generated by the chemical reprocessing of SNF and irradiated targets generated in DOE programs for research, development, testing, and production, and from Naval propulsion fuel. The radioactivity from HLW results primarily from radionuclides of cesium, and strontium; a very small amount results from the decay of transuranic radionuclides. HLW also contains toxic metals and organic materials that are considered hazardous under RCRA.

High-level waste may be found in a number of forms: acidic liquid, caustic liquid with or without sludge, saltcake, slurry, or dry granular calcine. As generated, HLW is a highly acidic liquid solution and must be handled and stored in corrosion resistant vessels, generally stainless steel. During World War II, because of a shortage of stainless steel, HLW was neutralized so it could be stored in carbon steel tanks. Treatment of HLW with excess caustic precipitated fission product metal oxides and hydroxides which collected as sludge on the tank floor. Often, high heat from fission product decay caused evaporation of significant amounts of water, leading to a viscous solution with elevated salt content and crystallized salts, commonly referred to as "saltcake." Although SRS and WVDP have neutralized their HLW, the INEL reprocessing plant kept its HLW acidic and stored it in stainless steel tanks pending pretreatment to a granular solid through a process called "calcination." This "calcine" is stored for future processing to a final waste form. Vitrification into a glass form, after radionuclide partitioning, has been chosen for testing for potential use in immobilizing the high-level liquid and calcine waste at the INEL (DOE, 1995c).

Most nuclear radiation from HLW, after several years of initial decay, comes from the fission product radionuclides cesium-137 and strontium-90 (each with a half-life of approximately 30 years) and small amounts of transuranic radionuclides such as plutonium and americium (half-lives of thousands to millions of years). In alkaline solution, cesium remains in solution but strontium and the transuranic metals are found almost entirely in the sludge as insoluble oxides. The primary health risk from HLW arises from the intense radiation, not from chemicals. No matter what the physical form, HLW must be stored behind heavy shielding and handled using remotely operable equipment.

9.2.2 FACILITIES

Treatment. All four HLW sites are in some stage of planning or constructing facilities to treat HLW into an acceptable waste form for repository disposal. The existing and planned treatment facilities are described in Section 9.1.3.

Storage. For purposes of this PEIS, DOE assumed that storage facilities would be based on a modular design. The Glass Waste Storage Building for SRS was assumed to be the model for future storage facilities. Anticipated capacity for each module is assumed to be 2,286 canisters. DOE also assumed that it would take approximately three years to construct each module. Based on the total estimated number of canisters to be

produced, 12 storage modules would need to be constructed system wide. One module currently exists at SRS and full storage capacity for the WVDP canisters exists at that site.

Disposal. Under the Nuclear Waste Policy Act, HLW is planned to be disposed of at a geologic repository; Yucca Mountain in Nevada is the site currently being studied for suitability to house a geologic repository. The DOE assumes that acceptance of DOE-managed HLW at this facility will begin in 2015. In accordance with the repository program, DOE's annual limit for disposal is 400 metric tons uranium (MTU) equivalent (DOE, 1994c). The WM PEIS assumed that one (1) canister equals 0.5 MTU. Therefore, only 800 canisters per year can be shipped to a geologic repository based on this disposal rate. However, due to the rate at which canisters will be accepted at a geologic repository, storage capacity will have to be constructed for the total number of canisters produced, or production of the canisters will have to be paced to the openings of a geologic repository. Further, although a geologic repository for the permanent disposal of HLW is scheduled to begin accepting DOE-managed HLW in 2015, for purposes of analysis in the WM PEIS, DOE has also analyzed HLW canister storage requirements should the opening of a geologic repository occur some time after 2015.

9.2.3 Canister Production Rates

For purposes of the WM PEIS, the following assumptions were made regarding the production of canisters at each of the four HLW sites:

Hanford[1]

- The No Action Alternative assumes a production rate of 320 canisters per year, based on the Hanford Site EIS (DOE, 1987). The more recent TWRS EIS (DOE, 1996d) indicates an average annual production rate of about 450 canisters per year. All other WM PEIS alternatives assume an average annual production rate of 790 canisters per year.
- Canister production would begin in 2009 and would be completed in 2028.
- The Hanford Site would produce an estimated 15,000 canisters.

[1] The Department's Storage and Disposition PEIS evaluates a "can-in-canister" alternative for the disposition of plutonium in an immobilized form, where small cans of plutonium would be imbedded into larger canisters of vitrified HLW. This alternative could result in the production of a small number of additional canisters at one of these two sites because some of the vitrified HLW would be displaced by the smaller cans of immobilized plutonium. The small number of additional HLW canisters would not affect the conclusions reached in the WM PEIS.

INEL

- An average annual production rate of about 81 canisters per year is assumed for all alternatives, except the No Action Alternative. The No Action Alternative assumes no canister production because INEL does not have existing or planned HLW canister storage facilities and is not authorized for treatment to a final waste form acceptable for disposal in a candidate repository.
- Canister production would begin in 2015, and all HLW would be treated so that it is ready to be moved out of Idaho by a target date of 2035 consistent with the Court's order in the case of Public Service Company of Colorado v. Philip E. Batt Civil No. 91-0054-S-EJL (District of Idaho, Oct. 17, 1995).
- INEL would produce an estimated 1,700 canisters.

SRS[1]

- An annual average production rate of 190 canisters per year is assumed for all alternatives. The *High-Level Waste System Plan* (WSRC, 1995) indicates a maximum production rate of about 300 canisters per year.
- Canister production began in 1996 and will be completed in 2020.
- SRS would produce an estimated 4,572 canisters.

WVDP

- A production rate of approximately 100 canisters per year is assumed for all alternatives.
- Canister production began in 1996 and will be completed in 1998.
- WVDP would produce an estimated 340 canisters, based on the assumption that any retrieved spent fuel fines would be considered residues and handled in a manner consistent with HLW (DOE, 1996a).

Table 9.2-1 provides a summary of anticipated production rates for the No Action Alternative and all other alternatives.

Additional Canisters Generated From Foreign Research Reactor Spent Nuclear Fuel. Additional canisters of HLW could be generated from foreign research reactor SNF and other sources if chemical processing were applied to these materials (DOE, 1996b). These additional canisters could add to the inventory of canisters evaluated in the WM PEIS. It is estimated that up to 200 canisters could be produced at SRS in addition to the 4,572 canisters assumed in the WM PEIS, or alternatively, 300 canisters could

Table 9.2–1. High-Level Waste Canister Production Schedule for the No Action Alternative and All Other Alternatives

Action	Site			
	Hanford	**INEL**	**SRS[a]**	**WVDP**
High-Level Waste Canister Production for the No Action Alternative[b]				
Anticipated start of production	2009	0	1996	1996
Anticipated end of production	2028	0	2020	1998
Anticipated start of shipping to repository	2016	0	2037	2016
Anticipated end of shipping to repository	2036	0	2042	2018
Estimated number of canisters produced	15,000	0	4,572	340
Existing or planned storage?	Yes	No	Yes	Yes
Existing or planned storage capacity, number of canisters	750	0	4,572	340
High-Level Waste Canister Production for All Other Alternatives[b]				
Anticipated start of production	2009	2015	1996	1996
Anticipated end of production	2028	2035	2020	1998
Estimated number of canisters produced	15,000	1,700	4,572	340
Existing or planned storage?	Yes	Yes	Yes	Yes
Existing or planned storage capacity, number of canisters	15,000	1,700	4,572	340

[a] Storage capacity for 2,286 canisters currently exists at SRS. Another 2,286-canister facility has been approved and will be constructed in 2007. Impacts from constructing the second canister storage facility have been included in the WM PEIS analysis.
[b] If there is a delay in the schedule for a geologic repository, all timelines would require adjustment.

be produced at INEL in addition to the 1,700 assumed at INEL. At SRS, the additional 200 canisters would represent an increase of 4.4%, and at INEL, the 300 additional canisters would represent an increase of 18%.

9.2.4 TRANSPORTATION

Transportation by truck is assumed in most calculations. The WM PEIS assumed that a truck cask would contain only a single HLW canister and that five HLW canisters would be shipped per rail cask; therefore, transportation by rail would reduce the number of trips by at least 80%. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines; however,

because the routes were determined for the purpose of risk assessment, they do not necessarily represent actual routes that would be used to transport HLW in the future. Actual HLW routes will be determined during the transportation planning process described in Section 4.3.10.

Under all alternatives, DOE would be required to complete designs and obtain the necessary certification for transport of casks for HLW canisters to either another site or a geologic repository along transportation routes approved by the DOT. In addition, transportation of all DOE radioactive material would conform to the Hazardous Materials Transportation Act and applicable DOT and NRC regulations.

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, NRC, and EPA regulations and by the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

9.3 High-Level Waste Alternatives

DOE analyzed five alternatives for HLW within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. The foldout table at the end of this chapter shows the sites at which HLW would be stored under each alternative. This table is designed to be used as a quick reference when reading the HLW impact sections.

Each of the alternatives was developed in order to capture and quantify the human health risks, environmental impacts, and costs associated with the range of HLW canister storage options, and to provide input for a decision about where to store HLW. For each of the five alternatives, DOE assumed that a geologic repository would begin accepting DOE-managed HLW in 2015 at the rate of 800 canisters a year. The schedule for acceptance of DOE-managed HLW at the repository is out of scope for this PEIS. However, for purposes of analysis, DOE also evaluated a scenario that assumed that there would be a delay in acceptance of DOE-managed HLW by a geologic repository until some time later than 2015, but at the same rate of acceptance of 800 canisters per year.

9.3.1 No Action Alternative

Under the No Action Alternative, only existing and approved HLW canister storage facilities would be used. The existing HLW canister storage facilities include the Glass Waste Storage Building at SRS with a storage capacity of approximately 2,286 HLW canisters and the Chemical Process Cell at WVDP with a storage capacity of approximately 340 HLW canisters. In addition to these existing HLW canister storage facilities, DOE has authorized the construction of a second glass storage building at SRS having a capacity of 2,286 canisters (DOE, 1994a). DOE also approved a Hanford storage facility that would provide enough storage capacity for approximately 750 HLW canisters (DOE, 1987). This facility is expected to be operational by 2009. The more recent TWRS EIS (DOE, 1996d) considers storage for a total of 12,200 HLW canisters proposed to be produced at the Hanford Site. The WM PEIS applies the storage capacity given in the Record of Decision based on DOE (1987) as the baseline for the No Action Alternative. No HLW canister storage facility exists or is approved for INEL (DOE, 1995c).

Each site would store only those canisters produced at that site. The Hanford Site would run out of HLW canister storage capacity before HLW canister acceptance begins at a geologic repository in 2015 as planned, based on an anticipated HLW canister production rate of 790 canisters per year and the expected startup of vitrification operations in 2009. Without sufficient storage capacity for HLW canisters, the anticipated HLW vitrification operations at the Hanford Site and INEL would be interrupted or delayed until sufficient storage capacity could be built or capacity at a geologic repository is completed as planned.

Figure 9.3–1 illustrates the No Action Alternative. Table 9.3–1 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canister shipments by truck for the No Action Alternative.

Because the No Action Alternative is based on existing or approved capacity at each of the four sites and the anticipated acceptance rate by a geologic repository, the following assumptions were developed for performing the No Action Alternative analysis for this PEIS. These assumptions were necessary to allow for the processing of HLW to continue once operations began since not all sites have sufficient storage capacity and the repository is not scheduled to accept DOE-managed HLW until 2015.

HLW No Action Alternative

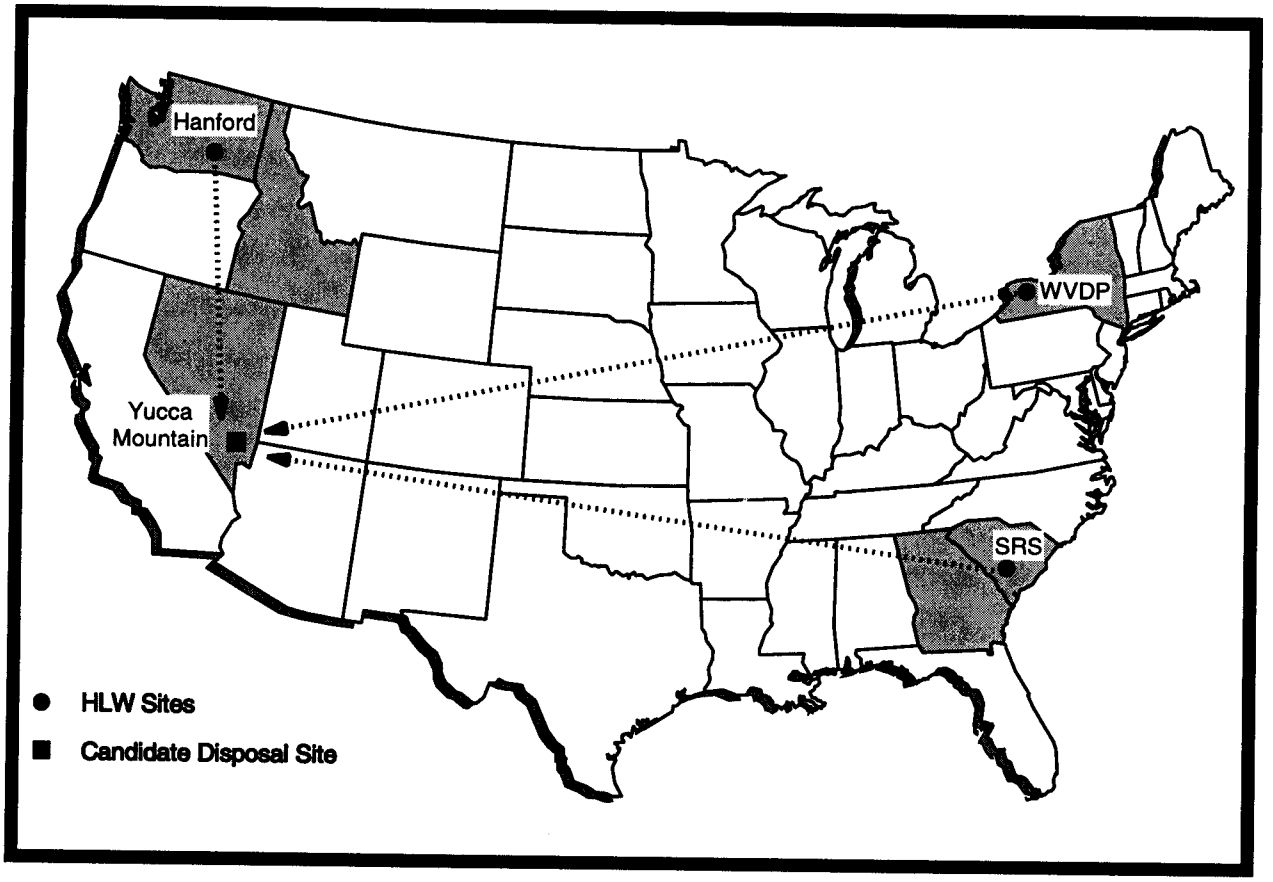

Figure 9.3-1. HLW No Action Alternative

Activity	Hanford	INEL	SRS	WVDP	Totals
Number of Canisters Stored	750	0	4,572	340	5,660
Number of Canister Shipments By Truck	15,000	0	4,572	340	19,900
Shipment Destination	Geologic Repository				

Notes: Estimated number of HLW canisters is based on HLW canister storage capacity authorized in approved NEPA documents. Although the Hanford Site has authorized storage for 750 HLW canisters, under the No Action Alternative, the Hanford Site will ultimately produce an estimated 15,000 HLW canisters.

Table 9.3-1. HLW No Action Alternative Canister Disposition

- Production of HLW canisters under the No Action Alternative would be phased in due to the lack of existing storage capacity at most of the sites and the assumed acceptance rate by a geologic repository of 800 canisters per year. Using this assumption, production of canisters would not stop once it began, but it deviates from actual site-specific planning schedules for the Hanford Site and INEL. This assumption is necessary unless a higher acceptance rate by a geologic repository is allowed.
- If a geologic repository does not begin accepting DOE-managed HLW by January 1, 2016, further delays in the start of production of HLW canisters would occur.
- WVDP—As soon as the repository begins accepting HLW canisters, WVDP would ship canisters at a rate of 100 per year. It would take approximately three years to ship all WVDP HLW canisters.
- Hanford—As soon as the repository begins accepting HLW canisters, the Hanford Site would ship canisters at a rate of 700 per year for the first three years while WVDP ships its canisters, and then ships at a rate of 800 canisters per year. It will take approximately 21 years to ship all Hanford canisters. Since the Hanford Site will construct storage capacity for 750 canisters under the No Action Alternative, DOE assumed that 750 canisters would be in storage the entire time until only 750 canisters are left and then these would be shipped in the last 2 years.
- SRS—The canisters remain in storage until all of Hanford's canisters are shipped to a geologic repository. Storage capacity exists at SRS but not at Hanford. If the Hanford Site began shipping its canisters in 2016, shipment of SRS canisters would begin in 2037 and be completed in 2042 at a rate of 800 canisters per year. If the repository does not open as scheduled, shipment of SRS canisters would start the year Hanford's shipments ended. It would take about 6 years at a rate of 800 canisters per year to ship all SRS canisters to the repository.
- INEL—INEL has no HLW storage capacity under the No Action Alternative because there are no existing or planned HLW canister storage facilities onsite and because no decision has been made on whether further treatment of the calcinated waste will occur before shipment to a repository (DOE, 1995b). The WM PEIS assumed that the final waste form would be a borosilicate glass.

9.3.2 DECENTRALIZED ALTERNATIVE

Under the Decentralized Alternative, storage capacity equal to the anticipated total production of HLW canisters would be constructed at each site. This would allow each site to start generating HLW canisters as soon as the treatment facilities were available, prior to acceptance by a geologic repository. With adequate storage capacity at all four sites until canister acceptance at a geologic repository in 2015, no

delays in the production of HLW canisters would occur. Figure 9.3–2 illustrates the Decentralized Alternative. Table 9.3–2 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck for the Decentralized Alternative.

9.3.3 REGIONALIZED ALTERNATIVE 1

Under Regionalized Alternative 1, the HLW canisters produced at WVDP would be transported to SRS for storage in approved transportation casks. Adequate storage capacity for HLW canisters would be constructed at the Hanford Site, INEL, and SRS; the canisters would be stored there until a geologic repository opens for operation in 2015. Figure 9.3–3 illustrates Regionalized Alternative 1. Table 9.3–3 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck for Regionalized Alternative 1.

9.3.4 REGIONALIZED ALTERNATIVE 2

Under Regionalized Alternative 2, the HLW canisters produced at WVDP would be transported to the Hanford Site in approved transportation casks. Adequate storage capacity for HLW canisters would be provided at the Hanford Site, INEL, and SRS until HLW canisters were accepted at a geologic repository. Figure 9.3-4 illustrates Regionalized Alternative 2. Table 9.3-4 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck.

9.3.5 CENTRALIZED ALTERNATIVE

Under the Centralized Alternative, the HLW canisters produced at INEL, SRS, and WVDP would be transported to the Hanford Site in approved transportation casks, where adequate storage capacity for HLW waste canisters would be provided at the Hanford Site until the canisters were accepted at a geologic repository. Figure 9.3–5 illustrates the Centralized Alternative. Table 9.3–5 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck.

HLW Decentralized Alternative

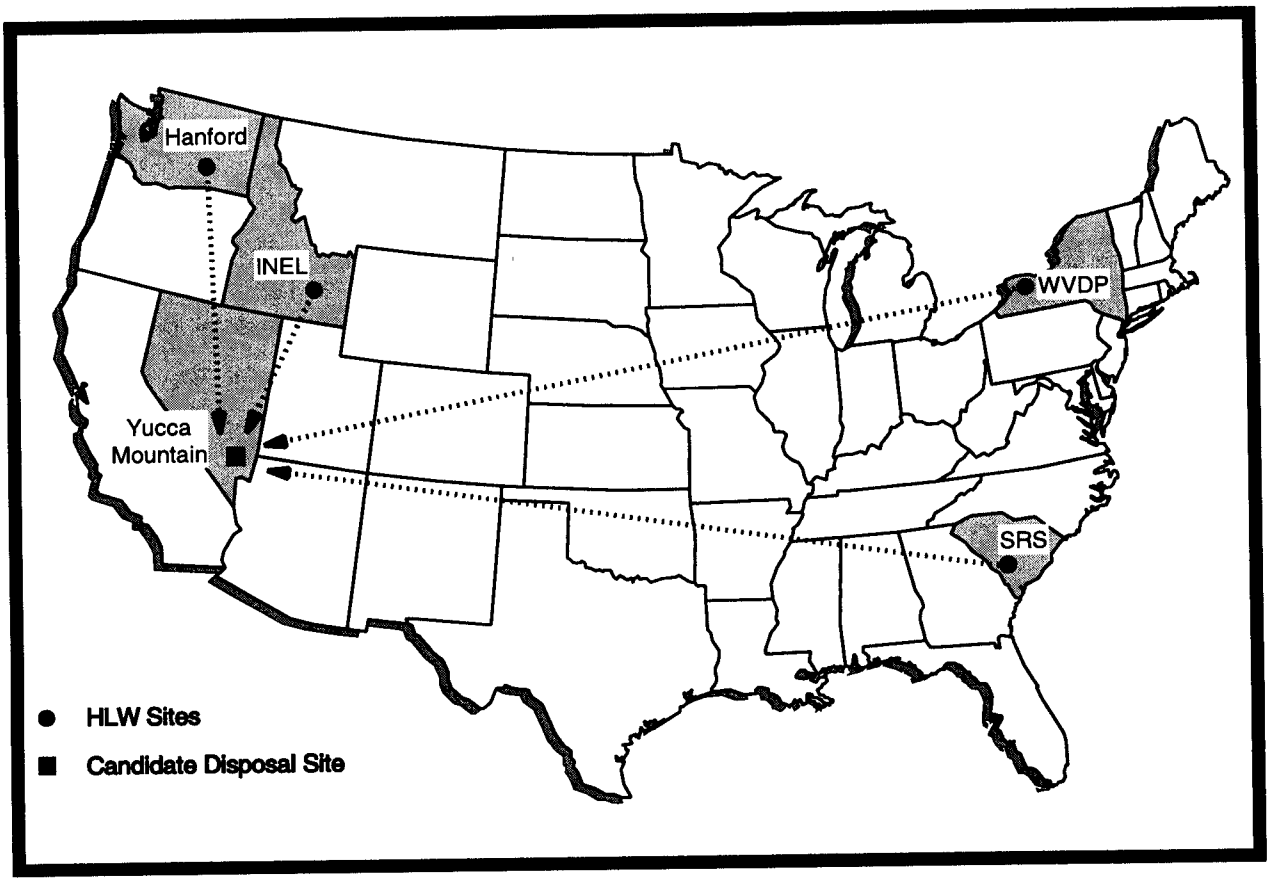

Figure 9.3–2. HLW Decentralized Alternative

Activity	Hanford	INEL	SRS	WVDP	Totals
Number of Canisters Stored	15,000	1,700	4,572	340	21,600
Number of Canister Shipments By Truck	15,000	1,700	4,572	340	21,600
Shipment Destination	Geologic Repository				

Notes: Estimated number of HLW canisters is based on total estimated HLW canister production at the site.

Table 9.3–2. HLW Decentralized Alternative Canister Disposition

HLW Regionalized Alternative 1

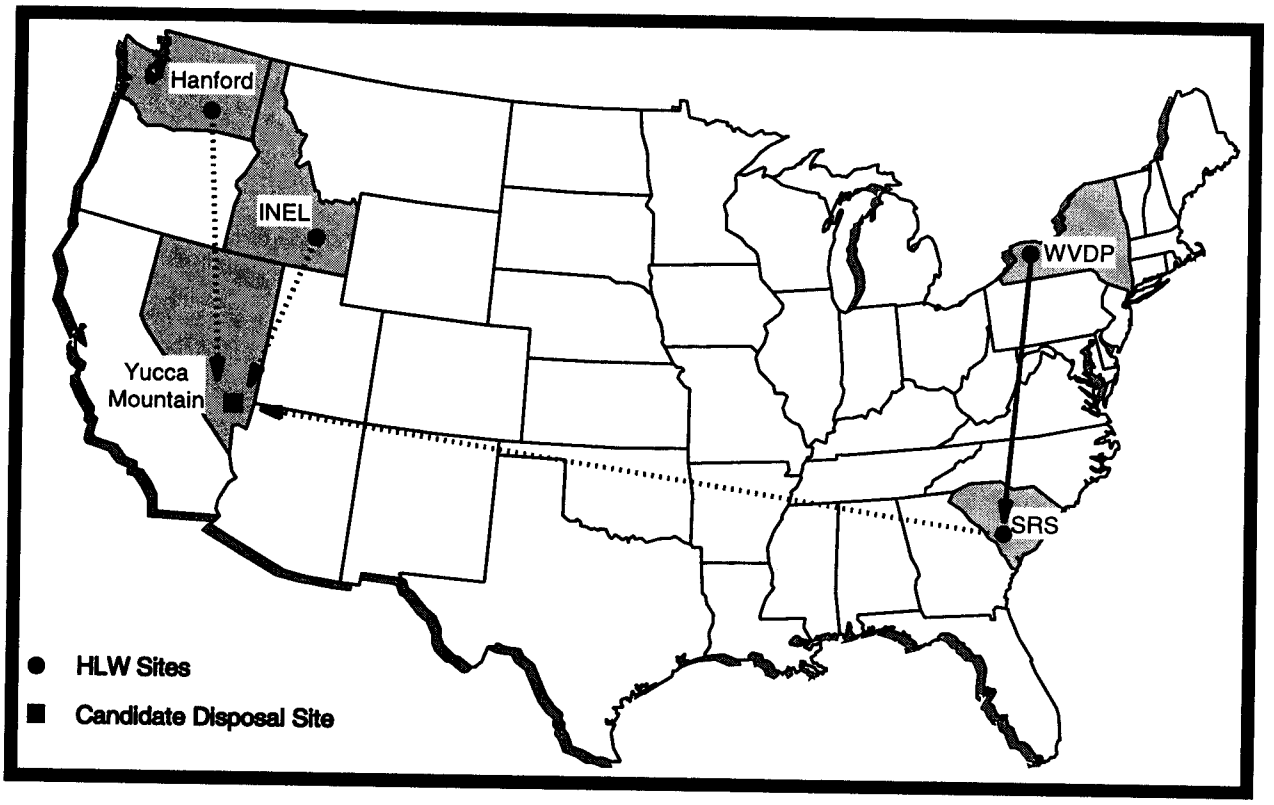

Figure 9.3–3. HLW Regionalized Alternative 1

Activity	Hanford	INEL	SRS[a]	WVDP	Totals
Number of Canisters Stored	15,000	1,700	4,912	0	21,600
Number of Canister Shipments By Truck	15,000	1,700	4,912	340	22,000
Shipment Destination	Geologic Repository			Storage at SRS	

[a] This total number includes the 340 HLW canisters from WVDP that were initially shipped to SRS.

Table 9.3–3. HLW Regionalized Alternative 1 Canister Disposition

HLW Regionalized Alternative 2

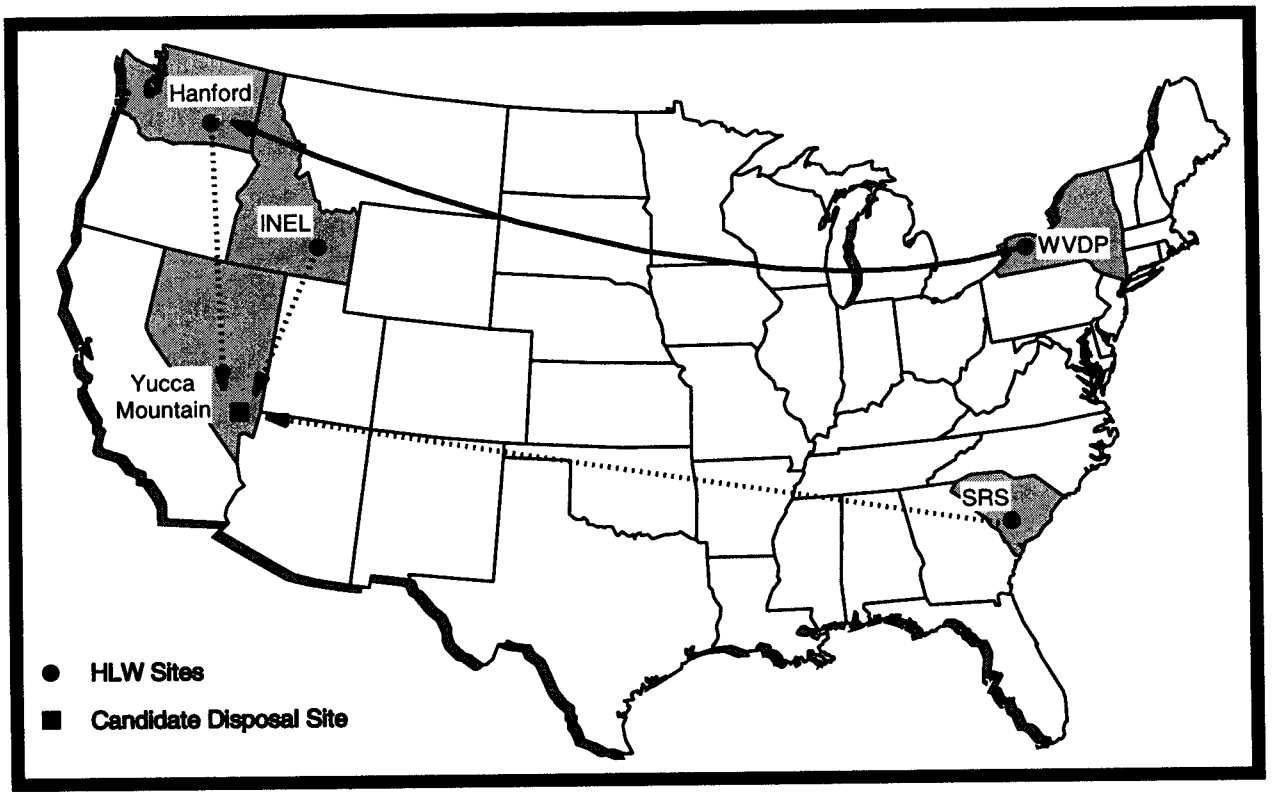

Figure 9.3–4. HLW Regionalized Alternative 2

Activity	Hanford[a]	INEL	SRS	WVDP	Totals
Number of Canisters Stored	15,340	1,700	4,572	0	21,600
Number of Canister Shipments By Truck	15,340	1,700	4,572	340	22,000
Shipment Destination	Geologic Repository			Storage at Hanford	

[a] This number includes the 340 HLW canisters from WVDP that were initially shipped to the Hanford Site.

Table 9.3–4. HLW Regionalized Alternative 2 Canister Disposition

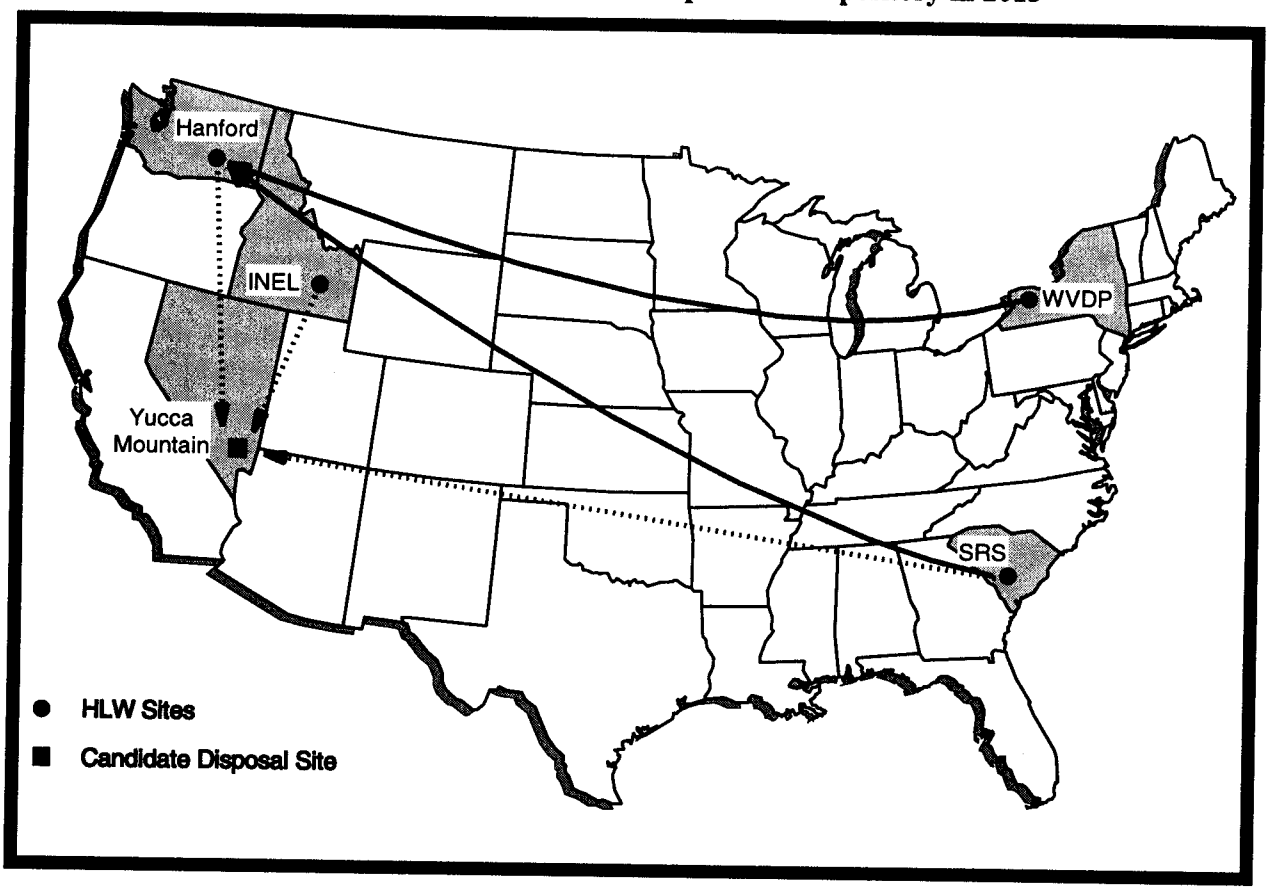

Figure 9.3–5. HLW Centralized Alternative—Geologic Repository Operates in 2015

Activity	Hanford[a]	INEL	SRS		WVDP	Totals
Number of Canisters Stored	17,500	1,700	2,199		0	21,600
Number of Canister Shipments	17,500	1,700	2,199	2,373	340	24,300
Shipment Destination	Geologic Repository	Geologic Repository		Storage at Hanford		

[a] Geologic repository begins accepting DOE-managed HLW in 2015: number of HLW canisters stored and shipped includes the 340 from WVDP and 2,373 from SRS that were initially shipped to the Hanford Site.

Table 9.3–5. HLW Centralized Alternative—Geologic Repository Operates in 2015

If this alternative were selected, the Hanford Site Tri-Party Agreement (1994) may have to be modified in consultation with the State of Washington to include a provision for the storage of INEL, SRS, and WVDP HLW canisters and modify the start-up and completion construction dates for the Hanford Site canister storage facility.

Because the WM PEIS analyzed two different timing assumptions for acceptance of HLW at the repository, the assumptions for the Centralized Alternatives vary. The WM PEIS assumed only that HLW canisters produced before the repository begins accepting DOE-managed HLW in 2015 would be shipped to the Hanford Site for Centralized storage. The remaining canisters produced at SRS and INEL after 2015 would be shipped directly to the repository. WVDP produces all its canisters prior to 2015; therefore, all 340 canisters would be shipped to the Hanford Site. This would be the basis for only a fraction of the total number of canisters being centrally stored at the Hanford Site. For the scenario where acceptance of DOE-managed HLW at the repository is delayed past 2015, all canisters produced at WVDP, SRS, and INEL would be shipped to the Hanford Site for storage prior to shipment to the repository once it begins accepting HLW; this scenario is illustrated in Figure 9.3–6 and Table 9.3–6.

9.3.6 Rationale for Selecting Storage Sites

The five HLW storage alternatives were developed to cover the range of reasonable alternatives. From one to four sites are available for storage of HLW canisters (the Centralized and Decentralized Alternatives, respectively). DOE selected two intermediate alternatives, transporting the relatively small amount of WVDP HLW canisters to either the Hanford Site or SRS. To select the Regionalized Alternatives, DOE focused on the sites with the largest amount of HLW canisters (Hanford) and where transportation would be minimized (SRS). INEL was eliminated from consideration as a Regionalized Alternative site because it has no existing or approved storage facilities.

In the Centralized Alternative, all HLW canisters would be shipped to the Hanford Site for storage. The Hanford Site was selected because it is a reasonable estimate of the impacts no matter which site is ultimately selected. The major variable is the total miles transported between existing DOE sites, the central storage site and the repository. Consolidating all HLW canisters at the Hanford Site minimizes transportation for Centralized storage, because the largest number of canisters (those produced at Hanford) would be shipped directly to the repository. Choosing an eastern site is not considered reasonable because

HLW Centralized Alternative—Shipment to Repository Later Than 2015

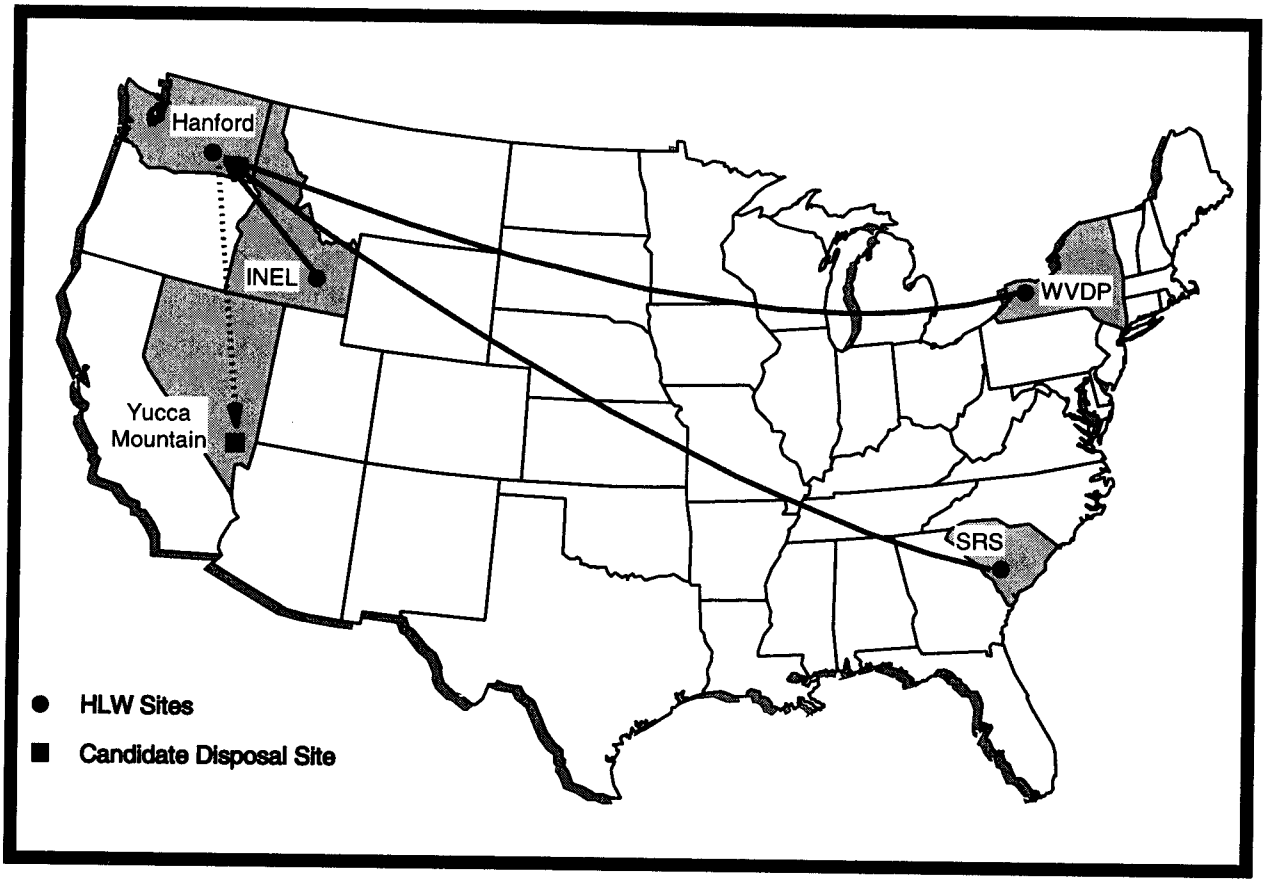

Figure 9.3-6. HLW Centralized Alternative—Geologic Repository Operates Later Than 2015

Activity	Hanford[a]	INEL	SRS	WVDP	Totals
Number of Canisters Stored	21,600	0	0	0	21,600
Number of Canister Shipments	21,600	1,700	4,572	340	28,200
Shipment Destination	Geologic Repository	Storage at Hanford			

[a] Acceptance of DOE-managed HLW at a geologic repository is delayed past 2015: number of HLW canisters stored and shipped includes 340 from WVDP, 4,572 from SRS, and 1,700 from INEL that were initially shipped to the Hanford Site.

Table 9.3-6. HLW Centralized Alternative—Geologic Repository Operates Later Than 2015

it would require the greatest number of canisters (those at Hanford and INEL) to be transported twice across the United States (the only site currently under consideration as a candidate repository is Yucca Mountain, Nevada). WVDP was eliminated from consideration for the Centralized Alternative because it has the smallest volume of HLW canisters, only 1.6% of the total HLW canisters, and would be inconsistent with the West Valley Demonstration Project Act.

9.4 Health Risks

Both fatalities and cancer incidences for WM workers are comparable for the Decentralized, Regionalized, and Centralized Alternatives and do not favor one alternative over another. Worker cancer fatalities from radiation exposure exceed fatalities from physical hazards. Transportation risks are approximately the same for all alternatives.

Health risk impacts can result from exposure to radiation and from physical trauma associated with constructing and operating storage facilities or transporting waste. Health effects resulting from radiation, whether from sources external or internal to the body, can affect either the exposed individual (known as a "somatic" effect [e.g., cancer]) or descendants of the exposed individual (known as a "genetic" effect). This section discusses the estimated adverse health impacts resulting from radiation exposure as well as the physical hazards for each HLW storage alternative. Details of the HLW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5 and in ORNL technical reports (ORNL, 1995a-c).

The potential health risks from the construction and routine operation of HLW storage facilities were evaluated for the waste management worker population (or "WM workers"). The WM worker population includes onsite employees working in a site's waste management facilities, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste. Other receptor groups were not considered for routine facility operation impacts. The offsite population and noninvolved worker population (see Section 5.4.1.2) were considered in the evaluation of potential HLW storage facility accidents (Section 9.4.3).

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer fatalities from radiation exposure

- Cancer incidences from radiation exposure
- Genetic effects from radiation exposure

9.4 *Health Risks*
9.5 *Air Quality Impacts*
9.6 *Water Resources Impacts*
9.7 *Ecological Resources Impacts*
9.8 *Economic Impacts*
9.9 *Population Impacts*
9.10 *Environmental Justice Concerns*
9.11 *Land Use Impacts*
9.12 *Infrastructure Impacts*
9.13 *Cultural Resources Impacts*
9.14 *Costs*
9.15 *Comparison of Alternatives Summary*

9.4.1 ROUTINE OPERATION IMPACTS

For operations involving storage of HLW canisters, waste management workers directly involved in storage activities are the only population of concern for potential adverse health effects. Waste management workers are at risk of developing adverse health effects as a result of the external dose from the presence of high activity radionuclides in vitrified HLW and from physical trauma resulting from storage facility construction and operation accidents. Health risks from the chemical constituents of vitrified HLW canisters in storage are not estimated since vitrifying the HLW minimizes the exposure to workers and the public. Waste management worker health risks are presented as the *total number* of workers who are estimated to experience adverse health impacts if a particular alternative is implemented. Table 9.4–1 provides the number of waste management storage workers analyzed by alternative. These numbers are derived from generic baselines which established the number of personnel required to operate storage facilities needed to manage a given number of canisters.

Worker risks associated with physical hazards were evaluated for between 20 and 45 years of construction and operation, depending on the site. In addition, these estimates included risks due to loading HLW canisters into storage, storage, and loading HLW canisters onto trucks for shipment. Worker risks from direct radiation exposure were evaluated for an entire lifetime (70 years), because health impacts could occur throughout the lifetime of the exposed individual.

Table 9.4–2 provides an overview of the health risk endpoints, hazard sources, pathways, and exposure periods evaluated for HLW canister storage.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The

Table 9.4–1. Waste Management Storage Workers Population by Alternative

Site	WM Storage Workers Population by Alternative[a]				
	No Action	Decentralized	Regionalized 1	Regionalized 2	Centralized
Hanford	113	197	197	197	210
INEL	0	81	81	81	81
SRS	102	102	102	102	93
WVDP	23	23	23	23	23

[a] Values represent the number of full-time equivalents (FTEs) over the entire storage period evaluated.

Table 9.4–2. HLW Health Risk Analysis Components

HLW Canister Storage					
Endpoints	Receptor	Source	Pathways	Exposure Period	Table Reference
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20–45 years[a]	9.4–4
Number of cancer fatalities	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–4
Number of cancer incidences	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–6
Number of genetic effects	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–6

[a] Period includes 10-year duration of construction.

numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases.

9.4.1.1 Estimated Number of Fatalities

Table 9.4–3 presents an overview, by alternative, of the total program wide fatalities associated with storage of HLW canisters until the repository begins accepting DOE-managed HLW in 2015. For HLW operations, fatalities resulting from direct radiation exposure are estimated to be greater than those from physical hazards for all alternatives.

Table 9.4-3. HLW Canister Storage: Estimated Number of Fatalities Programwide

Alternative	Number of Storage Sites	Storage Acceptance at the Repository Beginning in 2015	
		WM Worker Radiation Exposure	WM Worker Physical Hazards
No Action	4	2	1
Decentralized	4	3	1
Regionalized 1	3	3	1
Regionalized 2	3	3	2
Centralized	1	3	2

Understanding Scientific Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10
$10^1 = 10 \times 1 = 10$
$10^2 = 10 \times 10 = 100$
and so on, therefore,
$10^6 = 1{,}000{,}000$ *(or 1 million)*
etc.

Negative Powers of 10
$10^{-1} = 1/10 = 0.1$
$10^{-2} = 1/100 = 0.01$
and so on, therefore,
$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^5 *can also be written as 3.0E+05, and* 3×10^{-5} *is equivalent to 3.0E-05. Therefore, 3.0E+05 = 300,000 and 3.0E-05 = 0.00003.*

The health risk data tables in this section use "E" notation with negative exponents. Probability is expressed as a number between 0 and 1. The notation 3.0E-06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., total cancer) will occur in the period covered by the analysis.

On a site-level basis, the number of latent cancer fatalities from direct radiation exposure is estimated to equal or exceed one only at the Hanford Site under all alternatives and at SRS under No Action and Regionalized Alternative 1. Estimated latent cancer fatalities for HLW can be found in Volume II in the site data tables for Hanford, INEL, SRS, and WVDP.

Cancer fatalities were also evaluated as annual incremental risks for each year past 2015 if acceptance of DOE-managed HLW by the repository is delayed. Estimated annual fatality risks for both radiation exposure (cancer) and physical hazards varied slightly from site to site; however, for a given site, the estimated values were generally constant across the proposed alternatives. These values are presented in Table 9.4–4.

9.4.1.2 Estimated Number of Cancer Incidences and Genetic Effects

Table 9.4–5 presents an overview, by alternative, of the total programwide estimated cancer incidences and genetic effects associated with direct radiation exposure received as a result of storage of HLW until the repository begins accepting DOE-managed HLW in 2015. Cancer incidence is estimated to exceed one under each alternative; the No Action Alternative has the lowest estimated number of radiation-induced latent cancers. Genetic effects incidence equal to one was estimated only under the Centralized Alternative.

Table 9.4–4. HLW Storage: Incremental Annual Exposure Risks Associated With Storage Beyond 2015

Alternative	Hanford		INEL		SRS		WVDP	
	WM Worker Radiation Exposure Fatalities	WM Worker Physical Hazard Fatalities	WM Worker Radiation Exposure Fatalities	WM Worker Physical Hazard Fatalities	WM Worker Radiation Exposure Fatalities	WM Worker Physical Hazard Fatalities	WM Worker Radiation Exposure Fatalities	WM Worker Physical Hazard Fatalities
No Action	2E-03	1E-03	0	0	7E-03	3E-03	2E-03	7E-04
Decentralized	4E-02	2E-02	3E-03	1E-03	7E-03	3E-03	2E-03	7E-04
Regionalized 1	4E-02	2E-02	3E-03	1E-03	7E-03	3E-03	0	0
Regionalized 2	4E-02	2E-02	3E-03	1E-03	7E-03	3E-03	0	0
Centralized	5E-02	2E-02	0	0	0	0	0	0

Table 9.4–5. HLW Canister Storage: Estimated Number of Cancer Incidences and Genetic Effects Programwide

Alternative	Number of Storage Sites	Storage Assuming Acceptance at the Repository Beginning in 2015		
		WM Worker Population Dose (person-rem)	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects
No Action	4	5,400	8	*
Decentralized	4	8,100	11	*
Regionalized 1	3	8,100	11	*
Regionalized 2	3	8,200	12	*
Centralized	1	8,400	12	1

Note: * = greater than 0 but less than 0.5.

On a site-level basis, estimated cancer incidences equaled or exceeded one at the Hanford Site, INEL, and SRS under all alternatives. Genetic effects incidence was not estimated to exceed one at any site under any alternative. Estimated cancer incidences and genetic effects for HLW can be found in Volume II in the site data tables for Hanford, INEL, SRS, and WVDP.

Estimated cancer incidence and genetic effects incidence were evaluated as annual incremental risks for each year past 2015 if acceptance of DOE-managed HLW by the repository is delayed. Estimated annual cancer incidence and genetic effects risks varied slightly from site to site; however, for a given site, the estimated values were generally constant across the proposed alternatives. The estimated annual cancer incidence and genetic effects incidence risks are presented in Table 9.4-6.

9.4.2 Transportation-Related Impacts

The transportation of HLW canisters between sites and to the repository is expected to affect the health of the truck or rail crew and the public along the transportation route because of exposure to radiation and vehicle exhaust and physical trauma from vehicle accidents. Appendix E contains a description of the methods used to estimate transportation risks.

Table 9.4–6. HLW Storage: Incremental Annual Exposure Risks Associated With Storage Beyond 2015

Alternative	Hanford		INEL		SRS		WVDP	
	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects
No Action	8E-03	4E-04	0	0	3E-02	1E-03	6E-03	2E-04
Decentralized	1E-01	5E-03	1E-02	5E-04	3E-02	1E-03	6E-03	2E-04
Regionalized 1	1E-01	5E-03	1E-02	5E-04	3E-02	1E-03	0	0
Regionalized 2	1E-01	5E-03	1E-02	5E-04	3E-02	1E-03	0	0
Centralized	2E-01	8E-03	0	0	0	0	0	0

Table 9.4–7 presents the estimated transportation fatality totals for workers and the public resulting from radiation exposure associated with vitrified HLW canisters and vehicle exhaust emissions, as well as from vehicle accidents. Shipment of vitrified HLW canisters by truck is estimated to produce approximately five deaths in the crew and the public from radiological exposure and traffic accident injuries, whereas, one death might be expected from rail shipments. The estimated number of radiation-induced cancer fatalities listed in Table 9.4–7 is higher for the public than the crew because the public, as a group of receptors, contains more individuals than the crew. As described in Appendix E, the public includes individuals living along the transportation route, people traveling along the highway, and individuals at rest stops. The public would receive a higher collective dose than the crew, but more individuals of the public are potentially exposed, with a single member of the public receiving a much lower dose than a member of the crew.

9.4.3 Facility Accident Impacts

Vitrified HLW is very stable; therefore, the only accident likely to occur is the dropping of a vitrified HLW canister in a storage facility. To determine the consequences of a storage facility accident, a hypothetical accident was analyzed in

Maximally Exposed Individual (MEI)

In keeping with the standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants.

Table 9.4–7. HLW Truck and Rail Transportation: Estimated Fatalities From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Shipments		Shipment Miles in Millions		Estimated Number of Radiological Fatalities[a]					
					Routine Operations Public		Routine Operations Crew		Exposure From Traffic Accidents	
	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
No Action	19,912	3,983	29.4	6.68	2	*	1	*	*	*
Decentralized	21,612	4,323	30.7	6.93	2	*	1	*	*	*
Regionalized 1	21,952	4,391	31.0	7.04	2	*	1	*	*	*
Regionalized 2	21,952	4,391	31.2	7.03	2	*	1	*	*	*
Centralized 1[b]	24,325	4,866	34.6	7.70	2	*	1	*	*	*
Centralized 2[c]	28,224	5,646	39.5	8.74	2	*	1	*	*	*

Alternative	Number of Shipments		Shipment Miles in Millions		Estimated Number of Nonradiological Fatalities			
					Fuel Emission		Injury From Traffic Accidents	
	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
No Action	19,912	3,983	29.4	6.68	*	*	2	*
Decentralized	21,612	4,323	30.7	6.93	*	*	2	*
Regionalized 1	21,952	4,391	31.0	7.04	*	*	2	*
Regionalized 2	21,952	4,391	31.2	7.03	*	*	2	*
Centralized 1[b]	24,325	4,866	34.6	7.70	*	*	2	*
Centralized 2[c]	28,224	5,646	39.5	8.74	*	*	2	*

Notes: * = greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced latent cancer.
[b] Centralized Alternative 1 assumes storage until repository begins accepting DOE-managed HLW in 2015.
[c] Centralized Alternative 2 assumes acceptance at the repository is delayed past 2015.

which a severe drop caused a breach in a vitrified HLW canister. The canister would be inside a contained, shielded environment, but a small quantity of radioactive material could be released to the air because of the breach. Table 9.4–8 contains the results of the analysis for potential storage facility accidents. If a facility's HEPA filtration system was not functioning, allowing the entire quantity of contaminated air released from the canister to escape from the building, no deaths among the offsite population or workers are estimated from such an accident. Appendix D contains additional details.

Table 9.4–8. HLW Facility Accidents: Cancer Fatalities From Potential Maximum Reasonably Foreseeable Storage Facility Accidents

Filtered Canister Breach Accident	Hanford	SRS	WVDP	INEL
Offsite population	*	*	*	*
Offsite MEI	3E-08	4E-12	2E-10	2E-11
Noninvolved worker population	*	*	*	*
Noninvolved worker MEI	1E-09	4E-11	2E-11	3E-12
Waste management workers	*	*	*	*
Unfiltered Canister Breach Accident[a]				
Offsite population	*	*	*	*
Offsite MEI	3E-06	2E-06	9E-05	9E-06
Noninvolved worker population	*	*	*	*
Noninvolved worker MEI	4E-05	2E-05	1E-05	2E-06
Waste management workers	*	*	*	*

Notes: * = greater than 0 but less than 0.5; NA = not applicable. The values for offsite population, noninvolved worker population, and waste management workers are numbers of latent cancer fatalities; the values for MEIs are probabilities of fatality. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] The unfiltered canister breach accident is included due to its high consequences, even though it is not a "reasonably foreseeable" accident in terms of frequency (i.e., annual frequency of occurrence less than 1E-06).

9.4.4 Risks From Canisters From Foreign Reactor Spent Nuclear Fuel

As discussed in Section 9.2.3, additional canisters of HLW would be generated from foreign research reactor spent nuclear fuel and other sources during chemical processing. At SRS, an additional 200 canisters would represent an increase of 4.4%. At INEL, an additional 300 canisters would represent an increase of 18%. Although the WM PEIS did not quantitatively evaluate the storage and transport of these additional canisters, the incremental risks associated with their storage, handling, and shipment are expected to be small, assuming that the canisters are similar to others being managed at each site.

For canisters with comparable radiological characteristics, the additional risks would be proportional to the increase in the number of canisters. The additional canisters would add between 0.04–0.05 expected worker fatalities at SRS and approximately 0.02 worker fatalities at INEL for the range of alternatives. Truck transport of the additional canisters would increase the total HLW transport mileage by 0.6% to 3.2%, depending on the alternative selected, leading to 0.04–0.02 total additional fatalities from transportation. Transport by rail would result in even lower risks.

9.5 Air Quality Impacts

The management of HLW would not appreciably affect the air quality at any site. No criteria air pollutants would exceed standards at any site. Emissions of hazardous air pollutants (including radionuclides) and toxic air pollutants from storage facilities, were assumed to be negligible.

As illustrated in Table 9.5-1, DOE evaluated air quality impacts at each proposed HLW canister storage site based on estimated increases in emissions of the six criteria air pollutants. Hazardous air pollutant emissions (which include radionuclides), and toxic air pollutant emissions from HLW canister storage facilities were assumed to be negligible given the physical form of vitrified HLW. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals preventing releases to the atmosphere. Criteria air pollutant emission estimates were made for HLW facility construction activities and for operation and maintenance activities.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new sources of emissions from both "stationary" (e.g., storage facilities) and mobile (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria air pollutant. An entity which seeks to engage in an activity that will result in emissions that equal or exceed those limits in a nonattainment area must first obtain a permit.

Table 9.5-1. Air Quality Impacts Evaluated for HLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Text discussion only
	Operations and maintenance	Estimated for fuel use by HLW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Text discussion only

In "attainment areas" (where air pollution standards are met), only new sources of emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit is required for a new stationary source that equals or exceeds the allowable increase. However, a permit is not required for criteria air pollutant emissions from mobile sources.

9.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site ("mobile sources").

Major Types of Air Pollutants

***Criteria Air Pollutants**: carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*

***Hazardous Air Pollutants**: 189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

***Toxic Air Pollutants**: Other toxic compounds regulated by EPA and state or local governments*

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities under all the HLW alternatives would result in emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. DOE chose the 10% threshold to highlight those sites where criteria air pollutant emissions could result in adverse air quality impacts.

DOE estimates that no site would have emissions from construction activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

9.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operations and maintenance (O&M) of HLW facilities ("stationary sources") and by vehicles that are driven by workers to the facility or used to transport waste ("mobile sources"). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

DOE estimates that no site would have emissions from O&M activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 km (62 miles) of a PSD Class I area. INEL is the only site proposed for HLW activities that is located within 100 km of a PSD Class I area, although emissions would be below levels that may affect a Class I area.

Concentrations resulting from criteria air pollutant emissions from stationary-sources were not compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50) since there would be no stationary-sources (treatment facilities) for HLW.

9.5.3 Hazardous and Toxic Air Pollutant Emissions

Hazardous air pollutant (which include radionuclides) and toxic air pollutant emissions from HLW canister storage facilities were assumed to be negligible due to the physical form of the vitrified HLW. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals, such that releases to the atmosphere are negligible.

9.6 Water Resources Impacts

Major impacts to water resources at all affected sites are unlikely even if the HLW repository does not begin to accept DOE-managed HLW in 2015 and long-term storage of HLW canisters at the sites is required.

As illustrated in Table 9.6–1, DOE analyzed the impacts on water resources of HLW canister storage activities. DOE evaluated the effects on water availability from building and operating storage facilities. The impacts of long-term storage were also evaluated should the HLW repository be unable to accept DOE HLW beginning in 2015.

Table 9.6-1. Water Resource Impacts Evaluated for HLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by storage processes	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

9.6.1 WATER AVAILABILITY

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of HLW canister storage facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to a major offsite stream at a given site.

As shown in the Volume II tables, projected water usage would increase by more than 1% only at WVDP. The 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Water use at WVDP would be 1.4% of current use for all alternatives under both sets of timing assumptions. The 1,000 gallons per day required for operations at WVDP would be supplied by surface water taken from two onsite reservoirs. Since normal household water use in the United States is estimated at approximately 105 gallons per day per person (Solley et al., 1988), water use rates that are equivalent to the water used by approximately 10 people are unlikely to cause major changes in surface water flow rates and levels.

As shown in the Volume II tables, for DOE sites that withdraw water directly from a surface water source (the Hanford Site and WVDP), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (SRS and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

9.6.2 WATER QUALITY

Impacts to groundwater quality were not evaluated for HLW since disposal is not within the scope of the WM PEIS. However, groundwater quality will be addressed in the environmental impact statement for the repository.

9.7 Ecological Resources Impacts

Loss of limited acreages of habitat at the DOE sites during construction of HLW canister storage facilities should not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. Operation of HLW canister storage facilities would not affect ecological resources because airborne emissions and liquid effluents are expected to be negligible. DOE would be able to locate new HLW canister storage facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction site acreages are small compared to the total acreage at each site suitable for waste operations. When specific HLW facility locations are proposed, DOE will conduct site- and project-level analyses to determine if any sensitive species, including Federally and State-listed endangered and threatened species, may be affected and will establish appropriate protection measures. Transportation accidents involving shipment of HLW canisters would be extremely rare and would not affect aquatic habitats because of the vitrified form of the HLW and special packaging.

DOE analyzed the ecological impacts of constructing HLW canister storage facilities (Table 9.7–1). The ecological impacts of operating HLW canister storage facilities and shipping HLW canisters among sites or to a geologic repository were not analyzed quantitatively. Airborne emissions and liquid effluents from HLW canister storage facilities and any resulting exposures of nearby ecological communities are expected to be negligible. HLW transportation accidents involving a spill into an aquatic environment are expected

Table 9.7–1. Ecological Resources Impacts Evaluated for HLW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at HLW construction sites to general habitat range	Text discussion
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats by comparing construction acreage to available acreage of nonsensitive habitats	Text discussion
Sensitive species concerns	Sensitive species including Federally and State-listed endangered and threatened species	Numbers of Federally and State-listed species displayed by site/alternative	Text discussion

to be extremely rare. Even if such an accident does occur, the vitrified form of HLW, and the design of the Type B shipping cask will prevent any substantial release of radionuclides. Type B shipping casks are designed to maintain the integrity of the package with essentially no loss of radionuclide content or serious impairment of the shielding capability even in a severe accident.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

9.7.1 General Impacts of Site Clearing

The extent of construction site clearing would be extremely small for any HLW alternative at any site relative to the extent of the general habitats supported at the sites. Acreage requirements for alternatives involving storage of HLW canisters ranged from 1 acre at the Hanford Site under the No Action Alternative to 16 acres at the Hanford Site under the Centralized Alternative. Therefore, although site clearing will destroy individual plants and will kill or displace individual animals, particularly small mammals and song birds with limited home ranges, no significant effects to general species populations or communities are expected from implementation of any HLW alternatives.

9.7.2 Site Clearing Effects on Sensitive Habitats

All four HLW sites contain sensitive habitats. The closer the HLW canister storage facility construction activities are to those habitats, the more likely that they would be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment. Avoiding such impacts depends on DOE's ability to avoid locating the facilities near these habitats. A measure of this ability is the percentage of available land that facility construction under any HLW alternative requires at a site. Available acreage was estimated from site development plans, either as land designated for waste operations or by subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage ranged from 0.001% under several alternatives to about 0.26% at the Hanford Site under the Centralized

Alternative. DOE would therefore have a great degree of flexibility in siting facilities and effects on sensitive habitats should be avoided. Even if these habitats could not be avoided, mitigation measures could be employed.

Aquatic resources may be indirectly affected through increased runoff and sedimentation loadings to surface waters from disturbed terrestrial areas. However, the use of various mitigation techniques should minimize potential storage facility construction impacts to aquatic ecological resources. Direct discharges to surface waters from the routine operation of HLW canister storage facilities are expected to be limited by the use of engineering control practices. Therefore, the impacts to aquatic organisms are expected to be minimal.

9.7.3 Consideration of Sensitive Species

Federally and State-listed endangered species can be found on all four HLW sites. The number of species occurring or potentially occurring at each of the HLW sites is—the Hanford Site: 3/11, INEL: 2/2, SRS: 8/8, and WVDP: 1/8; where the first number indicates Federally listed species and the second number indicates State-listed species. No major construction is proposed at WVDP under any of the HLW alternatives nor INEL under the No Action Alternative. Major construction actions are proposed at INEL for all other alternatives and at the Hanford Site and SRS under all HLW alternatives. However, site-specific analysis would be required to assess these impacts. Such analysis would take into account specific siting locations for the HLW canister storage facilities in relation to the location of sensitive habitats and sensitive species at each site, including those listed by the U.S. Fish and Wildlife Service as endangered or threatened.

9.7.4 Effects of HLW Transportation Accidents

The ecological impacts of a transportation accident involving shipment of HLW canisters on aquatic environments are expected to be minimal. Like TRUW, HLW will be shipped in type B Casks/Containers, which should limit any potential release of radionuclides or hazardous chemicals in the waste to surface waters. In addition, vitrification of the HLW further limits any potential releases if the shipping casks were breached during an accident.

9.8 Economic Impacts

HLW canister storage facility construction and operations expenditures would minimally benefit the local economy at the four HLW sites because estimated job and personal income for all HLW alternatives are well below 1% of regional employment and income at all sites. None of the HLW alternatives would significantly affect the national economy, although 400 to 1,400 jobs would be directly or indirectly financed.

DOE estimated the effects of expenditures for HLW management on the local and national economies. Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of HLW canister storage facilities. The socioeconomic region of influence (ROI), consists essentially of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data. Local increases in jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at a national level only.

Local economic effects were estimated on an annual basis (Table 9.8-1). Activities at the HLW sites vary from site to site among alternatives, many continuing well beyond the anticipated repository acceptance date of 2015.

Because the regional economies are subject to changes induced by many different variables other than DOE expenditures, DOE believed that estimating economic benefits beyond 2015 would be speculative. Therefore, the analysis was confined to estimating the economic effects of the total HLW canister storage facility construction and operations expenditures at each site for the 20-year period from 1996 to 2015. Costs beyond 2015 were not used to estimate economic benefits but are compared to show overall HLW alternative differences. Five years was added to the base 20-year period for determining annual economic impacts to account for the continued effects of DOE expenditures on employment and income after the end of the base period. Job and personal income increases are shown for each site in the Volume II site tables.

Table 9.8-1. Economic Impacts Evaluated for HLW Alternatives

Economic Effects Analyzed	Affected Economic Resource	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional employment multiplier at each HLW site	Text discussion
Increased regional incomes	Regional personal income	Proposed site expenditures multiplied by regional income multiplier at each HLW site	Text discussion
National economic effects	National economy	Proposed site expenditures plus total transportation expenditures multiplied by national employment and income multipliers	Text discussion
Costs beyond the year 2015	Continued annual program effects on regional and national employment and personal income	Display minimum and maximum costs beyond 2015 by site and alternative	Text discussion

9.8.1 Acceptance at the Repository Beginning in 2015

Across the HLW alternatives, none of the sites would experience a 1% or greater increase in the number of jobs or in personal income between 1996 and 2015 as a result of expenditures for HLW. A comparison of alternatives reveals that the number of new direct, indirect, and induced jobs from the construction and operation and maintenance activities in the ROIs range from 410 (under the No Action Alternative) to 670 (under the Regionalized 2 Alternative).

In addition to an evaluation of the effects on the regional economy, a comparison of these effects was made on the national economy. None of the HLW alternatives would substantially affect employment in the national economy. The number of jobs generated in the national economy from combined weighted construction and operations phase activities ranges from 480 under the No Action Alternative to 1,200 under the Centralized Alternative. Although the number of jobs appears large in absolute terms, 1,200 jobs represent 0.0009% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HLW projects, rather than a net change in national personal income.

9.8.2 Repository Acceptance Delayed Past 2015

Across the HLW alternatives, none of the sites would experience a 1% or greater change in jobs or personal income. The number of new direct, indirect, and induced jobs from HLW canister activities between 1996 and 2015 ranges from 410 (under the No Action Alternative) to 690 (under the Centralized Alternative).

The HLW alternative would only minimally benefit employment in the national economy even if acceptance of HLW canisters at a geologic repository is delayed past 2015. The number of jobs generated in the national economy ranges from 480 under the No Action Alternative to almost 1,400 under the Centralized Alternative. The 1,400 jobs represent 0.001% of the 137 million jobs in the national economy. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HLW canister storage projects, rather than a net change in national personal income.

Any economic impacts of expenditures beyond 2015 were not included but would derive from expenditures for additional storage of the canisters that are currently assumed to go straight to the repository. The additional interim storage at the Hanford Site, location of potential greatest impact, could cost as much as $180 million to construct storage for 3,887 additional canisters in the Centralized Alternative.

9.9 Population Impacts

The overall population in-migration remains relatively constant under all proposed alternatives and does not result in a major increase at any site. No corresponding changes to community characteristics or the provision of services would be anticipated.

Potential population changes in the ROI at each HLW site were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that associated effects would result, such as changes in community size and diversity, or changes in the provision of necessary services.

Because the scope of activity and the associated labor requirement proposed under each of the alternatives is relatively small, the overall impact of population in-migration would be negligible. No site would

experience ROI population increases greater than 0.1% of the current ROI population under any of the alternatives.

9.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of HLW canisters indicated that minority and low-income populations at the HLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HLW alternatives.

Analysis of environmental justice impacts from management of HLW canisters was based on a review of the impacts reported in this chapter regarding the HLW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the four HLW sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done. Appendix C also provides maps illustrating the distribution of minority and low-income populations within 50 miles of each HLW site.

9.10.1 RESULTS

The potential is low for adverse human health effects from exposure to radionuclide emissions from HLW canister storage facility operations. The calculated risk of cancer fatalities (see Section 9.4.1) associated with storage facility operations is small for radionuclide-related cancer for the offsite maximally exposed individual. Therefore, disproportionately high and adverse health effects to any segment of the population, minorities and low-income populations included, from HLW canister storage facility accidents are not expected to occur.

9.10.1.1 Transportation

Because incident-free HLW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income

populations, no environmental justice impacts are expected. As Section 9.4.2 indicates, the total number of potential fatalities is the sum of the fatalities caused by exposure to radiation and the fatalities caused by exposure to vehicular emissions. The total number of truck shipments during HLW canister storage facility operations would vary from about 20,000 under the No Action Alternative to about 28,000 shipments under the Centralized Alternative 2. The estimated total cancer fatalities resulting from incident-free transportation range from less than 0.5 to 3 fatalities under the HLW alternatives. This small number of collective population fatalities is spread across a large number of shipments. A disproportionate share of minority and low-income populations reside near interstate highways and railroads; however, the major routine risks to the public from truck transportation are from exposure during rest stops to travelers who are at the same rest stops. Minority and low-income populations are found to be disproportionately lower in representation at highway rest stops (DOT, 1992). For rail shipments, the primary risks to the public are from radiological exposure during railcar classification in railyards, primarily at the start and end of each shipment, and from the emission of diesel exhaust from the trains in urban areas.

The expected number of cancer fatalities due to radiation exposure from transportation accident releases is less than 0.5 under all alternatives. The expected number of transportation accident fatalities from trauma is also less than 0.5 under any HLW alternative. Therefore, no disproportionately high and adverse effects are expected to any particular segment of the population, including minority or low-income groups.

9.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 9.10.1 did not indicate any adverse impacts to air quality, water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Therefore, no disproportionately high and adverse environmental impacts are expected for any segment of the populations at the HLW sites, including minorities and low-income populations.

9.11 Land Use Impacts

No impacts to current onsite or offsite land uses would result from implementing any of the HLW alternatives because for all the sites, land requirements to build HLW canister storage facilities are less than 1% designated or suitable lands. In addition, the proposed HLW canister storage facilities do not conflict with the development plans for any site.

DOE examined the impacts of the alternatives on land use by comparing the acreage required for new HLW canister storage facilities to the acreage either designated for waste operations or suitable for development (see Table 9.11-1). Suitable land is the total site acreage, minus the acreage required for existing facilities and roads, known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts between the proposed facilities required under each alternative and plans for future site uses.

The land requirements analysis indicated that, for all of the sites under all the HLW alternatives, land requirements to build HLW canister storage facilities were less than 1% of designated or suitable lands. DOE should have considerable flexibility in locating HLW canister storage facilities and no land use impacts onsite are expected. For the same reason, no conflicts with adjacent land uses are expected. In addition, none of the site development plans indicated any instances where future use would conflict with the proposed HLW management actions.

Table 9.11-1. Land Use Impacts Evaluated for HLW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each HLW site	Land use shown in site development plans	Comparison of the required acreage with amount designated (or estimated) for HLW in site development plan—all instances where requirements are 1% were noted	Text discussion
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed waste management uses and nearby land uses	Text discussion

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations on a site.

9.12 Infrastructure Impacts

Proposed HLW activities show no potential for effects to onsite infrastructure. No offsite infrastructure impacts are expected at any site. Estimated new requirements for wastewater treatment at the Hanford Site increase current demand in all alternatives, except No Action. Employment increases do not approach or exceed 5% of current site employment at any site. Traffic increases would be minimal during construction, and would not affect onsite transportation infrastructure.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and electrical power (See Table 9.12–1). Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater produced by construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to the onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on community infrastructure.

Proposed HLW activities show no potential for effects on onsite infrastructure. No offsite infrastructure impacts are expected. Proposed HLW activities show no potential for effects on onsite or offsite demand for potable water, wastewater treatment, and power infrastructure.

Table 9.12-1. Infrastructure Impacts Evaluated for HLW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support HLW canister storage facilities	Capacity of onsite water, electrical power, and wastewater systems	Add increased HLW facility use to current use—compare to current capacities	Text discussion
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Text discussion
Capacity of community infrastructure to support increased worker populations and their families	Regional water, electrical power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion

Employment increases from the construction of HLW canister storage facilities do not approach or exceed 5% of current site employment. Therefore, it is expected that traffic increases will be minimal during construction, and will not substantially affect onsite transportation infrastructure.

9.13 Cultural Resources Impacts

Construction and operation of HLW canister storage facilities could adversely affect cultural resources. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where HLW canister storage facilities are proposed. Table 4.3-8 in Chapter 4 describes the status of cultural resources surveys and the reported resources at the four HLW sites. However, the impacts of the construction of HLW canister storage facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

The acreage requirements at all sites under all alternatives are only a small fraction of the areas available for waste operations so DOE should be able to avoid impacts to any known cultural resources or any identified during pre-construction site surveys. If not, measures would be taken to mitigate negative effects on these resources.

9.14 Costs

The costs of storing HLW canisters remain relatively stable at approximately $3 billion, for all alternatives. Costs do rise slightly when storage is Centralized. Delay in disposing the waste at a geologic repository causes the life-cycle costs to increase at a rate of 0.2% per year of delay, not counting inflation.

As indicated in Table 9.14–1, DOE estimated costs for building and operating storage facilities for canisters of vitrified HLW and for transportation (ANL, 1996). DOE evaluated costs associated with HLW canister storage and transportation from both a life-cycle and process perspective, using 1994 dollars.

Table 9.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts Are Assessed	Location of Impacts Assessment
Process Costs	Storage	Life-cycle costs for HLW canister storage facilities, including facilities and loading and unloading of canisters into and out of storage.	Table 9.14–2
Transportation Costs	Truck Rail	Inter-site common carrier costs for transportation from generating sites to storage sites, and to the candidate geologic repository.	Table 9.14–2

9.14.1 Facility Costs

DOE evaluated facility costs for two phases of the life-cycle of the HLW canister storage facilities: construction and O&M costs were estimated. Facility construction cost formulas were based on similar facility estimates made by DOE for HLW vitrification and storage facilities at SRS, WVDP, the Hanford Site, and INEL. Operations and maintenance cost formulas were also based on similar storage facilities. Facility costs do not include speculative factors, such as impacts to long-term land value.

9.14.2 Process Costs

DOE also analyzed costs based on storage and handling activities. Storage costs include the construction and operation of HLW canister storage facilities. Handling costs include the loading and unloading of HLW canisters from the production line into storage, and for transportation to follow-on storage sites or to the candidate geologic repository. Based on the advanced conceptual design of the candidate geologic repository, plans are to receive 800 canisters per year from DOE (March 1994).

Transportation costs include the costs associated with the movement of the HLW canisters from one site to another for either treatment or disposal. Transportation costs are evaluated for both truck and rail shipments (ANL, 1996).

The summary of costs is shown in Table 9.14–2 (ANL, 1996). The No Action Alternative includes the production of all required canisters, but does not include storage beyond that already approved. With no increase in approved storage facilities, the canisters are shipped to the repository, phasing by site in the following order—WVDP, the Hanford Site, and SRS. No vitrification is performed at INEL because the site-specific plan has not yet been approved. When approved, the cost of the No Action Alternative will increase by $280 million. The No Action Alternative provides a baseline by which to compare the other alternatives.

Considering the Decentralized, Regionalized and Centralized Alternatives, construction accounts for 12% to 13% of the total cost, and operations account for 71% to 73% of those costs. The stability of costs is driven by the preponderance of canisters produced at the Hanford Site (15,000 of 21,600 canister total in the complex). The small variations of the Decentralized and Regionalized Alternatives costs are driven

Table 9.14-2. Life-Cycle Costs (Billions of 1994 Dollars)

Alternatives	Description	HLW—Cost in Billions of 1994 Dollars						
		Total Cost[a]	Life-Cycle Costs (Construction and O&M Phases)		Process Costs[b]		Transportation Costs	
			Construction	O&M	Storage	Handling	Truck	Rail
No Action	Current Program	1.47	0.07	1.00	0.21	0.87	0.39	0.57
Decentralized	Storage of HLW canisters at generator sites until acceptance at Repository begins in 2015	2.69	0.33	1.95	0.60	1.68	0.41	0.59
Regionalized 1	Canisters from WVDP stored at SRS	2.72	0.33	1.98	0.61	1.70	0.41	0.60
Regionalized 2	Canisters from WVDP stored at Hanford	2.72	0.33	1.98	0.61	1.70	0.41	0.60
Centralized	Canisters from WVDP and SRS stored at Hanford	2.85	0.37	2.02	0.73	1.66	0.46	0.68

[a] The facility costs in this table are presented in two ways: as life-cycle costs (construction and O&M phases) and as process costs (storage and handling only). Life-cycle costs are equal to process costs. Total costs are obtained by adding truck costs to life-cycle costs or to process costs. Thus, "total costs" = sum of life-cycle and truck costs = sum of process and truck costs.
[b] The costs of storage after the manufacture of canisters filled with vitrified HLW were included in this PEIS. The costs of storage of waste prior to treatment were included in the site infrastructure costs, which are not part of this PEIS.

by the storage of the 340 canisters from WVDP. The increase in costs for the Centralized Alternative is driven by the canisters at SRS (2,373), which have been shipped to the Hanford Site for follow-on storage before the geologic repository opens.

If the opening of the geologic repository is delayed past 2015, costs will increase $4 million for every year of additional storage required.

9.15 Environmental-Restoration-Transferred Waste

There is no environmental-restoration-transferred HLW.

No HLW will be generated during environmental restoration activities and, therefore, such waste is not considered in this analysis.

9.16 Comparison of Alternatives Summary

Health Risks. Both fatalities and cancer incidences for waste management workers are comparable for the Decentralized, Regionalized, and Centralized Alternatives and do not favor one alternative over another. Worker cancer fatalities from radiation exposure exceed fatalities from physical hazards. The Decentralized, Regionalized, and Centralized Alternatives each have three estimated cancer fatalities and one to two estimated fatalities from physical hazards. Truck transportation risks are slightly higher for the Centralized Alternative when the opening of a geologic repository is delayed than for other alternatives in the categories of radiological risks and physical trauma from traffic accidents. Fatalities from facility accidents are less than one for each of the HLW alternatives.

Air Quality Impacts. The management of HLW canisters would not appreciably affect the air quality at any site. No criteria air pollutants would exceed standards at any site. Emissions of hazardous air pollutants (including radionuclides) and toxic air pollutants from storage facilities, were assumed to be negligible.

Water Resources Impacts. Major impacts to water resources at all affected sites are unlikely even if the HLW repository does not begin to accept DOE-managed HLW in 2015 and extended storage of HLW canisters at the sites is required.

Ecological Resources Impacts. Loss of limited acreages of habitat at the DOE sites during construction of HLW canister storage facilities should not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. Operation of HLW canister storage facilities should not affect ecological resources because airborne emissions and liquid effluents are expected to be negligible. When specific HLW canister storage facility locations are proposed, DOE will conduct site- and

project-level analyses to determine if any sensitive species, including Federally and State-listed endangered and threatened species, may be affected and will establish appropriate protection measures. DOE should be able to locate new HLW canister storage facilities to avoid impacts to nearby wetlands and other sensitive habitats, because construction site acreages are small compared to the total acreage at each site suitable for waste operations. Transportation accidents involving shipment of HLW canisters should be extremely rare and should not affect aquatic habitats because of the vitrified form of the HLW and special packaging.

Economic Impacts. HLW canister storage facility construction and operations expenditures would minimally benefit the local economy at the four HLW sites because estimated jobs and personal income are well below 1% of regional employment and income at all sites under all the alternatives. None of the HLW alternatives would affect the national economy, although 328 to 1,200 jobs would be directly or indirectly financed.

Population Impacts. The overall population in-migration remains relatively constant under all proposed alternatives and does not result in a major increase at any site. No corresponding changes to community characteristics or the provision of services would be anticipated; however, some impacts to the social environment are evident under all of the alternatives. The most serious concerns exist for the No Action Alternative, where existing limitations on HLW canister storage capability restrict canister production at the Hanford Site and INEL, and delay removal of untreated HLW from all sites; and for the Centralized Alternative, where the Hanford Site would receive large quantities of additional treated HLW for storage from other sites. Although the number of canisters received at the Hanford Site and SRS would be substantially lower in the Regionalized Alternatives, some public opposition to receipt of WVDP's HLW canisters could occur at these sites.

Environmental Justice Concerns. Assessment of potential environmental justice impacts from management of HLW canisters indicated that minority and low-income populations at the HLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HLW alternatives.

Land Use Impacts. No impacts to current onsite or offsite land uses would result from implementing any of the HLW alternatives because for all the sites, land requirements to build HLW canister storage facilities are less than 1% designated or suitable lands. In addition, the proposed HLW canister storage facilities do not conflict with the development plans for any site.

Infrastructure Impacts. Proposed HLW activities show a potential for effects to onsite infrastructure only at the Hanford Site although the effects would be minor. No offsite infrastructure impacts are expected at any site. Estimated new requirements for wastewater treatment at the Hanford Site increase current demand in all alternatives, except No Action. Employment increases do not approach or exceed 5% of current site employment. Traffic increases would be minimal during construction, and would not affect onsite transportation infrastructure.

Cultural Resources Impacts. Construction and operation of HLW canister storage facilities could adversely affect cultural resources. Potential adverse effects at specific candidate construction locations will be considered in sitewide or project-level NEPA reviews.

Costs. The costs of HLW canister storage and transportation remain relatively stable at approximately $3 billion, for all alternatives except No Action. Costs do rise slightly when HLW canister storage is Centralized. Delay in disposing the waste at the geologic repository causes the life-cycle costs to increase at a rate of 0.2% per year of delay.

Summary of Impacts by Alternatives. Table 9.16–1 summarizes the key impacts for each HLW alternative.

The Preferred Alternative. The Department's preferred alternative at this time is to store its HLW where the waste is treated pending a decision on its disposal or other disposition. Because it is impractical to ship liquid HLW for treatment, the Department had previously decided that each of the four sites with HLW (Hanford, INEL, SRS, and WVDP) will treat its own waste onsite.

The potential impacts of DOE's preferred alternative are presented under the Decentralized Alternative for HLW. This alternative minimizes the transportation of treated HLW, makes use of existing storage capacity at WVDP and SRS, and would cost less than regionalized or centralized storage. The potential environmental impacts of all alternatives for HLW evaluated in the WM PEIS are small.

Table 9.16-1. Comparison of HLW Alternatives—Selected Impacts

Alternative	Number of Sites Storing	Worker Physical Hazard Fatalities	Worker Cancer Fatalities	Truck Radiation Fatalities	Truck Non-Radiation Fatalities	Truck Shipments	Cost ($ Billions)
No Action	4	1	2	3	2	20,000	1.5
Decentralized	4	1	3	3	2	22,000	2.7
Regionalized 1	3	1	3	3	2	22,000	2.7
Regionalized 2	3	2	3	3	2	22,000	2.7
Centralized	1	2	3	3	2	24,000	2.9

Note: * = greater than 0 but less than 0.5.

Chapter 9

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WSRC. *See* Westinghouse Savannah River Company.

High-Level Waste Alternatives

Alternative	Store	Hanford	INEL	SRS	WVDP
No Action	4	S	S	S	S
Decentralized	4	S	S	S	S
Regionalized 1	3	S	S	S	
Regionalized 2	3	S	S	S	
Centralized[a]	1	S			

Note: Blanks indicate that storage of HLW does not occur at a site under the alternative specified.

[a] Canisters generated at WVDP, SRS, and INEL prior to acceptance at the candidate repository in 2015 would be shipped to the Hanford Site for storage. Canisters generated at SRS and INEL after 2015 would be shipped directly to the candidate repository. If acceptance of the DOE-managed HLW is delayed past 2015, then all HLW canisters would be shipped to Hanford for storage.

CHAPTER 10
Impacts of the Management of Hazardous Waste

Chapter 10 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for hazardous waste (HW). This chapter provides information on existing HW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to HW characteristics, the treatment and disposal technologies considered, and the rationale for selecting the specific sites analyzed under each alternative. The chapter discusses the human health risks, environmental impacts, and costs of the alternatives, and provides a comparison of alternatives.

The methods used to evaluate the impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the HW analysis are contained in a technical report entitled "Hazardous Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports listed in Chapter 15.

10.1 Background

10.1.1 DEFINITION AND ORIGIN

- *HW is nonradioactive chemical waste.*
- *HW is generated as a result of research and development and as a byproduct of nuclear weapons production and dismantlement.*
- *HW is generated or exists at most DOE sites.*
- *Most nonwastewater DOE HW is treated commercially.*
- *DOE needs to decide whether to develop additional capacity of its own to treat HW.*

Hazardous waste consists of nonradioactive waste materials generated as a result of nuclear weapons production and other research and development activities. HW is any solid waste, not otherwise precluded from regulation under the Resource Conservation and Recovery Act (RCRA), that exhibits the characteristics of ignitability, corrosivity, reactivity, or toxicity, as defined by RCRA, or which has otherwise been determined to pose a hazard and which has been designated by the RCRA as a listed HW. RCRA defines a "solid" waste to include solid, semi-solid, liquid or contained gas (42 USC 6901).

In addition to HW as defined by RCRA, DOE manages some State-regulated HW and those wastes specified in the Toxic Substances Control Act (TSCA) (15 USC 2601). Special nuclear material and byproduct

materials, as defined by the Atomic Energy Act, are specifically excluded from definition of wastes defined under RCRA.

Most DOE HW consists of wastewater that contains less than a 1% concentration of organic HW materials. Nonwastewater HW consists of sludges, solids and organic liquids (water containing higher concentrations of organic HW than wastewater). Wastewater HW is generated as a result of operations such as metal cleaning, etching and plating. DOE currently treats wastewater HW onsite and will continue to do so in the future because wastewater is not difficult to treat, but is difficult and not cost-effective to transport. Wastewater HW is treated to regulatory standards and released into the environment (EI, 1993).

The remainder of this chapter focuses on the nonwastewater HW. DOE currently ships most of this HW offsite to commercial facilities for treatment and disposal, and two sites (ORR and INEL) have the capability to treat nonwastewater HW thermally. DOE needs to decide the extent to which it should continue its reliance on the offsite treatment of nonwastewater HW.

In accordance with RCRA, the U.S. Environmental Protection Agency (EPA) has established requirements for managing HW:

- HW must be treated before land disposal and is subject to land disposal restrictions (LDRs) "best demonstrated available technology" (BDAT) requirements (e.g., thermal treatment units).
- HW storage is allowed only for a limited time to accumulate sufficient quantities for treatment.
- Disposal facilities must meet RCRA minimum technology requirements.

DOE must make decisions within the framework of these requirements to ensure that adequate treatment is available for HW. These decisions involve the location and construction of DOE facilities, and the extent to which the commercial HW facilities should be utilized for nonwastewater HW.

10.1.2 VOLUMES AND LOCATIONS

HW has been generated, or is projected to be generated at most DOE sites. Naval Nuclear Propulsion Program sites identified in this document may generate HW. Their management of this waste type is not considered in this PEIS analysis, and they are not subject to associated decisions. Although HW generation from the production of nuclear weapons has essentially stopped, many chemicals and chemical residues

were abandoned or left in containers and process lines. These wastes must be treated to comply with Federal and State hazardous waste regulations. The projected generation of HW from ongoing DOE research and development activities will include chemical wastes, organic solvents from incomplete chemical reactions, sludges from degreasing operations, and heavy metals from unrecycled batteries.

Based on RCRA uniform HW shipping manifests (40 CFR 262.20), facility reports, and HW generation and disposal information dating back to 1984, DOE estimates that more than 90% of the total HW (wastewater and nonwastewater) in a given year is generated by 11 or fewer of the 54 DOE sites, although these 11 sites are not always the same every year. Table 10.1-1 provides the quantities of HW at the 11 large HW generators used for the evaluation of the WM PEIS alternatives. Onsite treatment and storage tonnage was derived from 1991 data in biennial and annual reports (40 CFR 262.41). The offsite shipments to commercial treatment were derived from fiscal year 1992 shipping manifests, and include only RCRA-defined wastes. The focus of the WM PEIS alternatives is on the RCRA-defined waste shipped offsite and waste thermally treated[1] or used for fuel burning onsite—approximately 3,440 metric tons, almost all of which is nonwastewater (DOE[2]).

For purposes of this PEIS analysis, DOE assumed that these volumes of HW are representative of DOE's current HW treatment requirements. Of the 3,440 metric tons of HW sent from DOE sites to commercial facilities for treatment in FY 1992, about half of this amount was thermally treated. Another third was treated offsite to recover either solvents (distillation) or energy (phase separation and fuel blending), and the remainder was treated by stabilization, metal removal and recovery, deactivation, and aqueous treatment methods.

Analysis in the WM PEIS assumes use of existing and planned treatment facilities until their capacities are met. If additional capacity is needed, use of new conceptual DOE facilities or offsite commercial facilities is assumed. These new conceptual commercial facilities provide the difference in treatment capacity between the baseline (ANL, 1996) and what is necessary to manage the waste received under any given alternative. Conceptual treatment facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). An assumption was made that the impact of operating existing/planned facilities is essentially identical to the impact of operating conceptual facilities.

[1] The form of thermal treatment discussed in this chapter is incineration.

[2] DOE (1995; 1994a-e; 1993a,b; 1992a-c; 1987; 1982).

Table 10.1-1. HW at 11 Large DOE Generators[a] (metric tons[b]/year)

DOE Site	Total Wastewater Treated Onsite[c]	Onsite Thermal Treatment and Fuel Burning[c]	Other Onsite Treatment and Storage[c]	Offsite Commercial Treatment[d]
ANL-E	0	0	2	206
Fermi	0	0	12	49
Hanford	0	0	140	302
INEL	33,000	35	80	160
KCP[e]	343,000	0	80	600
LANL	0	0	40	246
LLNL	250	0	230	629
ORR	624,000	66	14,600	207
Pantex	3,000	0	2,700	512
SNL-NM	130,000	0	0	153
SRS[e]	59,000	0	50	273
Total	1,192,250	101	17,934	3,337

[a] These sites represent the largest DOE HW generators for the time periods indicated. HW volumes generated vary annually among all sites, but these sites typically accounted for more than 90% of the DOE HW.
[b] Metric ton = 1,000 kilograms = 2,205 lb. One metric ton of HW is approximately one cubic meter in volume.
[c] Based on 1991 data taken from biennial and annual reports.
[d] Based on FY 1992 manifests. Includes only RCRA-defined waste; an additional 6,600 metric tons of TSCA, State-regulated HW, environmental restoration generated HW was shipped to commercial treatment in FY 1992.
[e] Excludes wastewater treatment of groundwater remediation waste reported in KCP and SRS biennial reports.

In addition to the RCRA-regulated HW shipped in FY 1992, 6,600 metric tons of TSCA, State-regulated HW, and HW generated as a result of environmental restoration activities were generated at DOE sites in 1992.[3] All of these wastes were sent offsite, with about one-third of these wastes sent to commercial facilities for treatment and the other two-thirds sent directly to RCRA and TSCA approved landfills for disposal.

[3] The extent to which the volume of HW generated as a result of environmental restoration activities could affect the WM PEIS analysis is discussed in Section 10.15.

10.2 Analytical Methods and Assumptions

10.2.1 Characteristics

DOE HW can be categorized as RCRA-defined wastes, State-regulated waste, and TSCA-defined wastes. HW that is classified as RCRA waste is further categorized into three groups as shown in Table 10.2–1. The principal State-regulated wastes that DOE manages are waste oils and petroleum contaminated soils. The primary TSCA wastes managed by DOE are polychlorinated biphenyls (PCBs) and asbestos.

10.2.2 Technologies and Treatment Processes

Under RCRA, all HW must be treated to meet certain standards before the waste (or its treatment residues) may be placed on the land for final disposal. These treatment standards may be either concentration-based or technology-based. EPA regulations identify the treatment technologies that EPA recognizes as appropriate for HW. These technologies serve as the basis for DOE treatment technology groups. The nine major treatment technology groups, along with a brief description of each, are as follows:

Organic Destruction. Destruction of organic liquids and solids can be accomplished by a broad spectrum of technologies that include the following subgroups: incineration, other thermal technologies (e.g., metal melting, plasma torch), biological treatment, and chemical destruction. Besides neutralizing toxic organic constituents of the waste, organic destruction can significantly reduce the primary waste volume.

Table 10.2–1. Three Categories of RCRA Hazardous Waste

Listed Hazardous Wastes	Characteristic Hazardous Wastes	Other Hazardous Wastes
• Nonspecific sources • Specific sources • Commercial chemical products—acutely hazardous • Commercial chemical products—nonacutely hazardous	• Ignitable • Corrosive • Reactive • Toxic	• Mixtures (hazardous and nonhazardous) • Derived from wastes (treatment residues) • Materials containing listed hazardous wastes

Aqueous Treatment. This group incorporates a number of specialized treatment technologies. Examples include biological treatment, wet oxidation, and chemical oxidation/reduction. These technologies are often very specialized and waste specific. As such, they are generally not as readily available on a commercial basis as some of the other treatment technologies.

Deactivation/Neutralization. The technologies in this group refer to processes that remove the hazardous characteristics of a waste when these characteristics are based on ignitability, explosivity, corrosivity, and/or reactivity. Commercially, deactivation/neutralization is most commonly employed in the neutralization of corrosive wastes, while deactivation is also the preferred technology for most reactive wastes.

Organic Removal/Recovery. Along with incineration, organic removal/recovery is one of the most common forms of commercial treatment for organic liquids. This group encompasses a wide range of technologies including solvent recycling and distillation, fuel substitution (organic liquid hazardous wastes with high energy content are substituted for virgin fuels in industrial equipment permitted by EPA to burn hazardous waste fuel), carbon absorption, steam stripping, liquid-liquid extraction, and chemical/physical phase separation. Of the above, solvent distillation and fuel substitution are the most readily available on a commercial basis.

Metal Removal/Recovery. This technology group incorporates processes that are designed to remove and/or recover heavy metals present in RCRA wastes. The technologies most commonly used for metal removal/recovery include ion exchange, resin or solid adsorption, reverse osmosis, chelation/solvent extraction, ultrafiltration, and/or simple chemical precipitation. Some thermal processes may be used as well. Frequently, some form of physical phase separation or concentration techniques such as decantation, filtration and centrifugation are used in conjunction with the technologies noted above.

Mercury Recovery/Removal. As a technology group, mercury recovery/removal is actually a subset of the metal removal/recovery treatment technology group. From a practical standpoint, it is addressed separately because the commercial facilities that manage waste with high levels of mercury are usually very specialized. The actual technologies employed include amalgamation and recovery, mercury retorting, and thermal treatment with specialized control equipment.

Stabilization/Solidification. Stabilization and/or solidification refers to processes that tend to immobilize waste through chemical and/or physical means. Stabilization is one of the most common forms of treatment for inorganic wastes. Stabilization occurs when HW is mixed with a solidification agent such as Portland cement, fly ash, or cement kiln dust to form a solid. Stabilization generally requires a special design mix between the waste and the solidification agent to ensure that the concentration based LDRs standards are met. Stabilization is generally followed by land disposal at a HW landfill.

Recycling. Many of the technologies and technology groups described above incorporate some type of recycling (e.g., metal removal/recovery, organic removal/recovery, etc.). Recycling, in the context of the WM PEIS, refers to the use of materials that would otherwise be a hazardous waste as a direct substitute for raw materials. Most waste that meets these criteria would be exempt from regulation under RCRA although many States would require that a HW shipping manifest be used when the waste is transported.

Land Disposal. Though not an actual form of treatment and not evaluated in the WM PEIS alternatives, land disposal is included as a technology group and discussed here since some direct disposal of HW in permitted landfills still occurs. The types of HW that might be deposited directly into a landfill include newly identified wastes (wastes that have been identified since 1984) for which no treatment standards have been established (e.g., 25 newly identified Toxicity Characteristic Leaching Procedure organic wastes) and wastes that are covered by a variance under the LDRs.

10.2.3 WM PEIS Assumptions: Facilities, Treatment, and Disposal

Key assumptions and considerations used in the WM PEIS to characterize HW, develop treatment alternatives, and analyze associated impacts include the following:

- Wastewater HW, previously buried or disposed HW, waste generated by environmental restoration activities, or waste generated as a result of decontamination operations are not part of the HW loads considered in the WM PEIS and are not included in the HW alternatives analysis.
- Wastewater HW will continue to be treated onsite at DOE facilities.
- Future HW generation rates are assumed to be the same as those identified in Table 10.1-1.
- Factors that could result in a decline in the quantities of HW (e.g., waste minimization efforts, reconfiguration of the DOE Nuclear Weapons Complex, reductions in generated HW from cancellation of DOE weapons programs) will not affect the analysis of the HW alternatives.

- Factors that could result in an increase in HW quantities (e.g., reclassification of low-level mixed waste (LLMW) or HW generated from the dismantlement of weapons) will not affect the analysis of the HW alternatives.
- Since onsite storage of HW is limited under RCRA to 90 days without a RCRA Part B permit, HW inventories will not accumulate at generator sites.
- The estimated cost associated with the commercial treatment of HW assumes that the treated residue is disposed of in compliance with applicable Federal and State LDRs.

10.3 Hazardous Waste Alternatives

The WM PEIS HW analysis considers four alternatives for treatment facilities within the broad categories of management alternatives: No Action, Decentralized, and two Regionalized. The alternatives were selected to provide representative results for the range of onsite options. Thus, the alternatives evaluate 3%, 9%, 50%, and 90% of the DOE RCRA waste (excluding wastewater) being treated onsite. The Centralized Alternative for the management of HW was not considered a prudent alternative from the standpoint of cost, health risk, and environmental or socioeconomic impacts and from the standpoint of a number of practical considerations, such as the significant amount of transportation that would be required even under the best waste minimization programs. The foldout table at the end of this chapter shows the sites at which HW would be treated under each alternative. The table is designed to be used as a quick reference when reading the HW impact sections.

Each of the alternatives was developed in order to capture and quantify the human health risks, environmental impacts, and costs associated with the range of HW treatment options available to DOE and to provide input for a decision about whether to continue to rely on offsite treatment of HW.

Public and worker risks and environmental impacts were not analyzed quantitatively for commercial treatment facilities for all four alternatives. Each of those facilities has obtained its own RCRA permit, which involved separate risk assessments done in support of the permitting process. In addition, the DOE portion of the annual waste processed by those facilities is less than 5% per year.

10.3.1 No Action Alternative

Under this alternative, the current operations would be maintained. HW that is currently being treated onsite at DOE facilities (e.g., incineration of organic materials at ORR and INEL) will continue to be treated onsite, and other HW will continue to be treated offsite at commercial facilities. Figure 10.3–1 and Table 10.3–1 illustrate the No Action Alternative.

HW No Action Alternative (Treatment of 3% of Nonwastewater HW at 2 Sites; 97% at Commercial Facilities)

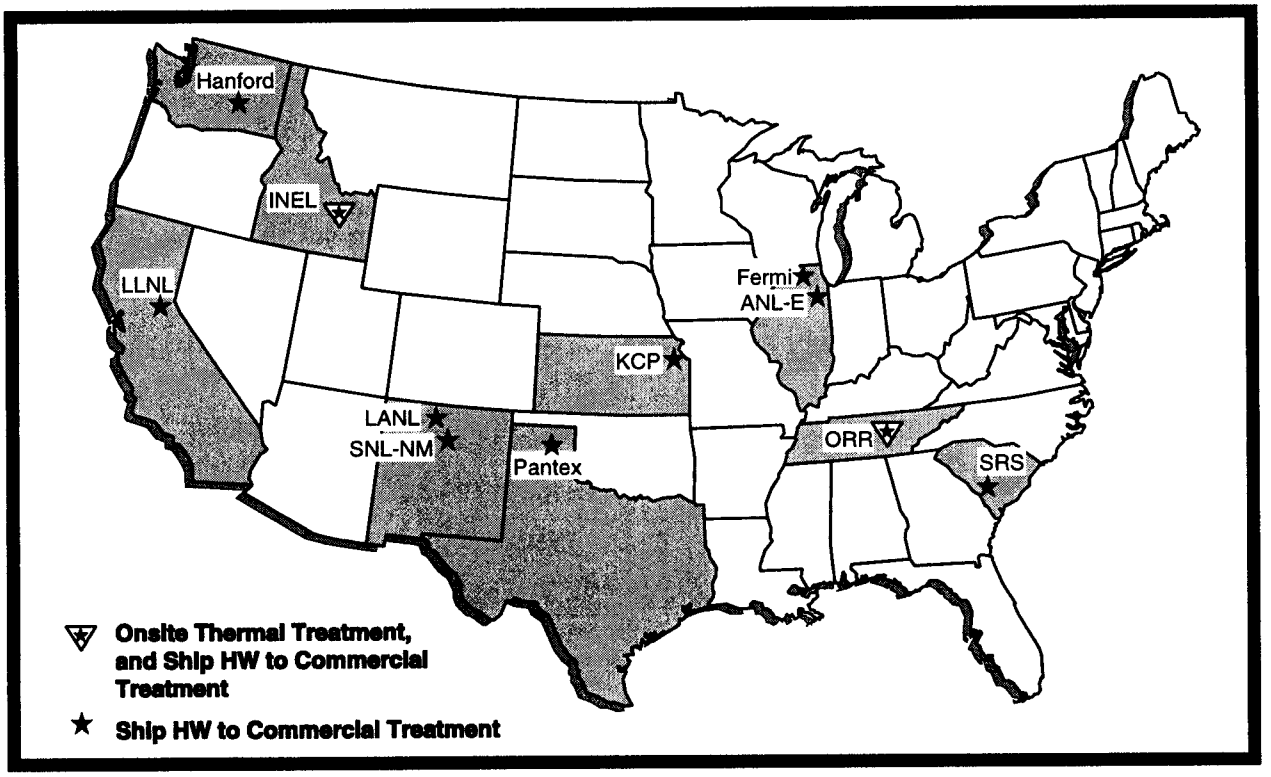

Figure 10.3–1. HW No Action Alternative

	Generating Sites		
	INEL	ORR	ANL-E, Fermi, Hanford, INEL, KCP, LANL, LLNL, ORR, Pantex, SNL-NM, SRS
Treat	INEL	ORR	Commercial treatment

Table 10.3–1. HW No Action Alternative

10.3.2 DECENTRALIZED ALTERNATIVE

Under this alternative, DOE would implement thermal treatment at the Idaho National Engineering Laboratory (INEL), the Oak Ridge Reservation (ORR), and the Savannah River Site (SRS). DOE modified the Decentralized Alternative to replace LANL with INEL as a candidate site for onsite treatment of HW. This change reflects the fact that INEL currently has thermal HW treatment capacity, while LANL does not. In addition, the use of commercial facilities would continue as needed, with greater DOE controls on the number of facilities used, the services provided, and the performance delivered. The use of brokers, companies that consolidate HW from more than one customer to reduce storage and improve the economics of shipping, would be reduced. Brokering of HW usually increases total transport miles to get a waste package from the generator to the facility site because the packages are frequently brought to a collection site to be sorted and combined with similar packages for shipment to a facility location.

The main difference between the No Action and Decentralized Alternatives is a 6% shift in the waste totals for thermal treatment and fuel substitution from offsite treatment (No Action) to onsite treatment (Decentralized). Because of this relatively small difference, the No Action and Decentralized Alternatives are discussed together.

The waste management strategy for the No Action and Decentralized Alternatives can be summarized as follows:

- Package HW and ship it to commercial treatment facilities.
- Maintain and operate existing and planned DOE HW storage facilities and limited treatment facilities at DOE sites in accordance with applicable permit requirements for treatment facilities.
- Minimize generation of HW to the greatest extent possible.
- The Decentralized Alternative would involve thermal treatment at three sites (INEL, SRS, and ORR).

Figure 10.3–2 illustrates the Decentralized Alternative. Table 10.3–2 shows that most of the HW loads at the major HW sites would be transferred to commercial facilities. Except for wastes to be thermally treated or treated through fuel burning at INEL, ORR, and SRS, most wastes generated by the other major sites would also be sent to commercial facilities. The change of use in facilities between the No Action and Decentralized Alternatives is summarized in Table 10.3–3. The total net change in going from the No Action to the Decentralized Alternatives would be an increase of approximately 180 metric tons/yr in thermal treatment and 43 metric tons/yr in onsite fuel burning.

HW Decentralized Alternative (Treatment of 9% of Nonwastewater HW at 3 DOE Sites; 91% at Commercial Facilities)

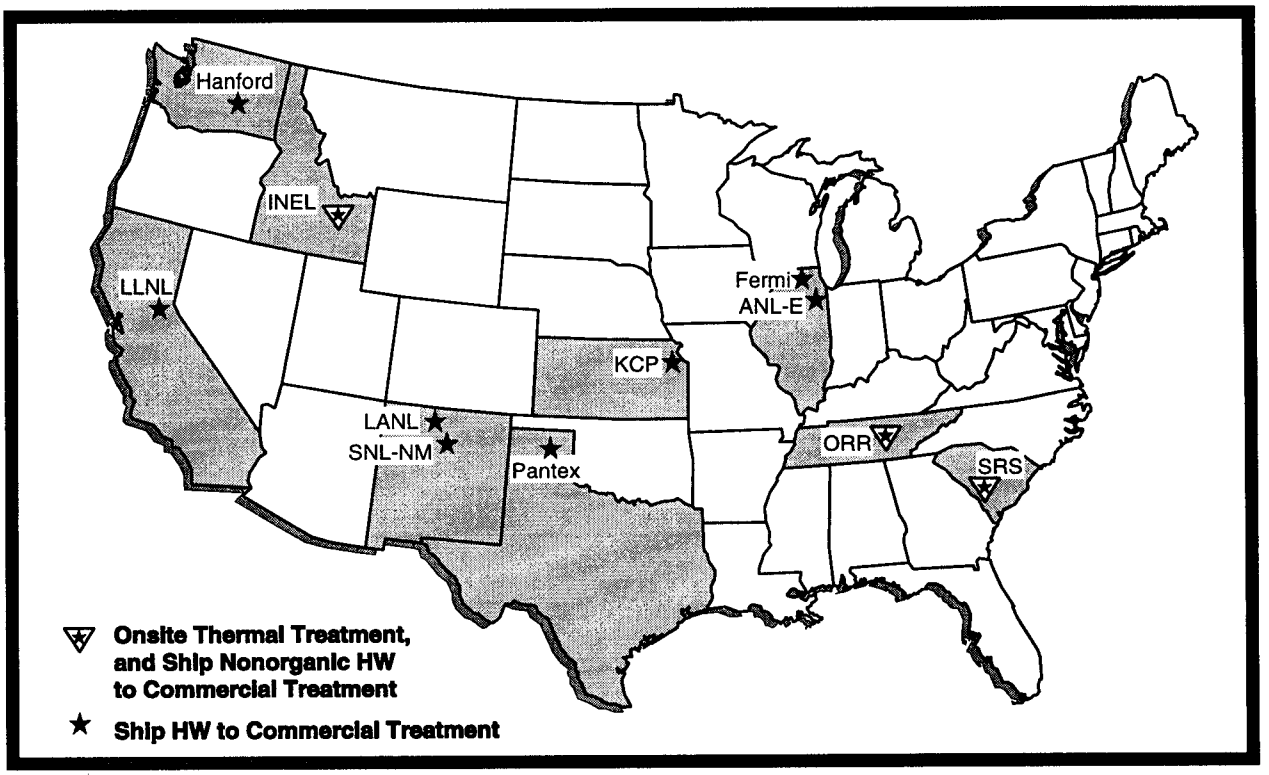

Figure 10.3–2. HW Decentralized Alternative

	Generating Sites			
	INEL	ORR	SRS	ANL-E, Fermi, Hanford, INEL, KCP, LANL, LLNL, ORR, Pantex, SNL-NM, SRS
Treat	INEL	ORR	SRS	Commercial treatment

Table 10.3–2. HW Decentralized Alternative

Table 10.3–3. Change in Use of Onsite Thermal Destruction and Waste-Fuel Burning Under No Action and Decentralized Alternatives

Site and Treatment	HW Treated by Thermal Destruction and Fuel Burning (metric tons/year)	
	No Action Alternative	Decentralized Alternative
INEL		
Thermal treatment	17.4	17.4
Fuel burning	17.4	17.4
ORR		
Thermal treatment	53.203	116.6
Fuel burning	12.6	27.7
SRS		
Thermal treatment	0	116.6
Fuel burning	0	27.7
Total		
Thermal treatment	70.6	250.6
Fuel burning	30.0	72.8

Tables 10.3–4 and 10.3–5 depict the No Action and Decentralized Alternatives in terms of HW treatment by treatment technology group for the major DOE HW sites. The treatment technology group of Organic Removal/Recovery involves three types of treatments: fuel blending, fuel burning, and solvent recycling. Because HW treated by fuel blending is ultimately burned, the amounts for fuel blending are included in the fuel burning row. The totals for treatment at commercial facilities are based on the overall amounts shipped offsite for FY 1992.

10.3.3 Regionalized Alternatives

Under Regionalized Alternative 1, half of the HW generated by 11 major HW sites would be retained and treated at five onsite DOE treatment centers or hubs: Hanford, INEL, LANL, ORR, and SRS. Each regional hub would be permitted under RCRA and onsite treatment facilities would be constructed for thermal treatment and organic removal/recovery. Figure 10.3–3 and Table 10.3–6 illustrate Regionalized Alternative 1.

Table 10.3-4. No Action Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ANL-E											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	72.0	0	0	1.2	19.0	20.0	3.4	90.0	0	0	205.6
Site total	**72.0**	**NA**	**0**	**1.2**	**19.0**	**20.0**	**3.4**	**90.0**	**0**	**0**	**205.6**
Fermi											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	28.0	0	0	10.6	2.2	7.5	0.1	0.6	0	0	49.0
Site total	**28.0**	**NA**	**0**	**10.6**	**2.2**	**7.5**	**0.1**	**0.6**	**0**	**0**	**49.0**
Hanford											
Onsite	0	0	0	0	0	0	0	0	0[e]	0	0
Commercial	22.0	0	151.8	78.2	3.0	45.0	0.1	1.5	0[e]	0.7	302.3
Site total	**22.0**	**NA**	**151.8**	**78.2**	**3.0**	**45.0**	**0.1**	**1.5**	**0[e]**	**0.7**	**302.3**
INEL											
Onsite	17.4	30.5	17.4	0	0	0	0	0	0	0	34.8
Commercial	93.5	0	13.1	15.7	9.3	15.0	7.4	1.7	3.7	0.5	159.9
Site total	**110.9**	**NA**	**30.5**	**15.7**	**9.3**	**15.0**	**7.4**	**1.7**	**3.7**	**0.5**	**194.7**
KCP											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	380.0	0	70.0	35.0	50.0	12.0	50.0	2.5	1.0	0	600.5
Site total	**380.0**	**NA**	**70.0**	**35.0**	**50.0**	**12.0**	**50.0**	**2.5**	**1.0**	**0**	**600.5**
LANL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	48.0	110.0	110.0	56.4	11.0	13.5	2.0	4.0	0	0.7	245.6
Site total	**48.0**	**NA**	**110.0**	**56.4**	**11.0**	**13.5**	**2.0**	**4.0**	**0**	**0.7**	**245.6**
LLNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	268.0	0	160.3	82.7	57.0	1.2	5.3	4.3	48.0	2.0	628.8
Site total	**268.0**	**NA**	**160.3**	**82.7**	**57.0**	**1.2**	**5.3**	**4.3**	**48.0**	**2.0**	**628.8**

Table 10.3–4. No Action Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)—Continued

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ORR											
Onsite	53.2	42.7	12.6	0	0	0	0	0	0	0	65.8
Commercial	102.3	0	30.1	22.8	13.0	20.8	10.4	2.3	5.0	0.7	207.4
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Pantex											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	319.0	0	0	26.0	60.0	106.1	0	0.6	0	0	511.7
Site total	**319.0**	**NA**	**0**	**26.0**	**60.0**	**106.1**	**0**	**0.6**	**0**	**0**	**511.7**
SNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	93.0	0	0	17.0	24.0	11.0	5.5	0.9	0	1.5	152.9
Site total	**93.0**	**NA**	**0**	**17.0**	**24.0**	**11.0**	**5.5**	**0.9**	**0**	**1.5**	**152.9**
SRS[d]											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	155.5	42.7	42.7	22.8	13.0	20.8	10.4	2.3	0.5	0.7	273.2
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**0.5**	**0.7**	**273.2**
Total											
Onsite	70.6	NA	30.0	0	0	0	0	0	0	0	100.6
Commercial	1,581.3	NA	578	368.4	261.5	272.9	94.6	110.7	62.7	6.8	3,336.9
Site Total	**1,651.9**	**NA**	**608**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.

[a] Assumes that this technology was the appropriate technology for 1992 amounts incinerated. Much of this waste could have gone to removal and recovery of organics or was corrosive and could have been deactivated.

[b] The amount blended was not counted in the total waste amount generation; amount was counted when burned as fuel.

[c] At each location, some of these solvents (approximately 10%) were also recycled by Safety-Kleen.

[d] Waste amounts were derived from manifests. Because of the moratorium, the precise amount of actual waste generated cannot be determined at this time. For this table, amounts for SRS are assumed to be the same as those for ORR.

Table 10.3–5. Decentralized Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Site and Location of HW Treatment	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ANL-E											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	72.0	0	0	1.2	19.0	20.0	3.4	90.0	0	0	205.6
Site total	**72.0**	**NA**	**0**	**1.2**	**19.0**	**20.0**	**3.4**	**90.0**	**0**	**0**	**205.6**
Fermi											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	28.0	0	0	10.6	2.2	7.5	0.1	0.6	0	0	49.0
Site total	**28.0**	**NA**	**0**	**10.6**	**2.2**	**7.5**	**0.1**	**0.6**	**0**	**0**	**49.0**
Hanford											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	22.0	0	151.8	78.2	3.0	45.0	0.1	1.5	0	0.7	302.3
Site total	**22.0**	**NA**	**151.8**	**78.2**	**3.0**	**45.0**	**0.1**	**1.5**	**0**	**0.7**	**302.3**
INEL											
Onsite	17.4	0	17.4	0	0	0	0	0	0	0	34.8
Commercial	93.5	0	13.1	15.7	9.3	15.0	7.4	1.7	3.7	0.5	159.9
Site total	**110.9**	**NA**	**30.5**	**15.7**	**9.3**	**15.0**	**7.4**	**1.7**	**3.7**	**0.5**	**194.7**
KCP											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	380.0	0	70.0	35.0	50.0	12.0	50.0	2.5	1.0	0	600.5
Site total	**380.0**	**NA**	**70.0**	**35.0**	**50.0**	**12.0**	**50.0**	**2.5**	**1.0**	**0**	**600.5**
LANL											
Onsite	0[d]	0	0	0	0		0	0	0	0	0
Commercial	48.0	110.0	110.0	56.4	11.0	13.5	2.0	4.0	0	0.7	245.6
Site total	**48.0**	**NA**	**110.0**	**56.4**	**11.0**	**13.5**	**2.0**	**4.0**	**0**	**0.7**	**245.6**
LLNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	268.0	0	160.3	82.7	57.0	1.2	5.3	4.3	48.0	2.0	628.8
Site total	**268.0**	**NA**	**160.3**	**82.7**	**57.0**	**1.2**	**5.3**	**4.3**	**48.0**	**2.0**	**628.8**

Table 10.3-5. Decentralized Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)—Continued

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ORR											
Onsite	116.6[e]	42.7	27.7	0	0	0	0	0	0	0	144.3
Commercial	38.9	0	15.0	22.8	13.0	20.8[c]	10.4	2.3	5.0	0.7	128.9
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Pantex											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	319.0	0	0	26.0	60.0	106.1	0	0.6	0	0	511.7
Site total	**319.0**	**NA**	**0**	**26.0**	**60.0**	**106.1**	**0**	**0.6**	**0**	**0**	**511.7**
SNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	93.0	0	0	17.0	24.0	11.0	5.5	0.9	0	1.5	152.9
Site total	**93.0**	**NA**	**0**	**17.0**	**24.0**	**11.0**	**5.5**	**0.9**	**0**	**1.5**	**152.9**
SRS[f]											
Onsite	116.6[e]	42.7	27.7	0	0	0	0	0	0	0	144.3
Commercial	38.9	0	15.0	22.8	13.0	20.9	10.4	2.3	5.0	0.7	128.9
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.9**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Total											
Onsite	250.6	NA	72.8	0	0	0	0	0	0	0	323.4
Commercial	1,401.3	NA	535.2	368.4	261.5	272.9	94.6	110.7	62.7	6.8	3,114.1
Total	**1,651.9**	**NA**	**608**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.

[a] Assumes that this technology was the appropriate technology for 1992 amounts thermally treated. Much of this waste could have gone to removal and recovery of organics or was corrosive and could have been deactivated.

[b] The amount blended was not counted in the total waste amount generation; amount was counted when burned as fuel.

[c] At each location, some of these solvents (assuming approximately 10%) were also recycled by Safety-Kleen.

[d] Assumes onsite thermal treatment can destroy 50% of generated liquid HW that can be thermally treated.

[e] Assumes that onsite thermal treatment at ORR and SRS can destroy 75% of generated liquid HW that can be thermally treated.

[f] Waste amounts were derived from manifests. The precise amount of actual waste generated cannot be determined at this time. For this table, amounts for SRS are assumed to be the same as those for ORR.

HW Regionalized Alternative 1 (Treatment of 50% of Nonwastewater HW at 5 DOE Sites; 50% at Commercial Facilities)

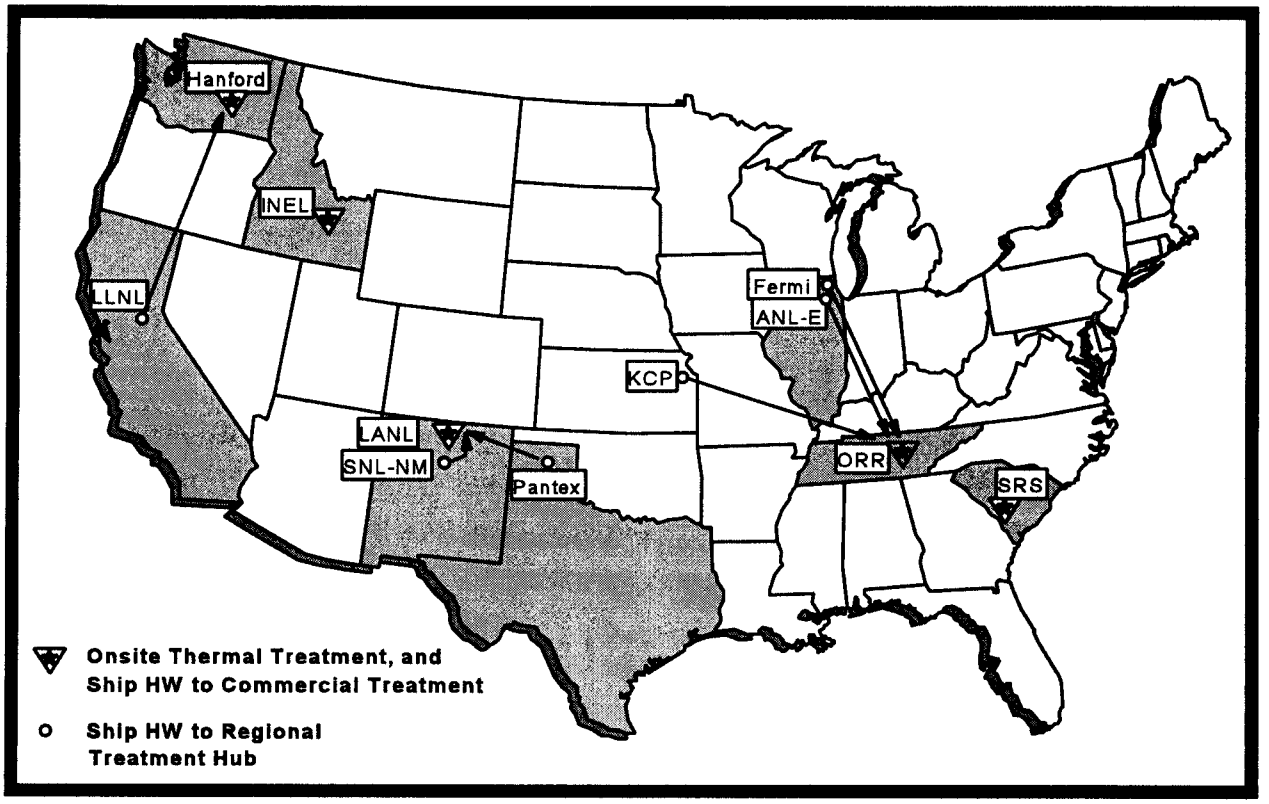

Figure 10.3–3. HW Regionalized Alternative 1

	Generating Sites					
	Hanford, LLNL	INEL	LANL, Pantex, SNL-NM	ANL-E, Fermi, KCP, ORR	SRS	Hanford, INEL, LANL, ORR, SRS
Treat	Hanford	INEL	LANL	ORR	SRS	Commercial treatment

Table 10.3–6. HW Regionalized Alternative 1

Data for Regionalized Alternative 1 are presented in Table 10.3–7. Under this alternative, HW that could be treated through the organic removal/recovery technologies would be sent to five regional hub sites from the major generating sites. The hub sites would treat two-thirds of the received HW and send the other one-third to commercial facilities. For HW that could be treated through thermal treatment, two-thirds would be sent to the regional hubs from the generating sites, and the other third would be sent directly to commercial thermal treatment facilities from the generating sites. The amounts of HW to be treated by the various treatment technology groups at the regional hubs and associated commercial facilities are shown in the table. Approximately 50% of the estimated 3,437 metric tons of HW listed in Table 10.3–7 would be treated at DOE HW facilities.

Under Regionalized Alternative 2, DOE would build facilities at INEL and ORR for organic treatment and deactivation/neutralization. Figure 10.3–4 illustrates Regionalized Alternative 2. All HW treatable in these facilities would be shipped from the other sites presented in Table 10.3–8. Metal recovery and recycling, battery recycling, stabilization, and land disposal would continue to be provided by offsite commercial establishments.

Under Regionalized Alternative 2, all deactivation waste would be treated at the appropriate hub, with INEL the only hub expected to receive such waste. The Pantex Plant, LANL, LLNL, the Sandia National Laboratories-New Mexico (SNL-NM) and the Nevada Test Site (NTS) would ship to INEL for thermal deactivation. Approximately 90% or 3,058 metric tons of HW listed in Table 10.3–9 would be treated at DOE HW facilities.

10.3.4 CENTRALIZED ALTERNATIVE

A single site Centralized Alternative for the management of HW was not considered in this PEIS because the DOE decision of concern is whether DOE should continue to use commercial facilities for the treatment and disposal of HW, or construct its own facilities. Current policy is the decentralized or regionalized use of commercial facilities. This PEIS seeks to compare decentralization and regionalization of proposed DOE facilities to the current HW practices.

Table 10.3-7. Regionalized Alternative 1: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Hub	Organic Destruction by Thermal Treatment[a]	Organic Removal/Recovery[b]			Stabilization	Deactivation	Metal Removal/ Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
Hanford Hub (Hanford; LLNL)											
Onsite	191.5	(312.0)[d]	206.0	106.0	0	0	0	0	0	0	503.5
Commercial	98.5	0	106.1	54.9	60.0	46.2	5.4	5.8	48.0	2.7	427.6
Hub total	**290.0**	**NA**	**312.1**	**160.9**	**60.0**	**46.2**	**5.4**	**5.8**	**48.0**	**2.7**	**931.1**
INEL Hub (INEL)											
Onsite	73.2	(30.5)[d]	30.5	0	0	0	0	0	0	0	103.7
Commercial	37.7	0	0	15.7	9.3	15.0	7.4	1.7	3.7	0.5	91.0
Hub total	**110.9**	**NA**	**30.5**	**15.7**	**9.3**	**15.0**	**7.4**	**1.7**	**3.7**	**0.5**	**194.7**
Los Alamos Hub (LANL; SNL; Pantex)											
Onsite	303.6	(137.6)[d]	73.3	66.3	0	0	0	0	0	0	443.2
Commercial	156.4	0	36.7	33.1	95.0	130.6	7.5	5.5	0	2.2	467.0
Hub total	**460.0**	**NA**	**110.0**	**99.4**	**95.0**	**130.6**	**7.5**	**5.5**	**0**	**2.2**	**910.2**
Oak Ridge Hub (ORR; Fermi; KCP; ANL-E)											
Onsite	420.0	(120.4)[d]	75.1	46.4	0	0	0	0	0	0	538.8
Commercial	215.5	0	37.6	23.2	84.2	60.3	63.9	95.4	6.0	0.7	589.5
Hub total	**635.5**	**NA**	**112.7**	**69.6**	**84.2**	**60.3**	**63.9**	**95.4**	**6.0**	**0.7**	**1,128.3**
Savannah Hub (SRS)											
Onsite	102.6	(42.7)[d]	28.0	15.0	0	0	5.2	0	0	0	150.8
Commercial	52.9	0	14.7	7.8	13.0	20.8	5.2	2.3	5.0	0.7	122.4
Hub total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Total											
Onsite	1,090.9	(643.2)[d]	412.9	233.7	0	0	5.2	0	0	0	1,738.1
Commercial	560.9	(0)	195.1	134.7	261.5	272.9	89.5	110.7	62.7	6.8	1,698.2
Total	**1651.9**	**NA**	**608**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3437.5**

Notes: Hg = mercury; NA = not applicable.

[a] Assumes that 2/3 of all material that can be thermally treated is thermally treated at regional hub and 1/3 at commercial facilities.

[b] Assumes that 2/3 of removal and recovery of organics is conducted onsite at regional hub and 1/3 at commercial facilities.

[c] Some of these solvents (approximately 10%) are also recycled by Safety-Kleen at each individual site location.

[d] This amount was not counted on overall treatment totals when blended. Rather, amount was counted when burned as fuel.

HW Regionalized Alternative 2 (Treatment of 90% of Nonwastewater HW at 2 DOE Sites; 10% at Commercial Facilities)

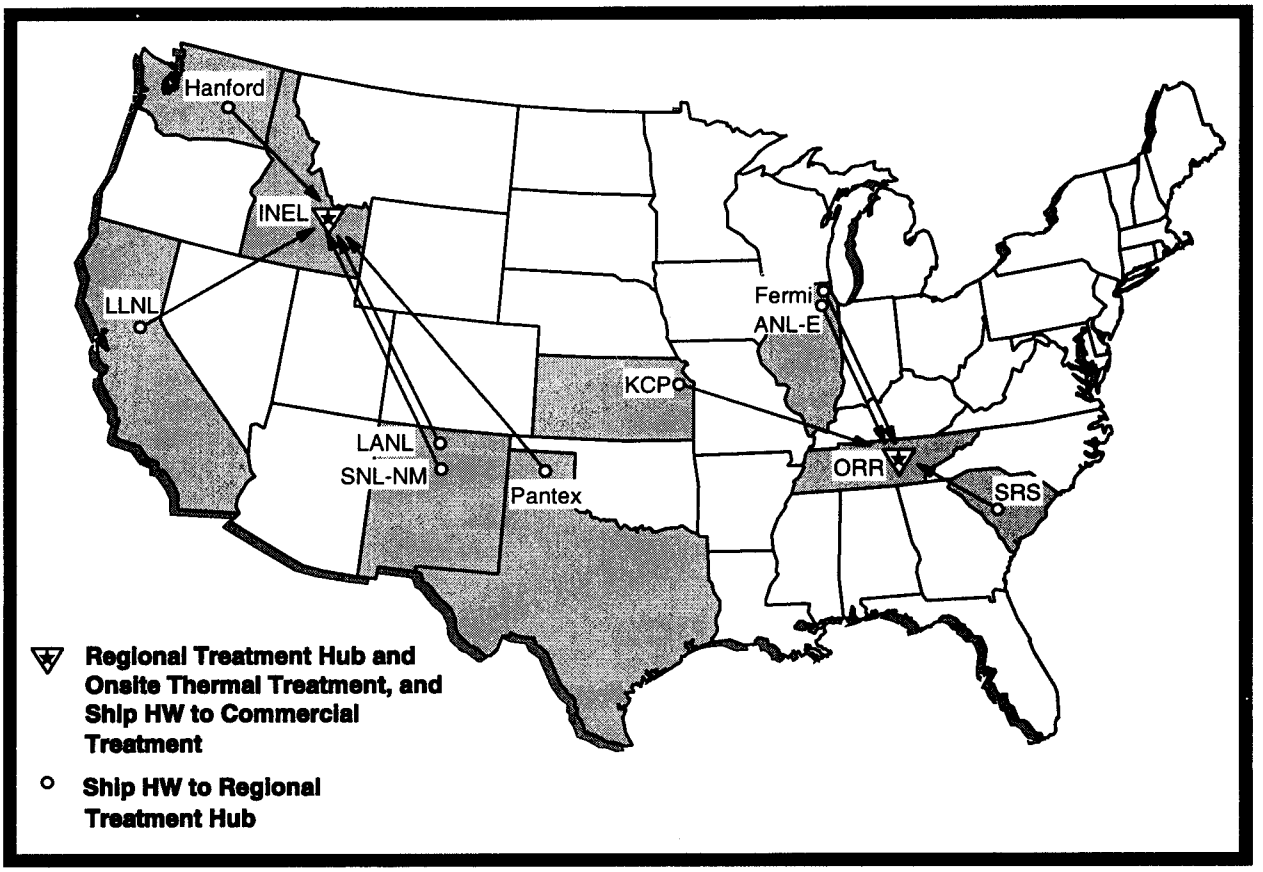

Figure 10.3–4. HW Regionalized Alternative 2

	Generating Sites		
	Hanford, INEL, LANL, LLNL, Pantex, SNL-NM	ANL-E, Fermi, KCP, ORR, SRS	INEL, ORR
Treat	INEL	ORR	Commercial treatment

Table 10.3–8. HW Regionalized Alternative 2

Table 10.3-9. Regionalized Alternative 2: HW Treatment for 11 Large HW Sites (in metric tons)

Hub and Location of HW Treatment	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending	Fuel Burning	Solvent Recycling[b]			Non-Hg	Hg			
INEL Hub (western region) (Hanford; INEL; LLNL; LANL; SNL-NM; Pantex)											
Onsite	860.9	(445.0)[c]	452.6	276.0	0	191.8	20.3	0	51.7	0	1,853.3
Commercial	0	0	0	0	164.3	0	0	13.0	0	5.4	182.7
Hub total	**860.9**	**NA**	**452.6**	**276.0**	**164.3**	**191.8**	**20.3**	**13.0**	**51.7**	**5.4**	**2,036.0**
ORR Hub (eastern region) (KCP; Fermi; ANL-E; SRS; ORR)											
Onsite	791.0	(163.0)[c]	155.4	92.4	0	81.1	74.3	0	11.0	0	1,205.2
Commercial	0	0	0	0	97.2	0	0	97.7	0	1.4	196.3
Hub total	**791.0**	**NA**	**155.4**	**92.4**	**97.2**	**81.1**	**74.3**	**97.7**	**11.0**	**1.4**	**1,401.5**
Total											
Onsite	1,651.9	(608.0)[c]	608.0	368.4	0	272.9	94.6	0	62.7	0	3,058.5
Commercial	0	(0)	0	0	261.5	0	0	110.7	0	6.8	379.0
Total	**1,651.9**	**NA**	**608.0**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.

[a] In some cases, attaining 90% onsite treatment without conducting stabilization and land disposal may not be possible.

[b] Some solvents (approximately 10%) would still be handled on a decentralized basis through Safety-Kleen.

[c] This amount is only counted in total when burnt as fuel.

The Regionalized 2 Alternative includes waste treatment using two sites, one east and one west of the Mississippi River. These locations are reasonable locations considering that DOE sites are spread throughout the continental United States. Treatment at two sites would lead to risk and cost reductions over using a single U.S. site.

10.3.5 RATIONALE FOR SELECTION OF SITES

The HW treatment alternatives were selected to cover the range of reasonable alternatives based on two primary criteria: (1) site experience with key HW treatment technologies, and (2) location of sites. As in the case of evaluating alternatives for the management of the radioactive waste types, consideration was given to avoiding the introduction of HW to DOE sites for treatment that do not generate HW. These criteria and considerations serve to minimize the costs and impacts associated with the alternatives and sites selected.

The technologies evaluated for onsite treatment of HW are thermal treatment, fuel burning, and deactivation. Five of the sites listed in Table 10.3-1 for the No Action Alternative (current HW management approach)—the Hanford Site, INEL, LANL, ORR, and SRS—have operated or plan to operate thermal treatment systems.

Regionalized Alternative 1 uses the five DOE sites with the operational or planned thermal treatment systems satisfying the criterion for site technology experience. The location criterion is addressed in that the five sites are somewhat regionally distributed which serves to minimize transportation of HW and associated risks.

Regionalized Alternative 2 is based on using two sites for HW treatment. The two sites proposed, INEL and ORR, satisfy the technology experience criterion since they are among the five sites discussed above, and their locations (west and east in the United States) require the least transportation of HW compared to other site combinations. Onsite deactivation, or neutralizing, also considered in this alternative, is planned for the two hub-sites.

In calculating the mileage traveled in each HW alternative, the mileage to commercial facilities was included along with the mileage to DOE hub facilities. In this way, total mileage is calculated from the shipper to the location where final treatment takes place. A set of commercial facilities was chosen to represent the most probable choices of commercial facilities nearby, considering the types of waste needing treatment at the various DOE facilities.

10.4 Health Risks

The health risk estimates include a fraction of a single fatality for each of the proposed HW alternatives from vehicle accidents associated with HW transportation. The Regionalized Alternatives result in greater worker exposure to HW chemicals than the No Action and Decentralized Alternatives because DOE treats more HW under the Regionalized Alternatives. This analysis did not evaluate the risk to workers at commercial facilities which are the principal HW treatment facilities under the No Action and Decentralized Alternatives. It is expected that HW worker risks would be the same regardless of whether commercial or DOE facilities are used. In view of this, there is no significant difference between the alternatives with regard to HW worker risk.

Health risk impacts can result from exposure to hazardous chemicals and from physical trauma associated with constructing and operating treatment facilities or transporting waste. This section discusses the estimated adverse health impacts resulting from chemical exposure as well as the physical hazards for each HW treatment alternative. Details of the HW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5 and in ORNL technical reports (ORNL, 1995a-c). Potential health risks to a number of receptor populations and individuals are reported including:

- The offsite population—those individuals living within a 50-mile radius of the site, as well as along transportation routes
- Noninvolved workers population—the workers on DOE sites who are not involved directly in waste management activities.
- Waste management worker population (or "waste management workers")—onsite employees working in a site's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and

trains that transport the waste. Although DOE treats more of its HW under the Regionalized Alternatives, whereas commercial HW treatment facilities are used under the No Action and Decentralized Alternatives, worker risk is assumed to be similar whether HW treatment is conducted at a DOE or a commercial facility.

10.4 Health Risks
10.5 Air Quality Impacts
10.6 Water Resources Impacts
10.7 Ecological Resources Impacts
10.8 Economic Impacts
10.9 Population Impacts
10.10 Environmental Justice Concerns
10.11 Land Use Impacts
10.12 Infrastructure Impacts
10.13 Cultural Resources Impacts
10.14 Costs
10.15 Environmental Restoration Analysis
10.16 Comparison of Alternatives Summary

- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose.
- A most-exposed waste management worker— an individual who would experience potential noncancer effects, as estimated using the Exposure Index, following exposure to HW.
- The human health and environmental impacts at and surrounding the commercial facilities involved in hazardous waste treatment were not considered quantitatively in this WM PEIS. Each of those facilities has obtained its own RCRA permit, which involved separate risk assessments done in support of the permitting process. In addition, the DOE portion of the annual waste processed by those facilities is less than 5% per year.

Maximally Exposed Individual

In keeping with standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of treatment operations analyzed in the WM PEIS.

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer incidence from chemical exposure
- Noncancer effects from chemical exposure (for example, headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for a further discussion of these issues.

10.4.1 Routine Operation Impacts

For operations involving HW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in HW treatment ("noninvolved workers"), and waste management workers directly involved in treatment activities. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts. Table 10.4–1 presents the sizes of offsite populations and waste management treatment worker populations used in the health risk analysis.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented.

Individual impacts focus on the *probability* that the "maximally exposed individual" (MEI) within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk

Table 10.4–1. Offsite and Waste Management Treatment Worker Populations

Site	Offsite Population[a]	WM Treatment Worker Population by Alternative[b]			
		No Action	Decentralized	Regionalized 1	Regionalized 2
Hanford	377,645	--	--	91	--
INEL	153,061	16	16	35	160
LANL	159,152	--	--	88	--
ORR	881,652	36	36	101	212
SRS	620,618	--	--	40	--

Note: -- = no waste treatment at this site under this alternative.
[a] Within 50-mile radius of sites.
[b] Waste management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation periods.

is presented as a probability (e.g., one in one million, or 1E–06) of that individual experiencing an adverse health impact, rather than the total number of impacts for a selected population.

DOE analyzed the potential effects of exposure to hazardous chemicals on the receptor groups. The pathways of exposure analyzed were inhalation of contaminated air and ingestion of contaminated plants and animals.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment facilities, and a subsequent 10-year period of operation. However, worker and public risks from exposure to chemicals (received during the 10-year operation period) were evaluated for an entire lifetime (70 years), because health impacts from airborne contaminants could occur throughout the lifetime of the exposed individual.

Table 10.4–2 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for HW treatment.

Table 10.4–2. HW Health Risk Analysis Components

Endpoints	Receptor	Source	Pathways	Exposure Period	Table References
Number of Trauma Fatalities	WM Workers	Physical Hazards	Physical Hazards	20 years	Text only
Number of Cancer Incidences	Offsite Population	Chemicals	Inhalation, Ingestion	10 years	10.4–3
	Noninvolved Workers		Inhalation		
	WM Workers		Inhalation		
Probability of Cancer Incidence	Offsite MEI	Chemicals	Inhalation, Ingestion	10 years	10.4–4
	Noninvolved Worker MEI		Inhalation		
Noncancer Risk	Offsite MEI	Chemicals	Inhalation, Ingestion	10 years	10.4–5
	Noninvolved Worker MEI		Inhalation		
	WM Worker		Inhalation		

Understanding Scientific Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10	***Negative Powers of 10***
$10^1 = 10 \times 1 = 10$	$10^{-1} = 1/10 = 0.1$
$10^2 = 10 \times 10 = 100$	$10^{-2} = 1/100 = 0.01$
and so on; therefore,	*and so on; therefore,*
$10^6 = 1{,}000{,}000$ *(or 1 million)*	$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.	*etc.*

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^5 *can also be written as 3.0E+05, and* 3×10^{-5} *is equivalent to 3.0E-05. Therefore, 3.0E+05 = 300,000 and 3.0E-05 = 0.00003.*

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3.0E-06 can be used as 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., fatal cancer) will occur over the period covered by the analysis.

The health risk impacts associated with the routine operation of HW treatment facilities are presented in several tables in this section. Summary tables show programwide results by alternative. The site data tables in Volume II present the health impacts for all sites.

10.4.1.1 Estimated Number of Fatalities

On a programwide basis, waste management worker physical hazard fatalities did not equal or exceed one under any of the alternatives evaluated. On a site-level basis, worker fatalities did not equal or exceed one at any HW treatment site under any alternative.

10.4.1.2 Estimated Number of Cancer Incidences

Table 10.4–3 presents an overview, by alternative, of the total estimated programwide cancer incidences associated with treatment of HW. These impacts result from chemical exposures of the offsite population, noninvolved workers, and waste management workers.

The number of cancer incidences on a programwide basis are estimated to be less than one for all receptor groups except waste management workers. Programwide waste management worker cancer incidences of one and two were estimated under the Regionalized 1 and 2 alternatives, respectively. On a site-level basis, one waste management worker cancer was estimated at ORR under Regionalized Alternative 2 as a result of exposure to chromium VI. The chromium cancer risk is probably an overestimate, since all of the chromium available for exposure was conservatively assumed to be in the form of chromium VI. Cancer incidences of less than one were estimated for the offsite and noninvolved worker populations at all sites under all alternatives.

10.4.1.3 Probability of MEI Cancer Incidence

Table 10.4–4 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidences resulting from chemical exposure. This table presents these estimated risks for the MEIs within the offsite population and noninvolved worker population.

Table 10.4–3. HW Treatment: Estimated Number of Cancer Incidences Programwide

Alternative	Sites[a]	Offsite Population Chemical Cancer Incidence	Noninvolved Worker Chemical Cancer Incidence	WM Worker Chemical Cancer Incidence
No Action	2	*	*	*
Decentralized	3	*	*	*
Regionalized 1	5	*	*	1
Regionalized 2	2	*	*	2

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

Table 10.4–4. HW Treatment: Greatest Probability of Cancer Incidence at Any HW Site

Alternative	Sites[a]	Offsite MEI Cancer[b] Incidence Probability	Noninvolved Worker MEI Cancer Incidence Probability
No Action	2	4E–07	2E–06
Decentralized	3	4E–07	2E–06
Regionalized 1	5	2E–06	1E–05
Regionalized 2	2	5E–06	3E–05

Note: Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] Number of DOE sites treating.
[b] The impacts presented in this table refer only to offsite populations surrounding DOE sites. Impacts to offsite populations from treatment at commercial facilities are not included.

The probability of a cancer incidence to the MEI was calculated for each site and the highest values under each alternative are presented in Table 10.4–4. The MEI risk is not a combined total of risks across all of the sites under an alternative.

The probabilities for the Regionalized Alternatives are relatively higher by about one order of magnitude (10 times) than the probabilities estimated for the No Action and Decentralized Alternatives. Four sites (the Hanford Site, INEL, LANL, ORR) are estimated to have the highest offsite or noninvolved worker MEI cancer incidence probabilities (greater than one-in-one million) from implementation of HW alternatives. Exposure to chromium VI drives the cancer risk at these sites.

10.4.1.4 MEI Noncancer Risks

The "Hazard Index" is an EPA standard indicator of potential noncancer toxicity caused by exposure to hazardous chemicals. It is derived by comparing the estimated exposure concentrations of noncarcinogenic chemicals to concentrations presumed to be protective of human health over an entire lifetime, assuming continuous low-level exposure. If the Hazard Index exceeds one, the estimated exposure concentrations exceed the concentrations presumed to be without adverse health effects. In the WM PEIS, the Hazard Index was estimated for the MEI of the offsite and noninvolved worker populations.

For waste management workers, an "Exposure Index" rather than a Hazard Index was estimated. The Exposure Index is derived by comparing the estimated exposure concentrations to appropriate occupational exposure limits. The Exposure Index was considered to be a better measure for waste management workers

because the Hazard Index uses standards designed to protect the health of the general population, including sensitive subgroups, such as children. Workers are generally assumed to be healthier than the general population, and worker populations do not contain sensitive subgroups. Therefore, the concentrations of noncarcinogenic chemicals presumed to be protective of human health are different for these two groups of receptors. If the Exposure Index exceeds one, the estimated concentrations exceed the concentrations presumed to be without adverse health effects.

Table 10.4–5 summarizes, by alternative, the programwide noncancer health risks resulting from chemical exposures associated with each HW alternative. This table presents the greatest noncancer health risks (presented as "Hazard Index") to the MEIs within the offsite and noninvolved worker populations, and to an individual waste management worker (presented as "Exposure Index") across the treatment sites.

None of the alternatives are estimated to produce noncancer risks at levels of concern to the MEIs of the offsite and noninvolved worker populations. However, the Exposure Index values for the waste management workers exceed one for each of the alternatives, indicating the potential for adverse noncancer health effects as a result of worker exposures. Five sites (the Hanford Site, INEL, LANL, ORR, and SRS) are estimated to have noncancer risks to the most exposed waste management worker, with Exposure Indices equal to or greater than one. Noncancer risks are of concern at ORR under each of the alternatives. At the other sites, noncancer risks are estimated mainly under the regionalized alternatives, although INEL

Table 10.4–5. HW Treatment: Greatest Noncancer Health Risks at Any HW Site

Alternative	Sites[a]	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Incidence	WM Worker Exposure Index
No Action	2	*	*	4
Decentralized	3	*	*	4
Regionalized 1	5	*	*	6
Regionalized 2	2	*	*	6

Notes: Hazard Index = sum of Hazard Quotient values for all noncarcinogenic chemicals; Hazard Quotient = the chemical-specific ratio of media exposure concentration to concentrations believed to have no appreciable adverse effects; Exposure Index = ratio of exposure concentration to chemical-specific occupational threshold limit; * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

and LANL have such risks under the No Action and Decentralized Alternatives, respectively. Hydrogen chloride is the noncancer risk driver at these sites.

10.4.2 TRANSPORTATION-RELATED IMPACTS

Although HW can be transported both by truck and rail, truck transportation is the predominant shipping method. Therefore, transportation impacts were estimated based solely on truck transportation. Potential health impacts from the transportation of HW were considered to be the result of exposure to vehicle exhaust during transportation operations, and exposure to HW chemicals due to transportation accidents in which HW shipment containers are breached. Physical injuries and fatalities sustained during vehicle accidents were also included in the transportation-related health impacts. The populations potentially affected in the transportation of HW are the public along transportation routes and the truck crews transporting the HW.

Some HW would be shipped to commercial vendors for treatment under all HW management alternatives. Therefore, shipments of HW were considered to occur uniformly over the 20-year construction and operation period. Appendix E describes the methods used to estimate the health risks from transporting HW.

Table 10.4–6 presents the health risk impacts from exposure to HW chemicals released as a result of transportation accidents. The estimated health risk impacts are based on the types of HW chemicals present and differing levels of concentrations released.

The exposed population includes the truck transportation workers and assumes the accident and release of HW chemicals take place in a populated urban area. The probability of an accident occurring with the most toxic chemicals present in large quantities, high population density, and meteorological conditions favoring extremely limited dispersal of the chemicals would be very low. For example, 285 of the estimated 1,700 shipments over a 20-year period under the No Action Alternative would involve HW chemicals that are considered as having a potential for causing "any adverse effect." Of those 285 shipments, only 36 of the shipments contain the combinations of HW chemicals that would contribute more than 50% of the adverse health risk. This amounts to 2/100ths of 1% of all HW shipments over 20 years. This relationship would also be true for the other HW alternatives.

Table 10.4-6. Health Risks From Chemical Exposure Following HW Transportation Accidents

HW Alternatives	Sites[a]	Shipment Miles (Millions)	Number of Shipments	Number of Potential Life Threatening Effects	Number of Potential Cancers	Number of Potential Adverse Noncancer Effects
No Action	2	20	34,000	*	2	78
Decentralized	3	19	41,500	*	1	49
Regionalized 1	5	35	50,000	*	3	86
Regionalized 2	2	19	34,000	*	2	60

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

Table 10.4-7 summarizes the total number of estimated fatalities associated with truck transportation of HW and provides the total number of shipments, the total shipment miles, and the source of the fatalities for each alternative. Regionalized Alternative 1 is the only alternative that is estimated to result in a fatality as a result of traffic accidents. None of the other alternatives are estimated to produce fatalities as a result of implementation of HW alternatives.

Table 10.4-7. Estimated Fatalities for HW Truck Transportation From Vehicular Accidents

Alternative	Sites[a]	Number of Shipments	Shipment Miles (Millions)	Source of Fatalities	
				Fuel Emissions	Injury from Traffic Accidents
No Action	2	34,000	20	*	*
Decentralized	3	41,500	19	*	*
Regionalized 1	5	50,000	35	*	1
Regionalized 2	2	34,000	19	*	*

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

10.4.3 FACILITY ACCIDENT IMPACTS

10.4.3.1 Storage Facility Accidents

Although DOE does not intend to make any HW storage decisions as a result of this PEIS, limited storage (or staging) is necessary to facilitate treatment. Therefore, health risks were evaluated for a number of potential HW storage facility accidents. The accidents analyzed included: (1) a fire that engulfs a significant number of HW containers; (2) an earthquake that ruptures a significant number of containers; and (3) the crash of a large or small aircraft into the facility resulting in fire and explosion. Additional information about the methods and assumptions used in the facility accident analysis, as well as details about the individual accident scenarios, can be found in Appendices D and F. Note that facility accidents were analyzed only under the regionalized alternatives because these alternatives had the largest estimated inventories of waste, and therefore, the largest potential consequences following an accident. Analyzing only these alternatives should provide an estimate of the potential maximum risks under all alternatives.

Table 10.4–8 summarizes the estimated cancer incidences resulting from chemical exposures associated with potential storage facility accidents. This table contains cancer incidence and frequency of occurrence estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. None of the receptor groups are estimated to have cancer incidences equal to or greater than one as a result of accidents related to storage of HW at any of the sites evaluated.

Table 10.4–9 summarizes the estimated noncancer risks to the MEI resulting from chemical exposures associated with potential HW storage facility accidents. This table contains noncancer risk and frequency of occurrence estimates (presented as a "Hazard Index" or an "IDLH [Immediately Dangerous to Life and Health] Index") for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2.

Regionalized Alternative 2 appeared to have the higher risks of the two alternatives evaluated, although noncancer risks are estimated to occur in each of the receptor groups at each of the sites evaluated under both alternatives if the accidents were to occur.

Table 10.4-8. Cancer Incidences From Potential Maximum Reasonably Foreseeable HW Storage Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite Population Number of Cancer Incidences	Noninvolved Workers Number of Cancer Incidences	WM Workers Number of Cancer Incidences
Regionalized Alternative 1					
Hanford	Storage facility fire	1.0E-04 to 1.0E-02	*	*	*
INEL	Large aircraft crash	<1.0E-06	*	*	*
LANL	Small aircraft crash	<1.0E-06	*	*	*
ORR	Small aircraft crash	<1.0E-06	*	*	*
SRS	Large aircraft crash	<1.0E-06	*	*	*
Regionalized Alternative 2					
INEL	Large aircraft crash	<1.0E-06	*	*	*
ORR	Small aircraft crash	<1.0E-06	*	*	*

Note: * = greater than 0 but less than 0.5.

Table 10.4-9. Noncancer Risks From Potential Maximum Reasonably Foreseeable HW Storage Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker IDLH Index
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E-06	1	6	1,400
INEL	Large aircraft crash	<1.0E-06	2	14	530
LANL	Small aircraft crash	<1.0E-06	32	450	2,700
ORR	Small aircraft crash	<1.0E-06	77	850	680
SRS	Large aircraft crash	<1.0E-06	2	110	1,300
Regionalized Alternative 2					
INEL	Large aircraft crash	<1.0E-06	37	330	6,200
ORR	Small aircraft crash	<1.0E-06	240	2,600	2,300

Note: IDLH = immediately dangerous to life and health.

10.4.3.2 Treatment Facility Accidents

The thermal treatment facility (incinerator) accidents evaluated included: (1) explosion and resulting feedstock fire; (2) earthquake followed by a facility fire; and (3) the crash of a large or small aircraft into the facility resulting in a facility fire.

Table 10.4–10 summarizes the estimated cancer incidences resulting from chemical exposures associated with potential treatment facility accidents. This table contains cancer incidence and frequency of occurrence estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. None of the receptor groups are estimated to have cancer incidences equal to or greater than one as a result of accidents related to treatment of HW at any of the sites evaluated.

Table 10.4–11 summarizes the estimated noncancer risks to the MEI resulting from chemical exposures associated with potential treatment facility accidents. This table contains noncancer risk estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. Noncancer risks are estimated to occur in each of the receptor groups at most of the sites evaluated under both alternatives if the accidents were to occur.

Table 10.4–10. Cancer Incidences From Potential Maximum Reasonably Foreseeable HW Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite Population Number of Cancer Incidences	Noninvolved Workers Number of Cancer Incidences	WM Workers Number of Cancer Incidences
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E-06	*	*	*
INEL	Large aircraft crash	<1.0E-06	*	*	*
LANL	Earthquake and fire	1.0E-06 to 1.0E-04	*	*	*
ORR	Small aircraft crash	<1.0E-06	*	*	*
SRS	Large aircraft crash	<1.0E-06	*	*	*
Regionalized Alternative 2					
INEL	Earthquake and thermal treatment unit fire	<1.0E-06	*	*	*
ORR	Small aircraft crash	<1.0E-06	*	*	*

Note: * = greater than 0 but less than 0.5.

Table 10.4-11. Noncancer Risks From Potential Maximum Reasonably Foreseeable HW Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker IDLH Index
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E-06	0.2	1	360
INEL	Large aircraft crash	<1.0E-06	0.08	0.5	230
LANL	Earthquake and fire	1.0E-06 to 1.0E-04	1	8	200
ORR	Small aircraft crash	<1.0E-06	7	7	320
SRS	Large aircraft crash	<1.0E-06	0.08	4	120
Regionalized Alternative 2					
INEL	Earthquake and thermal treatment unit fire	<1.0E-06	2	12	990
ORR	Small aircraft crash	<1.0E-06	11	11	560

Note: IDLH = immediately dangerous to life and health.

10.5 Air Quality Impacts

The management of HW would not appreciably affect the air quality at most sites. No site would equal or exceed criteria air pollutant standards. However, regionalization of treatment facilities at LANL and ORR could cause adverse air quality impacts requiring additional emission control measures primarily due to emissions of hazardous pollutants from thermal treatment.

As illustrated in Table 10.5-1, DOE evaluated air quality impacts at each proposed HW treatment site based on estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (HAPs), and toxic air pollutants (TAPs). Emissions of radionuclides are not applicable because HW does not contain radionuclides. DOE estimated pollutant emissions for HW facility construction activities and for operation and maintenance activities.

The Clean Air Act (42 USC 7401 *et seq.)* regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new emissions from both "stationary" (e.g., treatment facilities) and "mobile" (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for

Table 10.5-1. Air Quality Impacts Evaluated for HW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Text discussion only
	Operations	Estimated for thermal treatment units, for fuel use by all other HW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 10.5-2
Hazardous and toxic air pollutant emissions	Operations	For all HW treatment facilities	Percent of standard	Table 10.5-3

each criteria air pollutant for nonattainment areas. An entity which seeks to engage in an activity that will result in emissions equal to or exceeding those limits in a nonattainment area must first obtain a permit.

In "attainment areas" (where air pollution standards are met), only new emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit is required for a new stationary source that equals or exceeds the allowable increase. However, a permit is not required for criteria air pollutant emissions from mobile sources.

10.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site (mobile sources).

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities under the HW alternatives would result in

Major Types of Air Pollutants

***Criteria Air Pollutants**: carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*

***Hazardous Air Pollutants**: 189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

***Toxic Air Pollutants**: Other toxic compounds regulated by EPA and state or local governments*

emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. DOE chose the 10% threshold to highlight sites where criteria air pollutant emissions could result in adverse air quality impacts.

DOE estimates that no site would have emissions from construction activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

10.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operation and maintenance of HW facilities (stationary sources) and by vehicles that are driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

Of the nine major HW sites, only ORR and INEL would equal or exceed 10% of applicable air pollutant emission standards (Table 10.5-2). Both sites are located in attainment areas. Although ORR would equal or exceed 10% of the PM_{10} standard under both the Regionalized Alternatives 1 and 2 and INEL would exceed 10% of the PM_{10} standard under Regionalized 2, no site would equal or exceed any of the criteria air pollutant emission standards or need to obtain a Clean Air Act permit.

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 km (62 miles) of a PSD Class I area. Five sites proposed for HW activities under the alternatives are located within 100 km of a PSD Class I area: INEL, LANL, LLNL, ORR, and SNL-NM. None of these would have sufficient quantities of emissions to affect a PSD Class I area.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

Table 10.5-2. Percent of Sites' Allowable Air Emissions Discharged During Operations—HW Sites Equaling or Exceeding 10% of Standard

Alternative	Number of Treatment Sites	Criteria Pollutants (PM_{10})	
		Operation and Maintenance	
		INEL[a]	ORR[a]
No Action	2		
Decentralized	3		
Regionalized 1	5		10
Regionalized 2	2	17	13

Note: PM_{10} = particulate matter less than or equal to 10 micrometers in diameter. Values less than 10% are shown as blanks.
[a] Attainment area for this pollutant; PSD regulations are applied; total % represents stationary-source emissions only.

10.5.3 HAZARDOUS AND TOXIC AIR POLLUTANT EMISSIONS

Thermal treatment of HW will result in emission of small quantities of hazardous and toxic air pollutants. Hazardous air pollutants (HAPs), other than radionuclides, and toxic air pollutants (TAPs) were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits (AALs). Radionuclides emissions are not applicable because HW does not contain radionuclides.

As shown in Table 10.5-3, only vinyl chloride concentrations at LANL and ORR were estimated to equal or exceed 10% of the applicable guidelines or standards. These concentrations exceeded the standard for

Table 10.5-3. Percent of the Standard for Hazardous and Toxic Air Pollutants—HW Sites Equaling or Exceeding 10% of Standard

Alternative	Number of Treatment Sites	HAPs/TAPs (Vinyl Chloride[a])	
		LANL	ORR
No Action	2		14
Decentralized	3		35
Regionalized 1	5	153	120
Regionalized 2	2		322

Notes: HAPs = hazardous air pollutants; TAPs = toxic air pollutants. Values less than 10% are shown as blanks.
[a] Vinyl chloride exceeds 10% of the EPA Integrated Risk Information System annual toxic value of 0.012 $\mu g/m^3$.

both LANL and ORR in Regionalized Alternative 1, and ORR in Regionalized Alternative 2. These results are primarily due to the thermal treatment of HW, and may require additional control measures to reduce emissions to acceptable levels.

10.6 Water Resources Impacts

Major impacts to water resources at the HW sites are unlikely for treatment under any alternatives.

As illustrated in Table 10.6–1, DOE analyzed the impacts on water resources of HW treatment activities. Disposal of HW is not within the scope of the WM PEIS. DOE evaluated the effects on water availability from building and operating treatment facilities.

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

10.6.1 Water Availability

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of HW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 10.6-1. Water Resource Impacts Evaluated for HW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used • by personnel • by treatment processes	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only

As shown in the Volume II tables, projected water usage would be less than 1% of current use at all sites. The 1% threshold is based on the assumption that changes less than or equal to 1% are not likely to have significant impacts. Therefore, no site is likely to experience adverse impacts because of the relatively small amount of additional water needed.

For DOE sites that withdraw water directly from a surface water source (the Hanford Site and ORR), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, ORR, and SRS), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

10.6.2 WATER QUALITY

Impacts to groundwater quality were not evaluated for HW. Because HW disposal is conducted by commercial disposal facilities, the impacts to water quality would be analyzed by the commercial operator.

10.7 Ecological Resources Impacts

Loss of limited acreages of habitat at some HW sites during construction of HW facilities would not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. DOE should be able to locate new HW facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction site acreages are small compared to the total acreage at each site suitable for waste operations. A screening-level risk assessment of facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. Transportation accidents leading to spills of HW into aquatic environments could have serious short- and long-term consequences, but the long-term consequences could be mitigated in many instances through emergency response cleanup activities.

As illustrated by Table 10.7-1, DOE analyzed the effects of construction site clearing to build HW treatment facilities, and the operation of treatment facilities on ecological resources at the five large HW treatment sites. DOE qualitatively considered the effects of accidental spills of HW during transport.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

10.7.1 General Impacts of Site Clearing

None of the alternatives would require extensive site clearing for construction of HW facilities. Acreage requirements at any site under any alternative are less than or equal to the 3 acres required at INEL under the Regionalized Alternative 2. These acreage requirements are minimal compared with the regional extent of habitats for nonsensitive species at the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small mammals and song birds with limited home ranges), no significant effects to populations of these species are expected from implementation of any HW alternative.

Table 10.7-1. Ecological Resource Impacts Evaluated for HW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at HW construction sites to general habitat range.	Text discussion
Terrestrial species exposures	Terrestrial animal species	Comparison of estimated hazardous chemical exposures for representative species with the toxicity standard.	Text discussion
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats based on comparing construction acreage to available acreage of nonsensitive habitats.	Text discussion
Sensitive species concerns	Federally and State-listed endangered and threatened species	Numbers of Federally- and State-listed species displayed by site/alternative.	Table 10.7-2
Effects of transportation accidents	Aquatic species in streams crossing transportation corridors	Comparison of accidental spills into aquatic habitats based on number of HW shipments.	Text discussion

10.7.2 SITE CLEARING EFFECTS ON SENSITIVE HABITATS

For those sites that contain sensitive habitats, the degree to which they may be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby HW construction activities depends on DOE's ability to avoid siting near these habitats. A measure of this ability is the percentage of available land required for facility construction at a site under any HW alternative. Available acreage was estimated from site development plans either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage ranged from 0.0007% at SRS under the Decentralized Alternative and Regionalized Alternative 1 to 0.04% at ORR under the Regionalized Alternative 2. Considering these small fractions of available land required for the HW facilities, DOE would have a great degree of flexibility in its siting and can employ a range of mitigative measures, so that site clearing to implement any of the HW alternatives should not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices would minimize these effects. Direct

discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

10.7.3 Effects of HW Treatment Facility Emissions

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of hazardous chemicals from treatment facilities. This analysis used the same atmospheric emissions estimates as the human health risk assessment and provided estimates of chemicals deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Emissions of the following hazardous chemicals were evaluated: arsenic; cadmium; chromium (VI); copper; lead; mercury; nickel, zinc, dioxins, and furans. Hazard Indices were computed for each selected site-alternative combination as composite ratios between the estimated species exposures to the contaminants and known toxic levels for the species. Hazard Indices greater than one would indicate a potential for the combined exposures to adversely affect the health of the species. The maximum estimated Hazard Index values were less than 0.01 for all sites under all alternatives. Therefore, no impacts to terrestrial receptor populations from emissions of hazardous chemicals from HW treatment facilities are expected. Additional information on the methods used to assess potential toxicity to terrestrial animals and on the results of the analysis is presented in Section C.4.4 of Volume III and the Appendix C technical report.

10.7.4 Consideration of Sensitive Species

For comparison of the HW management program's potential to affect sensitive species, Table 10.7-2 lists the numbers of Federally- and State-listed sensitive species occurring or potentially occurring at each HW site that is proposed to treat HW under each alternative. Site-specific analysis would be required for an assessment of sensitive species impacts. That analysis would take into account specific locations for the HW facilities in relation to the location of sensitive habitats and sensitive species at each site, including species listed by the U.S. Fish and Wildlife Service as either endangered or threatened.

Table 10.7-2. Numbers of Federal/State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the Five Proposed HW Treatment Sites

Alternative	Number of Treatment Sites	Hanford	INEL	LANL	ORR	SRS
No Action	2	--	2/2	--	1/11	--
Decentralized	3	--	2/2	--	1/11	8/8
Regionalized 1	5	3/11	2/2	2/4	1/11	8/8
Regionalized 2	2	--	2/2	--	1/11	--

Note: -- = no major HW actions proposed at the site under the alternative.

10.7.5 Effects of HW Transportation Accidents

Transportation accidents involving spills of HW into aquatic environments would be rare. The number of expected accidents is related to the total number of miles traveled during HW shipment (also shipment routes near aquatic habitats). Thus, as fewer shipments of HW occur, as in Regionalized Alternative 2, the number of accidents would be expected to decrease. The potential for impacts to aquatic habitats would also decrease with a decrease in miles traveled. The toxic effects on aquatic resources from HW transportation accidents could be severe immediately following a spill, but are unlikely to have long-term effects due to emergency spill response efforts.

10.8 Economic Impacts

The HW alternatives would only minimally benefit the regional and national economies. The jobs involved in managing HW under the alternatives did not equal 1% of regional employment at any site. The greatest economic effects nationally were estimated to occur under Regionalized Alternative 1, and would result in an increase of 460 jobs.

DOE estimated the effects of expenditures for HW management on the local and national economies (See Table 10.8-1). Local economic effects were based on direct expenditures at each of the five large HW generator sites that treat HW for construction, operation and maintenance, and decontamination of treatment facilities. The socioeconomic region-of-influence (ROI) consists essentially of the counties of residence of

Table 10.8–1. Economic Impacts Evaluated for HW Alternatives

Economic Impact Analyzed	Affected Aspect of the Economy	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures for HW management multiplied by regional employment multiplier at each of the five HW treatment sites	Text discussion
Increased regional incomes	Regional personal income for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional income multiplier at each site	Text discussion
National economic effects	National employment and personal income	Proposed site expenditures at all HW sites and transportation expenditures multiplied by national employment and income multipliers	Text discussion

site employees. The local economy at each site of the five sites was represented by employment, personal income, and industry data. Local increases in jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at a national level only.

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined and weighted to estimate annual project effects at each site. For all alternatives, construction was assumed to take 4 years of the 10-year construction period; the operations phase was assumed to take 12 years (a 10-year operations and maintenance period and a 2-year decontamination period undertaken after the conclusion of operations). Five years was added to the decontamination and decommissioning phase to account for the continued effects on employment and income after this latter project phase ends. The sum of construction phase and operations phase effects was then divided by the total 21 years to determine the combined weighted average annual effects. Annual job and personal income increases are shown for each of the five large HW treatment sites in the Volume II site data tables.

Across the HW alternatives, the regions at all five sites would experience less than a 1% change in the number of jobs as a result of expenditures. No region would experience a 1% or greater increase in personal income under any of the alternatives. A comparison of alternatives reveals that the number of new direct, indirect, and induced jobs from the combined and weighted construction and operations and

maintenance activities across site ROIs ranges from 21 (under the No Action Alternative) to about 250 (under Regionalized Alternative 2).

In addition to analyzing these impacts on the regional economy, a comparison of these impacts on the national economy was made. The HW alternatives would only minimally benefit the national economy. The total number of jobs generated in the national economy from combined weighted construction and operations phase activities range from about 150 (under the No Action Alternative) to 460 jobs (under Regionalized Alternative 1) which represents 0.0003% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HW projects, rather than a net change in national personal income.

10.9 Population Impacts

Population increases resulting from proposed HW alternatives would be minor for all sites. Community characteristics and services would not be affected.

Population changes as a result of the in-migration of new HW workers to the ROI at each HW site were used as a basis to evaluate the likelihood of changes to the local environment. These include community size, diversity, and the provision of necessary services.

Impacts resulting from population changes were not estimated to be major for any of the proposed HW alternatives. The labor requirements and associated population in-migration were not estimated to be sufficient to change the overall population within the ROI at any site by more than 0.1%.

10.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of HW indicated that minority and low-income populations at the HW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HW alternatives.

Analysis of environmental justice impacts from management of HW was based on a review of the impacts reported in this chapter regarding the HW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the 5 large HW generator sites that serve as onsite HW treatment sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done along with maps illustrating the distribution of minority and low-income populations within 50 miles of each of these 5 large HW sites.

10.10.1 Results

The potential for adverse human health effects from exposures to chemical emissions from HW treatment facility operations and from reasonably foreseeable accidents is low for all HW management alternatives for all HW sites. Likewise, the number of cancer incidences due to chemical exposures and the number of fatalities from fuel emissions from truck or rail transportation of HW is small.

Incident-free HW treatment facility operations were analyzed in terms of risk to workers and the public. Incident-free operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the surrounding population. Table 10.4–3 in the health risk section of this chapter indicates that under all the alternatives, the estimated number of offsite population cancer incidence across all HW sites from the normal operation of DOE HW treatment facilities would be less than 0.5 during the conduct of the entire HW program.

10.10.1.1 Transportation

Incident-free HW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income populations. For incident-free transportation, the total number of life-threatening effects is less than 0.5 for any HW alternative. Fatalities from fuel emissions are expected to be less than 0.5 across the HW sites under all alternatives, and the expected number of transportation accident fatalities from trauma is no higher than one under any HW alternative.

10.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 10.10.1 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Air quality impacts are possible at three sites but because the air quality impacts can be mitigated by emission control measures or by using a nonthermal treatment technology. DOE does not anticipate any disproportionately high and adverse air quality impacts to any segment of the populations, including minority or low income populations, at the HW sites.

10.11 Land Use Impacts

Land required to construct HW facilities does not exceed 1% of suitable land for any site under any HW Alternative. Therefore, no impacts to current onsite land uses and no conflicts with offsite uses are expected. Site development plans indicated no conflict between proposed treatment facilities and other plans for the sites.

DOE examined the impacts of the HW alternatives on land use by comparing the acreage required for new treatment facilities to the acreage either designated for waste operations or suitable for development (See Table 10.11-1). Suitable land is the total site acreage, minus the acreage required for known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts between the proposed facilities required under each alternative and plans for future site uses.

Table 10.11-1. Land Use Impacts Evaluated for HW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each HW site	Land use shown in site development plans	Comparison of required acreage with amount designated (or estimated) for HW in site development plan—all instances where requirements are 1% or higher are noted	Text discussion only
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed HW uses and nearby land uses	Text discussion only

None of the development plans at affected sites indicated any conflicts between planned future uses and the proposed HW alternatives. Because the analysis showed that HW facilities would require less than 1% of the designated or suitable land at any site under any alternative, DOE should have considerable flexibility in locating them and no significant land use impacts onsite are expected. For the same reason, no conflicts with adjacent land uses are expected. In addition, none of the site development plans indicated any instances where future uses would conflict with the proposed HW management actions.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations on a site.

10.12 Infrastructure Impacts

Proposed HW activities show minimal potential to affect onsite or offsite infrastructure. In no case does an estimated new onsite requirement for water, wastewater treatment, or electric power approach 5% of current system capacity. Similarly, site employment increases from construction of HW facilities do not approach 5% of current site employment. Therefore, traffic increases would be minimal and would not substantially affect onsite transportation infrastructure.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and electric power (See Table 10.12-1). Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to the onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on community infrastructure.

Proposed HW activities show no potential for substantial effects on onsite or offsite demand for water, wastewater treatment, and power infrastructure. Estimated new requirements for wastewater treatment or power for proposed HW facilities do not exceed 5% of current system capacity at any site. Employment increases never approach 5% of current site employment needed to build and operate HW facilities. Therefore, it is expected that traffic increases will be minimal, and will not substantially affect onsite transportation infrastructure. Operations phase site employment will be lower than construction phase employment so no transportation infrastructure effects are expected.

Table 10.12-1. Infrastructure Impacts Analyzed for HW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support HW facilities	Capacity of onsite water, power, and wastewater systems	Add increased HW facility use to current use—compare to current capacities	Text discussion only
	Onsite transportation infrastructure	Compare new site employment with current site employment as an indicator of increased stress	Text discussion only
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

10.13 Cultural Resources Impacts

Construction and operation of HW facilities could adversely affect cultural resources. DOE will conduct further impact assessment cultural resources surveys when specific HW facility locations are proposed to ensure that any potential impacts are mitigated.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where HW treatment facilities are proposed to be built.

Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys at the five major proposed HW sites and lists reported cultural resources at those sites. However, the impacts of the construction of HW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Land requirements for the construction of HW waste management facilities are sufficiently small under all alternatives that DOE would probably have enough flexibility in siting HW facilities to avoid impacts on cultural resources. If not, measures would be taken to mitigate negative effects on these resources.

10.14 Costs

Costs for commercial treatment are less than for government treatment because of the relatively small volume of HW generation reported. Transportation costs are 15% to 34% of total costs.

As indicated in Table 10.14–1, DOE estimated costs for building and operating treatment facilities, and for transportation (INEL, 1995a,b). DOE evaluated costs associated with HW management from both a life-cycle and process perspective, using 1994 dollars.

10.14.1 Life-Cycle Costs

DOE evaluated government facility costs for four phases representing the life-cycle of the facilities and their operations: pre-operations, construction, operations and maintenance, and decontamination and decommissioning. These phases have been described in previous Chapters 6–8, and are the same for the HW cost estimate. Commercial costs are contractor payments, which fall wholly within the operations phase of the life-cycle. The transportation cost estimates include costs of truck transportation from generating sites to treating sites or to commercial vendors. Life-cycle costs do not include speculative factors, such as impacts to long-term land values.

10.14.2 Process Costs

DOE also analyzed costs based on treatment and storage activities. Government treatment costs include costs to build and operate treatment facilities (such as thermal treatment units) and common support facilities (such as maintenance, and certification/shipping facilities). Facilities are assumed to be Government-owned,

Table 10.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts Are Assessed	Location of Impacts Assessment
Process costs	Government treatment[a]	Life-cycle costs for facilities	Table 10.14–2
	Commercial treatment[a]	Life-cycle costs for facilities	Table 10.14–2
Transportation costs[b]	Truck[a]	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 10.14–2

[a] HW would be shipped to commercial vendors for treatment and disposal under all HW management alternatives. Therefore, shipments of HW were considered to occur uniformly over the 20-year construction and operation period.
[b] Rail costs were not estimated because the small volumes did not warrant rail shipment.

contractor-operated on DOE sites. Because of the small volume of most waste streams, it was not economically feasible to construct and operate government facilities. For organic liquids, waste volumes were high enough to warrant evaluation of government owned facilities. The Government facilities included several technologies—thermal treatment, aqueous treatment of scrubber blowdown, and grout solidification of fines and residues. The details of cost estimating are covered in Section 5.3.3, Volume I.

Commercial treatment includes those costs incurred for vendor treatment. DOE applied unit prices derived from vendor quotes for the following: thermal treatment and the supporting treatments of aqueous waste, organic removal, metal recycling, reactive metal deactivation, mercury recovery, and grout solidification.

As shown in Table 10.14–2 (INEL, 1996), the No Action Alternative is the least costly of the alternatives at an estimated $144 million, with only 3% of the nonwastewater HW being treated by government facilities. The Decentralized Alternative, which treats 9% of the nonwastewater HW in government facilities at three sites, is the second least expensive alternative at $183 million. Regionalized Alternative 1, which treats 50% of the nonwastewater HW in government facilities at five sites, is the most expensive at $376 million, closely followed by Regionalized Alternative 2, which treats 90% of the nonwastewater HW

Table 10.14–2. Life-Cycle Costs (Millions of 1994 Dollars)

Alternatives	Number of Treatment Sites	Total Costs (including truck transportation)	Life-Cycle Costs				Process Costs[a]		Transport Costs
			Pre-ops	Const	O&M	D&D	Comml T	Govt T&D	Truck
No Action	2	144	0	0	95	0	73	22	49
Decentralized	3	183	3	20	104	7	71	63	49
Regionalized 1	5	376	18	83	183	5	50	239	87
Regionalized 2	2	318	18	75	172	6	28	243	47

Notes: Pre-ops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning; Comml T = commercial treatment; Govt T&D = government treatment; Total costs = sum of life cycle costs plus truck transport = sum of process costs plus truck transport.

[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. Total Costs, also in the table, add truck costs to the facility costs. Therefore, Total Costs equals the sum of life-cycle costs and truck costs and also equals the sum of process costs and truck costs.

at two sites and costs $318 million. Conversely, commercial treatment costs are highest for the No Action Alternative and lowest for the Regionalized Alternative 2. Based on the reported waste volumes of 3,400 metric tons per year, the continued use of commercial vendors is the most cost-effective method of treatment. Transportation costs are relatively constant at $47–49 million for all alternatives except the Regionalized Alternative 1. Regionalized Alternative 1 has a much higher transportation cost ($87 million) because the shipping configuration includes a much larger number of small local shipments, thereby losing the economy of scale associated with larger capacity shipments (INEL, 1995a).

For the purpose of the WM PEIS analysis, DOE assumed existing storage capacity would be sufficient. Therefore, estimates of costs for HW do not include storage facilities.

10.15 Environmental-Restoration-Transferred Waste

DOE anticipates that volumes of HW generated during environmental restoration activities would be treated offsite at commercial facilities. Environmental-restoration HW will not be transferred to DOE HW treatment facilities.

10.16 Comparison of Alternatives Summary

Health Risk Impacts. The risk estimates indicate a fraction of a single fatality for each of the proposed HW alternatives from vehicle accidents associated with HW transportation. The Regionalized Alternatives result in greater worker exposure to HW chemicals than the No Action and Decentralized Alternatives because DOE treats more HW under the Regionalized Alternatives. This analysis did not evaluate the risk to workers at commercial facilities which are the principal HW treatment facilities under the No Action and Decentralized Alternatives. It is expected that HW worker risk would be the same regardless of whether commercial or DOE facilities are used. In view of this, there is no significant difference between the alternatives with regard to HW worker risk.

Air Quality Impacts. The management of HW would not appreciably affect the air quality at most sites. No criteria air pollutants would exceed standards at any site. However, regionalization of treatment facilities at LANL and ORR would cause adverse air quality impacts requiring additional emission control measures

for vinyl chloride. The exceedances at LANL and ORR are primarily due to emissions from thermal treatment. Emissions of radionuclides are not applicable since HW does not contain radioactive constituents.

Other Environmental Impacts. Results for ecological, cultural, and other environmental impacts did not indicate significant impacts for any of the HW alternatives, and therefore no meaningful comparison or discriminators between alternatives can be determined from these impact areas.

Commercial Treatment. In addition to worker risks, the environmental impacts were not analyzed for commercial treatment facilities which treat almost all nonwastewater DOE HW under the No Action and Decentralized alternative. Analysis of these impacts would require being able to determine the fraction of DOE HW contained in all waste treated at every commercial facility, the environmental setting and meteorology of each facility, and the total number of workers at each facility. Not all of this information is publicly available, and analyzing potential impacts at each facility based on fractional contributions of DOE HW would be extremely difficult with potentially large uncertainties and inaccuracies.

The No Action and Decentralized Alternatives are unique in several specific areas:

- Health risks were not estimated for commercial facilities as discussed above, but should not be different from risks estimated for the alternatives involving DOE treatment.
- Construction jobs would increase in the short term if DOE builds its own treatment facilities, but a one-for-one switch of commercial jobs to Federal jobs would be expected as operation of DOE facilities displaces operations in commercial facilities.
- Impacts dependent on location of facilities (e.g., air quality, water resources, ecological, environmental justice) may be more likely for commercial than DOE facilities since commercial facilities would probably be located in more densely populated areas than DOE sites.

The fundamental differences among the alternatives involve transportation and the implementation costs of the HW alternatives. Table 10.16–1 presents a summary of the transportation and cost differences among the alternatives.

The Preferred Alternative. The Department's preferred alternative for HW is the No Action Alternative, which means the Department would continue to use commercial facilities to treat most of its nonwastewater HW. The transportation and environmental impacts are low for all of the alternatives for HW evaluated in the WM PEIS; however, the No Action Alternative costs less than the Decentralized or Regionalized

Alternatives for HW treatment. The impacts for the preferred alternative are those presented for the No Action Alternative throughout Chapter 10.

Table 10.16-1. Summary Comparison of the HW Alternatives

Alternative	Sites	Shipments		Costs[c]			Transportation Risks[d]
		Mileage[a]	Number[b]	Transport	Project Life-Cycle	Total	
No Action	2	20	34	49	95	144	*
Decentralized	3	19	41	49	134	183	*
Regionalized 1	5	35	50	87	289	376	1
Regionalized 2	2	19	34	47	271	318	*

Note: * = greater than 0 but less than 0.5.
[a] Mileage in millions.
[b] Number of shipments in thousands.
[c] Cost in millions of dollars.
[d] Transportation risks in fatalities.

Chapter 10
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Hazardous Waste Alternatives

Alternative	Sites[a]	ANL-E[b]	Hanford	INEL	LANL	LLNL[b]	ORR	Pantex[b]	SNL-NM[b]	SRS
No Action	2			T			T			
Decentralized	3			T			T			T
Regionalized	5		T	T	T		T			T
Regionalized	2			T			T			

Notes: T=treatment. A blank indicates that a site does not treat HW under the specified alternative. Fermi and KCP were not included in this table because they were not major sites (as described in Section 1.6 of Chapter 1) and impacts were not evaluated at those sites.

[a] Number of sites treating HW.

[b] These sites are listed because they are major sites that are large HW generators. However, because they are assumed to continue to ship nonwastewater HW offsite for treatment, no significant impacts are expected at these sites under any of the HW alternatives.

CHAPTER 11
Cumulative Impacts

Chapter 11 discusses the combined impacts that could result from locating facilities for management of different waste types at each of the 17 major waste management sites, the cumulative impacts that could result at each of the 17 major sites and their surrounding regions, and the cumulative impacts of transporting waste. The chapter presents the minimum and maximum impacts of the waste management program at each site as well as the impacts of the preferred alternatives at each site.

Cumulative impacts are those impacts that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions. Examples of past and present actions include potential impacts from contaminated sites, ongoing activities that result in waste generation and waste management activities outside the scope of the WM PEIS. Both the Council on Environmental Quality and the U.S. Department of Energy (DOE) regulations for implementing National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*) require the assessment of cumulative impacts because significant impacts can result from several smaller actions that, by themselves, may not have significant impacts. To conduct the cumulative impacts analysis, DOE first examined the **combined impacts** of waste management alternatives (including the preferred alternatives identified in Section 3.7) for the five types of wastes analyzed in the WM PEIS for each of the 17 major sites. To these combined impacts, DOE then added the impacts of other past, present, and reasonably foreseeable future actions external to the WM PEIS analysis in order to assess the **cumulative impacts**.

Combined Impacts, in this WM PEIS, are those impacts resulting from the operations of multiple waste management facilities at a particular site, as defined in the WM PEIS analysis of alternatives.

Cumulative Impacts, as defined by the Council on Environmental Quality NEPA regulations, are the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7).

11.1 Combined Waste Management Impacts

The combined impact analysis considers the following impact areas:

Human Health Risk

- Collective radiation dose and cancer risk for the public (over the 10-year period of operations)

- Annual radiation dose for the hypothetical maximally exposed offsite individual resulting from normal operations
- Collective radiation dose and cancer risk for noninvolved workers (over the 10-year period of operations)
- Annual radiation dose for the hypothetical maximally exposed offsite individual resulting from waste shipments

Environmental Quality

- Air quality exceedances (list of those emissions that could exceed air quality standards)
- Groundwater quality exceedances (list of contaminants that could exceed drinking water standards as a result of disposal of LLMW and LLW)

Resource and Infrastructure Requirements

- Land requirements (acres of land occupied by new facilities)
- Water use (gallons of water used per day during operations)
- Wastewater production (gallons of sanitary wastewater produced each day during operations)
- Power requirements (megawatts of power used during operations)

Socioeconomic Factors

- Regional employment (percent change in regional employment resulting from operations)
- Regional population (percent change in regional population resulting from operations)
- Cost (life-cycle cost in 1994 dollars)

These are the major factors that might be additive across waste types and could logically be combined.

Other impacts that were addressed in Chapters 6 through 10 were not considered part of the identification of combined impacts for several reasons. Some impacts, such as impacts to ecological resources and cultural resources, were not combined because they are dependent on the facility location within the site boundary and location-specific environmental factors. This programmatic EIS does not address these issues. Some impacts, such as impacts of waste facility accidents, were not combined because it is highly improbable that they would occur together. Risks to individual waste management workers were not considered part of the

combined impact analysis because each worker was assumed to be dedicated to a single waste type (i.e., the worker at one waste type facility would not simultaneously be working at another waste type facility). In addition, DOE limits the dose to each involved worker through the use of health and safety standards and monitoring. Finally, human health risks resulting from potential groundwater contamination after the disposal of low-level waste (LLW) and low-level mixed waste (LLMW) were not considered because it was assumed that they would neither merge nor co-mingle within 300 m of a single unit. At greater distances, groundwater plumes from multiple units probably do mix, but it is likely that dilution and dispersion would lower concentrations to less than those estimated at 300 m.

Because the alternatives for the five waste types can be combined in numerous ways (for some sites, there are thousands of possible combinations of alternatives across all the waste types), the combined impacts of placing multiple facilities at each site were determined by identifying the *minimum* and *maximum* values for each of the combined impact areas (listed above) for each waste type. The values were then summed for each impact area to determine the combined minimum and maximum impacts for each site. Table 11.1-1 lists the alternatives under which a waste type facility could be located at each major site, except for onsite LLMW wastewater treatment and LLW minimum treatment facilities that would occur under all the LLMW and LLW alternatives. Table 11.1-2 lists the preferred alternatives for each site and the waste types at these sites. In the following discussions, a combined impacts table is presented for each major site; the table identifies the minimum and maximum impact values and the alternatives associated with these values. The minimum and maximum impact values are based directly on the data contained in the site data tables in Volume II of this WM PEIS for normal facility operations and on ANL (1996a-e) for site-specific transportation effects.

When reviewing the impacts and costs identified for the No Action Alternative for LLMW and TRUW, it is important to realize that the results for indefinite storage of those waste types are based on the initial 20 years of that indefinite period. This is consistent with the period of analysis for the other alternatives; however, not shown are the impacts from storage expected beyond this 20-year time frame. The longer term storage impacts and costs are likely to exceed those for the first 20 years, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of LLMW and TRUW, where risks to workers and the offsite population, and other impacts and costs, are reduced following disposal. The No Action Alternative does not reduce or avoid impacts and costs; rather it causes impacts and costs to be experienced every year for an indefinite period of time. A discussion of the longer term

Table 11.1-1. Major Waste Management Sites and Alternatives[a]

Sites	Waste Types	Alternatives		
		Treatment	Storage	Disposal
Argonne National Laboratory - East, IL	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Brookhaven National Laboratory, NY	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
Fernald Environmental Management Project, OH	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized and Regionalized 1 and 2
Hanford Site, WA	LLMW	All	No Action	All
	LLW	Regionalized 2, 4, 5, Centralized 3-5	None	No Action, Decentralized, Regionalized 1-6, Centralized 1, 3, and 5
		All		
	TRUW	None	All	None
	HLW	Regionalized 1	All	None
	HW		None	None
Idaho National Engineering Laboratory, ID	LLMW	All	No Action	All
	LLW	Regionalized 2, 4, 5, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1-3	No Action, Decentralized, Regionalized 1-3	None
	HLW	None	All	None
	HW	No Action, Decentralized, Regionalized 1 and 2	None	None
Lawrence Livermore National Laboratory, CA	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2 and No Action	None	Decentralized and Regionalized 1 and 2
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Los Alamos National Laboratory, NM	LLMW	Decentralized, Regionalized 1 and 2	No Action	Decentralized, Regionalized 1, 2, and 4
	LLW	Regionalized 2, 4, Centralized 2 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
	HW	Regionalized 1	None	None
Nevada Test Site, NV	LLMW	Decentralized	No Action	Decentralized, Regionalized 1-4
	LLW	None	None	No Action, Decentralized, Regionalized 1-5, 7, Centralized 2 and 4
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Oak Ridge Reservation, TN	LLMW	All	No Action	Decentralized, Regionalized 1,2,4
	LLW	Regionalized 2, 4, 5, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
	HW	No Action, Decentralized, Regionalized 1 and 2	None	None

Table 11.1-1. Major Waste Management Sites and Alternatives[a]—Continued

Sites	Waste Types	Alternatives		
		Treatment	Storage	Disposal
Paducah Gaseous Diffusion Plant, KY	LLMW	No Action, Decentralized, and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized, Regionalized 1 and 2
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Pantex Plant, TX	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized, Regionalized 1 and 2
Portsmouth Gaseous Diffusion Plant, OH	LLMW	Decentralized, Regionalized 1,2, and 3	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2, 4, Centralized 3 and 4	None	Decentralized, Regionalized 1 and 2
Rocky Flats Environmental Technology Site, CO	LLMW	No Action, Decentralized, Regionalized 1 and 2	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2, 4, Centralized 3 and 4	None	Decentralized, Regionalized 1 and 2
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
Sandia National Laboratories, NM	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Savannah River Site, SC	LLMW	All	No Action	All
	LLW	Regionalized 2, 4-7, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1-7
	TRUW	No Action, Decentralized, Regionalized 1-3	No Action, Decentralized, Regionalized 1-3	None
	HLW	None	All	None
	HW	Decentralized and Regionalized 1	None	None
Waste Isolation Pilot Plant, NM	TRUW	Centralized	None	Decentralized, Regionalized 1-3, Centralized
West Valley Demonstration Project, NY	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
	HLW	None	No Action and Decentralized	None

Notes: LLMW = low-level mixed waste; LLW = low-level waste; TRUW = transuranic waste; HLW = high-level waste; HW = hazardous waste.
[a] The alternatives listed do not include onsite LLMW wastewater treatment facilities and onsite minimum LLW treatment facilities that would occur under all the LLMW and LLW alternatives.

Table 11.1-2. Preferred Alternatives for Major Waste Management Sites

Waste Type	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR
LLMW	Treatment	D	R1[a]	D	R1	R4	D	D	R1[a]	R2
	Disposal[b]	R	R	R	R	R	R	R	R	R
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	R3	R3
	Disposal[b]	R	R	R	R	R	R	R	R	R
TRUW	Treatment/ Storage	D			D	R3	D	D	D	R1
HLW	Storage				D	D				
HW	Treatment	N	-	-	N	N	N	N	-	N

Waste Type	Decision	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	WIPP
LLMW	Treatment	R2	D	D	D	D	R1	R1[a]	
	Disposal[b]	R	R	R	R	R	R	R	
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	
	Disposal[b]	R	R	R	R	R	R	R	
TRUW	Treatment/ Storage	D	**		D	R1	R1	D	*
HLW	Storage						D	D	
HW	Treatment	-	N	-	-	N	N	-	

Notes: N = No Action; D = Decentralized; R, R1, R2, R3, R4 = Regionalized Alternatives; - = site not analyzed as a major generating site; * = no impacts from treatment/storage; ** = although not analyzed in the WM PEIS, the very small amount of TRUW at Pantex would be shipped to LANL for treatment and storage. A blank cell indicates that the waste type is not found at the site. Cumulative impacts for the preferred alternatives at each site are based on alternatives in this table.

[a] Wastes from these sites (BNL, NTS, and WVDP) are shipped offsite to regional treatment centers.

[b] DOE prefers to further narrow its configuration of LLMW and LLW disposal sites to 2-3 sites. The selection of sites would be made following consultation with regulatory authorities, state and tribal governments, and other interested stakeholders. Impacts for disposal will vary depending on final selection of sites. Cumulative impact estimates use alternatives with maximum potential impacts. For LLMW disposal, Alternative R2 was the basis for INEL, LANL, ORR, and SRS; Alternative R3 was the basis for NTS; and the Alternative C was the basis for Hanford. For LLW disposal, Alternative R3 was used for INEL, LANL, ORR, and SRS; Alternative C1 was used for Hanford; and Alternative C2 was used for NTS.

impacts expected for indefinite storage of LLMW can be found in Section 6.16 of Chapter 6. A brief discussion of the longer term effects of storage of TRUW can be found in Section 8.3.1 of Chapter 8, with a more detailed assessment in the WIPP SEIS-II (DOE, 1996m).

It should also be noted that the No Action Alternative for HLW does not provide enough canister storage for all of the canisters that would be produced after treatment of HLW. Provision of adequate storage capacity would lead to costs and impacts as great as shown for the other HLW alternatives. A discussion of the assumptions made to address this shortage of storage capacity in the HLW analyses is contained in Section 9.3.1 of Chapter 9.

11.2 Cumulative Impacts

The cumulative impacts analysis considers the following impact areas for existing conditions (incorporating past impacts), combined waste management impacts, and impacts of reasonably foreseeable future actions:

Human Health Risk

- Collective radiation dose and cancer risk for the public (over the 10-year period of operations)
- Annual radiation dose for the hypothetical maximally exposed offsite individual
- Collective radiation dose and cancer risk for the worker population at the site (over the 10-year period of operations)
- Number of truck or rail shipments of radioactive waste types to and from each site and the contributions to dose to a maximally exposed individual located 30 m from the site gate

Environmental Quality

- Air quality exceedances (list of those emissions that could exceed air quality standards or guidelines for combined waste management and future actions)
- Groundwater quality exceedances (list of those contaminants that could exceed drinking water standards for combined waste management LLMW and LLW disposal actions and other future actions)

Resource and Infrastructure Requirements

- Land requirements (presented as the percent of suitable land needed for combined waste management and future actions). For purposes of the cumulative impact analysis, the amount of suitable land at each site was based on the total amount of land that could be developed in any way and was defined as the total area of the site minus any areas that are undevelopable because of environmental or other restrictions (e.g., designated wetlands, ecological reserves, and buffer areas). This definition was used for the cumulative impact analysis to enable consideration of the impacts of past and present activities on land availability. In contrast, waste-specific analyses presented in Chapters 6 through 10 were based primarily on land that has been set aside specifically for waste management purposes.
- Percent of current water supply (presented as the percent of existing capacity needed for combined waste management and future actions)
- Percent of current wastewater treatment capacity (presented as the percent of existing capacity needed for combined waste management and future actions)
- Percent of current power capacity (presented as the percent of existing capacity needed for combined waste management and future actions)

Socioeconomic Factors

- Site employment (average number of people employed on an annual basis during operations)

Cumulative impacts for each of the 17 major sites were evaluated by adding the combined impacts of waste management alternatives to the impacts of other past, present, and reasonably foreseeable actions at the site and in the region (largely actions that DOE is considering for other programs). These include actions related to production and management of nuclear materials, management of nuclear fuel, research and development activities, and defense programs as described in various EAs and EISs (Table 11.2-1). Health risks from past DOE operations are not included in the cumulative impact analysis because the data are not currently available for most sites. Although dose reconstruction studies were conducted at several DOE sites, studies have not been conducted at most of the DOE sites.

Section 1.8 describes the relationship between the WM PEIS and other DOE NEPA activities. These other reasonably foreseeable future actions are ones for which an EA or an EIS has been prepared. Activities for which an EIS has not been prepared or for which a permit has not been issued are not considered to be reasonably foreseeable. Where decisions have not been made regarding the preferred alternatives for a

Table 11.2–1. Source Documents Describing Other Activities Included in the Cumulative Impact Analysis

Title	Applicable Sites	Reference
Final Environmental Impact Statement, Waste Isolation Pilot Plant	WIPP	DOE (1980)
Final Supplemental Environmental Impact Statement, Waste Isolation Pilot Plant	WIPP	DOE (1990b)
Final Environmental Impact Statement, Defense Waste Processing Facility	SRS	DOE (1982b)
Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility	SRS	DOE (1994h)
Savannah River Site Waste Management Final Environmental Impact Statement	SRS	DOE (1995c)
Final Environmental Impact Statement, Long-Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley	WVDP	DOE (1982a)
Final Environmental Impact Statement, Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington	Hanford	DOE (1996a)
Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement	Hanford, INEL, SRS	DOE (1995d)
Storage and Disposition of Weapons-Usable Fissile Materials, Draft Environmental Impact Statement	Hanford, INEL, NTS, ORR, Pantex, SRS	DOE (1996b)
Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement	LANL, SNL-NM	DOE (1996c)
Dual Axis Radiographic Hydrodynamic Test Facility, Final Environmental Impact Statement	LANL	DOE (1995e)
Final Environmental Impact Statement for the Tank Waste Remediation System	Hanford	DOE (1996d)
Plutonium Finishing Plant Stabilization Final Environmental Impact Statement	Hanford	DOE (1996e)
Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management	LLNL, LANL, NTS, ORR, Pantex, SRS	DOE (1996f)
The Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada	NTS	DOE (1996g)
Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Services Center	WVDP	DOE & NY ERDA (1996h)
Final F-Canyon Plutonium Solutions Environmental Impact Statement	SRS	DOE (1994g)
Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee	ORR	DOE (1994i)

Table 11.2-1. Source Documents Describing Other Activities Included in the Cumulative Impact Analysis—Continued

Title	Applicable Sites	Reference
Final Environmental Impact Statement for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories	LLNL, SNL-CA	DOE (1992b)
Disposition of Surplus Highly Enriched Uranium, Draft Environmental Impact Statement	ORR, SRS	DOE (1995f)
Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling	SRS	DOE (1995a)
Draft Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components	Pantex	DOE (1996i)
Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan	Hanford	DOE (1996j)
Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Cruiser, Ohio Class and Los Angeles Class Naval Nuclear Plants	Hanford	Navy (1996)
Nonnuclear Consolidation Environmental Assessment	LANL, ORR, RFETS, SNL-NM, SRS	DOE (1993)
Proposed 7-GeV Advanced Photon Source Environmental Assessment	ANL-E	DOE (1990c)
Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories	SNL-NM	DOE (1996k)

Notes: WIPP = Waste Isolation Pilot Plant; SRS = Savannah River Site; WVDP = West Valley Demonstration Project; INEL = Idaho National Engineering Laboratory; NTS = Nevada Test Site; ORR = Oak Ridge Reservation; LANL = Los Alamos National Laboratory; SNL-NM = Sandia National Laboratories (New Mexico); LLNL = Lawrence Livermore National Laboratory.

reasonably foreseeable action, the cumulative impacts analysis considers the range of impacts of those alternatives. Otherwise, only the impacts of the preferred alternative are included in the cumulative impact analysis.

No assumptions are made regarding future baseline conditions at each of the major sites that could potentially reduce impacts, such as cessation of certain ongoing operations that would reduce current levels of radioactive releases. If the preferred alternative of a sitewide EIS identifies changes in site operations, these changes are considered additional foreseeable future actions.

A number of other simplifying assumptions were made to estimate cumulative impacts regarding timing, site location, and consistency of analytical methods. Other existing or planned actions at each site were

assumed to occur over the entire 10-year period of waste management operations. These actions were assumed to be collocated with waste management facilities and therefore assumed to affect the same population and maximally exposed individual. For the assessment of site-specific transportation effects, if shipment contents were not specifically stated in reference documents, it was assumed these contents consisted of HLW, which would result in the highest dose. In addition, some double-counting of impacts occurred in cases where waste management actions would replace some existing activities (e.g., existing shipments of radioactive materials) rather than being added to those activities. These assumptions result in conservative analyses that overestimate actual cumulative impacts. These simplifying assumptions also may result in some differences in estimated impacts between the WM PEIS and site-specific documents. In addition, these simplifying assumptions and other assumptions used in performing calculations can result in some uncertainty regarding projected cumulative impacts. The cumulative impact analysis in the WM PEIS should be used only for evaluating the WM PEIS alternatives; any site-specific analysis is considered to supersede the WM PEIS cumulative analysis for that site.

The impacts of future environmental restoration activities at each of the major waste management sites have been incorporated into the cumulative impact analysis and referenced in all cases where that information is available in existing NEPA documents or in Comprehensive Environmental Response, Compensation, and Liability Act/Resource Conservation and Recovery Act (CERCLA/RCRA) program documents. At some sites, the impacts of future environmental restoration actions cannot be determined because of insufficient characterization of the contamination or because proposals for particular actions are not yet ripe. For these sites, the volumes of environmental restoration wastes are presented in this chapter, and the likely significance of impacts is discussed based on past environmental restoration activities at the site. Cumulative impacts of environmental restoration activities at these sites would be fully analyzed in later site-specific NEPA reviews or in CERCLA/RCRA program documents. Descriptions of the environmental restoration program at each of the major waste management sites are provided in Appendix B. A quantitative evaluation of Greater-than-Class-C waste and special-case waste is not included in the cumulative impact assessment because plans for these activities have not been sufficiently developed (see Sections 1.5.6 and 7.1.1) but would be the subject of site-specific and project-specific evaluations.

The following cumulative impact analyses focus on several key impact categories that include the human health risks to the offsite population and a hypothetical maximally exposed individual as a result of radioactive releases, potential air quality and water quality exceedances, resource and onsite infrastructure impacts, and changes in site employment. The human health risks to the offsite population are reported as

collective exposures and risks for the 10-year period of operation, while the dose to the maximally exposed individual is reported as an annual value. Annual exposures are used for the maximally exposed individual because annual exposures facilitate a direct comparison to the U.S. Environmental Protection Agency's (EPA's) standard of a 10-millirem exposure per year to a maximally exposed individual from atmospheric releases and DOE's standard of a 100-millirem exposure per year to a maximally exposed individual from all pathways. A cumulative impacts table containing the impact categories and the major elements comprising the cumulative impacts is presented for each of the major sites. These elements include the existing conditions at the site (which incorporate residual impacts from past actions), the combined impacts of the waste management alternatives (maximum and minimum alternatives and preferred alternatives) analyzed in this WM PEIS, and the impacts of other reasonably foreseeable future actions as described in recent EISs by DOE and others. The number of impact categories addressed as part of the cumulative impact analysis for each of the major sites is limited both by the availability of information (e.g., estimated chemical cancer incidences as a result of chemical releases are not reported for all other potential actions at a site) and by differences in assessment methodologies.

The following sections identify and discuss the combined and cumulative impacts for each of the major sites, followed by a discussion of combined and cumulative transportation impacts.

11.3 Argonne National Laboratory-East

Argonne National Laboratory-East (ANL-E) conducts programs in basic energy and related sciences. The existing environmental conditions at ANL-E resulting from these ongoing activities are described in Chapter 4.

11.3.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at ANL-E. Table 11.3-1 lists the minimum and maximum combined impacts of the waste management alternatives for ANL-E. Generally, the most adverse impacts that could occur at ANL-E and in the region would result from the Decentralized Alternatives, which involve construction of treatment and disposal facilities for ANL-E to manage its own waste. The least adverse impacts generally would result from the Regionalized and Centralized Alternatives, for which ANL-E would package and ship its waste for offsite treatment and disposal. The impacts of

Table 11.3–1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.2E–03	N	5.2E–01	R1-C	5.9E–07	N	2.6E–04	R1-C	6.2E–09	N	6.2E–06
Low Level[a]	N	4.7E–03	D-C5	5.0E–03	N	2.3E–06	D-C5	2.5E–06	--	--	--	--
Transuranic	N	1.2E–03	D	4.0E–03	N	6.2E–07	D	2.0E–06	N	3.8E–10	R1-C	2.9E–09
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**7.1E–03**		**5.3E–01**		**3.5E–06**		**2.6E–04**		**6.6E–09**		**6.2E–06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.5E–09	N	2.8E–06	R1-C	3.3E–12	N	1.4E–09	R1-C	3.9E–14	N	3.9E–11
Low Level[a]	N	2.6E–08	D-C5	2.8E–08	N	1.3E–11	D-C5	1.4E–11	--	--	--	--
Transuranic	N	6.9E–09	D	2.2E–08	N	3.5E–12	D	1.1E–11	D,N	0.0E+00	R1-C	1.3E–14
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.9E–08**		**2.9E–06**		**2.0E–11**		**1.4E–09**		**3.9E–14**		**3.9E–11**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10/yr)				Radiation Dose From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R1-C	20 / 20	N	0.0E+00	R1-C	3.20E–07	N	0.0E+00	R1-C	3.20E–07
Low Level[a]	D	450 / 180	N	1,060 / 400	D	7.20E–06	N	1.70E–05	D	2.90E–06	N	6.40E–06
Transuranic	N	0 / 0	D	590 / 300	N	0.0E+00	D	7.10E–05	N	0.0E+00	D	7.40E–05
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**450 / 180**		**1,670 / 720**		**7.2E–06**		**8.8E–05**		**2.9E–06**		**8.1E–05**

Table 11.3-1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.7E-06	N	2.5E-03	R1-C	8.6E-10	N	1.2E-06	R1-C	1.3E-10	N	1.3E-07
Low Level[a]	N	1.9E-05	D-C5	2.0E-05	N	9.3E-09	D-C5	9.8E-09	--	--	--	--
Transuranic	N	6.5E-06	D	2.1E-05	N	3.2E-09	D	1.0E-08	N	8.0E-12	R1-C	6.0E-11
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.7E-05**		**2.5E-03**		**1.3E-08**		**1.2E-06**		**1.3E-10**		**1.3E-07**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Types of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	N	0.6	D	2.3
Low Level	All/None	All/None	All	None	All	None	N	0.8	D	4.1
Transuranic	All/None	All/None	--	--	--	--	N	0	D	2.7
High Level[b]	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--
Total	**None[d]**	**None**		**None**		**None**		**1.4**		**9.1**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	1,336	D	2,825	N	37	D	919	R1-C	0.01	D	0.31
Low Level	N	1,875	D	12,053	N	640	D	1,014	N	0.11	D	1.70
Transuranic	N	921	D	4,769	N	921	D	1,509	N	0.09	D	0.44
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4,132**		**19,647**		**1,598**		**3,442**		**0.21**		**2.45**

Table 11.3–1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.00	D-C	<0.01	N	0.00	D-C	<0.01	N	22	D	59
Low Level	N,R1-C5	0.00	D	0.01	All	0.00	All	0.00	R1-C5	106	D	389
Transuranic	N	0.00	D-C	0.01	All	0.00	All	0.00	N	104	R2-C	334
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.00**		**0.02**		**0.00**		**<0.01**		**232**		**782**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Argonne National Laboratory-East does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

preferred alternatives at ANL-E are below the impacts of the maximum combined waste management alternatives at the site.

11.3.2 CUMULATIVE IMPACTS

Aside from continuing operations, the waste management activities considered in this PEIS, and environmental restoration activities, DOE has no other actions planned at ANL-E. The Advanced Photon Source (APS), an already-constructed accelerator facility (DOE, 1990c), recently became operational; its operation is considered a reasonably foreseeable future action for the purposes of this analysis. No other DOE or non-DOE actions are planned in the ANL-E region that would contribute to the cumulative impact of the alternatives.

The environmental restoration program at ANL-E will address cleanup of an estimated 148,000 m^3 of contaminated media and facilities (140,000 m^3, 8,800 m^3, and 190 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the NEPA reviews completed to date. Project-specific environmental evaluations that consider cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.3-2 identifies the range of cumulative impacts that could occur at ANL-E. As identified in Table 11.3-2, the minimum and maximum annual radioactive releases from waste management and other future actions (including transportation) would not measurably increase the current levels of risks from radioactive releases. ANL-E would continue to be below the EPA standard of 10 millirems per year to the maximally exposed offsite individual.

ANL-E is in a nonattainment region for particulates and for ozone. While the expected atmospheric emissions of particulates and ozone-producing contaminants under the alternatives would increase the levels of these emissions, the increases would be below the regulated levels in the nonattainment region. Disposal of LLMW or LLW at ANL-E under any alternative are not expected to result in any exceedances of drinking water standards in groundwater.

Table 11.3-2. Argonne National Laboratory-East Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.7E+02	7.1E-03	5.3E-01	4.20E-02	not reported	1.7E+02	1.7E+02	1.7E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0		~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	8.5E-03	3.9E-06	2.9E-04	2.3E-05	6.0E+00	6.0E+00	6.0E+00	6.0E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	4.3E+01	7.9E+01	2.1E+02	1.0E+02	not reported	1.2E+02	2.5E+02	1.4E+02
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0		~0	1.0E-01	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	1,080	450	1,670	1,660	0	1,530	2,750	2,740
Number of rail shipments (10 yr)		0	180	720	710	0	180	720	710
Annual dose (mrem) from truck transport		4.3E-01	7.2E-04	8.8E-03	8.83E-03	0.0E+00	4.3E-01	4.4E-01	4.4E-01
Annual dose (mrem) from rail transport		0.0E+00	2.9E-04	8.1E-03	8.06E-03	0.0E+00	2.9E-04	8.1E-03	8.1E-03
Resources and Infrastructure									
Land requirement (% of suitable area)		30%	0.09%	0.61%	0.43%	4.67%	35%	35%	35%
Water use (% of total capacity)		36%	0.23%	1.09%	0.54%	4.50%	41%	41%	41%
Wastewater production (% of treatment capacity)		60%	0.09%	0.19%	0.17%	4.40%	64%	65%	65%
Power demand (% current load)		96%	0.88%	10.21%	4.00%	142.00%	239%	248%	242%
Employment									
Number of site workers	(7)	4,670	86	247	132	300	5,056	5,217	5,102
Air Quality Exceedances	(8)	PM_{10}, ozone	None	None	None	None	PM_{10}, ozone	PM_{10}, ozone	PM_{10}, ozone
Groundwater Quality Exceedances	(9)	5 parameters exceeded	None	None	None	None	5 parameters exceeded	5 parameters exceeded	5 parameters exceeded

[a] Other reasonably foreseeable future actions planned by DOE at ANL include operation of the recently constructed Advanced Photon Source (DOE, 1990c).
[b] Sum of impacts of existing operations, combined waste management impact, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5E-04 cancer fatalities per person-rem. Calculated values less than 1E-01 are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point. Excludes radon-220, which is not subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) limits. Exposure from existing operations at ANL-E including radon-220 = 0.24 mrem.
(4) Includes both waste management and noninvolved workers. Assumes 4E-04 cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and is not an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in or be a substantial contributor to nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined actions would affect between 1 and 9 acres of land at ANL-E. This area is less than 1% of the total ANL-E site and less than 1% of the area available for waste management facilities. The increased demand for power under the maximum combined alternatives represents about 10% of current capacity, while the combined alternatives would not measurably change the current demand at ANL-E for water or wastewater treatment. Cumulatively, power demand would increase substantially as a result of operation of the new APS facility.

The combined waste management alternatives could add up to 247 jobs at ANL-E, or an approximately 5% increase at the maximum. The maximum increase in jobs at ANL-E would not be expected to result in offsite community infrastructure or institutional impacts because of the extremely large population and employment base of the ANL-E region.

11.4 Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) would continue in the future to conduct programs in basic and applied research in the physical, biomedical, and environmental sciences and selected energy technologies. The existing environmental conditions at BNL resulting from these ongoing activities are described in Chapter 4.

11.4.1 Combined Waste Management Impacts

DOE considered the management of LLMW[1] and LLW at BNL. Table 11.4-1 lists the minimum and maximum combined impacts of the waste management alternatives for BNL. The most adverse impacts at BNL and in the BNL region would result from the decentralized alternatives, for which treatment and disposal facilities would be constructed for BNL to manage its own waste. The least adverse impacts at BNL and in the BNL region generally would result from the regionalized and centralized alternatives for which BNL would package and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at BNL are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

[1] Analysis of LLMW impacts at BNL assumed an inventory of 85 cubic meters and 20-year projected volume of 110 cubic meters. Updated information from the site indicates that there are 10 cubic meters in inventory and a projected 20-year volume of 20-cubic meters. Therefore, LLMW impacts reported for BNL are expected to be conservative.

Table 11.4–1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.0E–04	N	2.3E–01	R1-C	5.2E–08	N	1.1E–04	R1-C	9.0E–09	N	8.0E–06
Low Level[a]	D	1.9E–05	R1-C5	4.7E–03	D	9.7E–09	R1-C5	2.3E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.2E–04**		**2.6E–01**		**6.0E–08**		**1.1E–04**		**9.0E–09**		**8.0E–06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.4E–09	N	3.0E–06	R1-C	7.0E–13	N	1.5E–09	R1-C	1.5E–13	N	1.3E–10
Low Level[a]	D	2.6E–10	R1-C5	6.2E–08	D	1.3E–13	R1-C5	3.1E–11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.7E–09**		**3.1E–06**		**8.3E–13**		**1.5E–09**		**1.5E–13**		**1.3E–10**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D,N	0 / 0	R1-C	20 / 20	D,N	0.0E+00	R1-C	3.20E–07	D,N	0.0E+00	R1-C	3.20E–07
Low Level	D	0 / 0	N / N, R4,C3, C4	1,360 / 520	D	0.0E+00	N	2.18E–05	D	0.0E+00	N,R4, C3, C4	8.32E–06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**1,380 / 540**		**0.0E+00**		**2.2E–05**		**0.0E+00**		**8.6E–06**

Table 11.4-1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.4E-07	N	1.4E-03	R1-C	3.2E-10	N	7.0E-07	R1-C	3.1E-10	N	2.8E-07
Low Level[a]	D	4.8E-08	R1-C5	2.4E-05	D	2.4E-11	R1-C5	1.2E-08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**6.9E-07**		**1.6E-03**		**3.4E-10**		**7.1E-07**		**3.1E-10**		**2.8E-07**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R1-C	0.0	D	1.6
Low Level	N,R1-C5/None	D/NO_2	All	None	All	None	N,R1-C5	1.2	D	2.8
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**NO_2**		**None**		**None**		**1.2**		**4.4**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	42	D	2,083	R1-C	42	D	370	R1-C	0.06	N	0.23
Low Level	N,R1-C5	1,258	D	8,000	N,R1-C5	441	D	865	N,R1-C5	0.12	D	1.10
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1,300**		**10,083**		**483**		**1,235**		**0.18**		**1.33**

Table 11.4–1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R1-C	0.00	D	0.01	All	0.00	All	0.00	R1-C	8	D	84
Low Level	N,R1-C5	<0.01	D	0.02	N,R1-C5	<0.01	D	0.01	N,R1-C5	111	D	230
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.00**		**0.03**		**0.00**		**0.01**		**119**		**314**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Brookhaven National Laboratory does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives. Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

11.4.2 CUMULATIVE IMPACTS

Aside from continuation of existing operations, the waste management activities considered in this PEIS, and environmental restoration activities, DOE has no other actions planned at BNL. No other DOE or non-DOE actions are planned in the BNL region that would contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at BNL will address cleanup of an estimated 139,800 m^3 of contaminated media and facilities (19,000 m^3 and 120,800 m^3 of LLMW and LLW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, no major changes are anticipated from ongoing environmental restoration activities, and any future impacts should be similar to those occurring under existing operations. Project-specific environmental evaluations that consider cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.4–2 identifies the range of cumulative impacts that could result from the combined waste management alternatives and current operations and activities at BNL. As identified in Table 11.4–1, the maximum annual radioactive releases to the atmosphere from waste management activities (including transportation) would result in some increase in dose to the offsite population; however, BNL atmospheric releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

BNL is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under the alternatives would increase the levels of ozone, the increases would be below the regulated levels in the nonattainment region. The maximum combined alternatives could result in exceedance of the air quality standard for NO_2. Mitigation would be required to maintain compliance should these alternatives be chosen. The combined preferred alternatives are not expected to result in an exceedance of the NO_2 standard. Disposal of LLMW or LLW at BNL under any alternative is not expected to result in any exceedances of drinking water standards in groundwater.

The combined actions would affect a maximum of 4 acres of land. This area is less than 1% of the total suitable acreage at BNL and less than 1% of the area available for waste management facilities. Onsite infrastructure demands for water and power and the generation of wastewater would not measurably

Table 11.4–2. Brookhaven National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.7E+01	1.2E-04	2.6E-01	4.8E-03	--	2.7E+01	2.7E+01	2.7E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.1E-01	1.7E-07	3.1E-04	6.3E-06	--	1.1E-01	1.1E-01	1.1E-01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	NA	9.9E+01	1.9E+02	9.9E+01	--	9.9E+01	1.9E+02	9.9E+01
Number of cancer fatalities from collective dose	(1)	NA	~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	80	0	1,380	1,370	--	80	1,460	1,370
Number of rail shipments (10 yr)		0	0	540	530	--	0	540	530
Annual dose (mrem) from truck transport		3.2E-02	0.0E+00	2.2E-03	2.23E-03	--	3.2E-02	3.4E-02	2.2E-03
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	8.6E-04	8.52E-04	--	0.0E+00	8.6E-04	8.5E-04
Resources and Infrastructure									
Land requirement (% of suitable area)		36%	0.03%	0.10%	0.03%	--	36%	36%	36%
Water use (% of total capacity)	(6)	75%	0.02%	0.17%	0.02%	--	75%	75%	75%
Wastewater production (% of treatment capacity)		43%	0.02%	0.05%	0.02%	--	44%	44%	44%
Power demand (% current load)		74%	0.38%	2.83%	0.38%	--	75%	77%	75%
Employment									
Number of site workers	(7)	3,557	41	105	41	--	3,598	3,744	3,598
Air Quality Exceedances	(8)	Ozone	None	NO_2	None	--	Ozone	Ozone, NO_2	Ozone
Groundwater Quality Exceedances	(9)	8 parameters exceeded	None	None	None	--	8 parameters exceeded	8 parameters exceeded	8 parameters exceeded

[a] Aside from continuation of existing operations, waste management activities, and environmental restoration actions, no other future actions are planned by DOE at BNL.
[b] Sum of impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5E-04 cancer fatalities per person-rem. Calculated values less than 1E-01 are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both waste management and noninvolved workers. Assumes 4E-04 cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and is not an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in or be a substantial contributor to nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

increase as a result of the combined alternatives. The combined alternatives could add up to 105 jobs at BNL, or an approximately 3% increase at the maximum, which would not affect offsite community infrastructures or institutions.

11.5 Fernald Environmental Management Project

The Fernald Environmental Management Project (FEMP) will continue in the future to conduct site cleanup and support waste management and base service activities. The existing environmental conditions at FEMP resulting from these ongoing activities are described in Chapter 4.

11.5.1 Combined Waste Management Impacts

DOE considered the management of LLMW and LLW at FEMP. Table 11.5-1 lists the minimum and maximum impacts of the alternatives for FEMP. The most adverse impacts at FEMP and in the FEMP region would occur as a result of Regionalized Alternatives for which treatment and disposal facilities would be constructed for FEMP to manage its own waste, as well as the treatment of LLMW from other sites.

Other Regionalized or Centralized Alternatives for which FEMP would only prepare and package waste for offsite treatment and disposal would result in the least adverse impacts. For most impact categories, the combined impacts of the preferred alternatives at FEMP are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.5.2 Cumulative Impacts

Aside from continuation of existing operations, the waste management activities considered in this PEIS, and future environmental restoration activities, DOE has no other actions planned at FEMP. No other DOE or non-DOE actions are planned in the FEMP region that would contribute to the cumulative impacts of waste management alternatives. The environmental impacts of environmental restoration activities have been presented in various CERCLA documents (DOE 1994j, k; 1995g, h; 1996l).

Table 11.5-1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2.9E-04	R1	1.4E+00	R2-C	1.4E-07	R1	7.0E-04	R2-C	9.2E-08	N	3.3E-05
Low Level[a]	--	--	R2	4.6E+02	--	--	R2	2.3E-01	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.9E-04**		**4.6E+02**		**1.4E-07**		**2.3E-01**		**9.2E-08**		**3.3E-05**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	5.4E-09	R1	2.6E-05	R2-C	2.7E-12	R1	1.3E-08	R2-C	2.9E-12	N	1.1E-09
Low Level[a]	--	--	R2	8.8E-03	--	--	R2	4.4E-06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.4E-09**		**8.8E-03**		**2.7E-12**		**4.4E-06**		**2.9E-12**		**1.1E-09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R1	1,060 / 410	N,D	0.0E+00	R1	1.70E-05	N,D	0.0E+00	R1	6.60E-06
Low Level[a]	--	--	R2	910 / 400	--	--	R2	1.50E-05	--	--	R2	6.40E-06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**1,970 / 810**		**0.0E+00**		**3.25E-05**		**0.0E+00**		**1.3E-05**

Table 11.5–1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2.1E–06	R1	9.4E–03	R2-C	1.1E–09	R1	4.7E–06	R2-C	6.4E–09	N	2.3E–06
Low Level[a]	--	--	R2	1.0E+00	--	--	R2	5.2E–04	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.1E–06**		**1.0E+00**		**1.1E–09**		**5.2E–04**		**6.4E–09**		**2.3E–06**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	--	--	D, R1	U-238	R2-C	1.4	R1	12.3
Low Level[a]	R2/None	R2/None	--	--	--	--	N,D,R1, R3-C5	0.0	R2	3.9
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**				**1.4**		**16.2**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2,104	R1	23,556	N	1,013	R1	4,630	R2-C	0.76	N	2.65
Low Level[a]	--	--	R2	5,254	--	--	R2	2,403	--	--	R2	0.50
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2,104**		**28,810**		**1,013**		**7,033**		**0.76**		**3.15**

Table 11.5-1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.01	R1	0.07	N,R2-C	0.01	R1	0.04	N	107	R1	584
Low Level[a]	--	--	R2	0.04	--	--	R2	0.02	N,D,R1, R3-C5	0	R2	312
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.01**		**0.11**		**0.01**		**0.06**		**107**		**896**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] The Fernald Environmental Management Project does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives. Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.5-2 identifies the range of cumulative impacts that could result from the combined waste management alternatives, current activities, and future actions at FEMP. However, the radiological effects of environmental restoration activities at FEMP are not included in this analysis because of differences in analytical approaches. As identified in Table 11.5-1, the maximum annual radioactive releases to the atmosphere from combined waste management activities (including transportation) would result in some increase in dose to the offsite population; however, atmospheric radioactive releases from existing operations and waste management activities would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite. FEMP is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under the combined alternatives would increase the levels of ozone, the increases would be below the regulated levels in the nonattainment region.

The combined actions could affect a maximum of 16 acres of land. This area is less than 2% of the total suitable acreage at FEMP and 6% of the area available for waste management facilities. Other actions could affect 208 acres of the FEMP site. Onsite cumulative demands for water, wastewater treatment, and power could exceed existing capacities. The combined alternatives could add up to 328 jobs at FEMP, or a maximum increase of about 15% over existing employment. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the FEMP region.

Disposal of LLMW at FEMP under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of drinking water standards in groundwater for U-238. Mitigation could be required to maintain compliance with drinking water standards should either of these alternatives be selected. No disposal of LLMW at FEMP would occur under the preferred alternative.

11.6 Hanford Site

The Hanford Site would continue in the future to conduct programs for waste disposal technologies and cleanup of site contamination. The existing environmental conditions at the Hanford Site resulting from these ongoing activities are described in Chapter 4.

Table 11.5-2. Fernald Environmental Management Project Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.3E+01	2.90E-04	4.60E+02	5.20E-02	Not available	1.30E+01	4.73E+02	1.31E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	2.30E-01	~0	Not available	~0	2.37E-01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.10E-03	5.40E-07	8.80E-01	9.70E-05	Not available	2.10E-03	8.82E-01	2.20E-03
Worker Population									
Collective dose, 10 years (person-rem)	(4)	6.75E+02	6.30E-01	8.47E+01	7.30E-01	Not available	6.76E+02	7.60E+02	6.76E+02
Number of cancer fatalities from collective dose	(1)	2.70E-01	~0	~0	~0	Not available	2.70E-01	3.04E-01	2.70E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	4,460	0	1,970	110	Not available	4,460	6,430	4,570
Number of rail shipments (10 yr)		0	0	810	50	Not available	0	810	50
Annual dose (mrem) from truck transport		1.8E+00	0.0E+00	3.2E-03	1.80E-04	Not available	1.8E+00	1.8E+00	1.8E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.3E-03	8.10E-05	Not available	0.0E+00	1.3E-03	8.1E-05
Resources and Infrastructure									
Land requirement (% of suitable area)		32%	0.16%	1.89%	0.99%	24.33%	57%	58%	57%
Water use (% of total capacity)		25%	0.13%	1.80%	1.10%	2,550%	2,575%	2,577%	2,576%
Wastewater production (% of treatment capacity)		96%	0.04%	0.31%	0.12%	9.52%	106%	106%	106%
Power demand (% current load)		91%	2.30%	9.55%	6.55%	6.00%	99%	106%	103%
Employment									
Number of site workers	(7)	2,124	38	328	134	0	2,162	2,452	2,258
Air Quality Exceedances	(8)	Ozone	None	None	None	None	Ozone	Ozone	Ozone
Groundwater Quality Exceedances	(9)	11 parameters exceeded	None	U-238	None	None	11 parameters exceeded	11 parameters exceeded	11 parameters exceeded

[a] Aside from waste management and environmental restoration activities, no other future actions are planned by DOE at FEMP. The impacts of environmental restoration activities have been presented in DOE 1994j, 1994k, 1995g, 1995h, 1996. In some cases, impacts were not presented in a manner that allowed addition to this table.

[b] Sum of impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.

[c] Cumulative impacts, including minimum combined waste management impacts.

[d] Cumulative impacts, including maximum combined waste management impacts.

Notes

(1) Assumes all facilities operate concurrently for the same 10-year period.

(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).

(3) Based in DOE (1994a), which contains releases for the year 1992. Excludes radon-220, which is not subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) limits. Exposure from existing operations at FEMP including radon-220 = 51 mrem.

(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.

(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.

(6) Suitable land includes land that is available for development or that is currently developed.

(7) Average annual employment operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.

(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements.

(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.6.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at the Hanford Site. Table 11.6–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for the Hanford Site. The most adverse impacts at the Hanford Site and in the Hanford Site region would occur as a result of some Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for the Hanford Site to manage its own waste and accept offsite LLMW and LLW for treatment and disposal, offsite TRUW for treatment, and offsite HLW canisters for storage. The least adverse impacts at Hanford and in the Hanford region generally would result from the No Action, Decentralized, and some Regionalized Alternatives for which the Hanford Site would be primarily responsible for its own waste, would package and ship its wastes for offsite treatment and disposal, or would only receive small quantities of waste from other sites for treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at Hanford are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.6.2 Cumulative Impacts

Aside from continuation of existing operations and the waste management activities considered in this PEIS, there are a number of other actions planned or being undertaken by DOE at the Hanford Site that have been the subject of various recent EISs. These include the (1) development of a tank waste remediation system (DOE, 1996d); (2) management of spent nuclear fuel from K Basin (DOE, 1996a); (3) disposal of decommissioned, defueled Cruiser, Ohio Class, and Los Angeles Class Naval nuclear plants (Navy, 1996); (4) storage and disposition of weapons-usable fissile materials (DOE, 1996b); (5) plutonium finishing plant stabilization (DOE, 1996e); and (6) DOE spent nuclear fuel management (DOE, 1995d). The findings presented in these EISs are included in the cumulative impacts analysis presented here.

Future environmental restoration activities at the Hanford Site include the decontamination and decommissioning of facilities (including eight surplus reactors) and groundwater remediation. Environmental contamination is present in some areas of the Hanford Site, and major efforts will be required to achieve the current cleanup scenario. The current cleanup scenario for the Hanford Site is considered in the *Draft Hanford Remedial Action EIS and Comprehensive Land Use Plan* (DOE, 1996j). This document analyzes the potential environmental impacts associated with establishing future land-use objectives for the site. Impact analysis was performed by examining the consequences (primarily from

Table 11.6–1. Hanford Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1	2.7E+00	C	5.0E+01	R1	1.4E–03	C	2.5E–02	D,R1	1.1E–06	N,C	1.2E–05
Low Level[a]	N	8.3E–04	C5	1.5E+02	N	4.2E–07	C5	7.5E–02	--	--	--	--
Transuranic	N	1.5E–02	R2,3	3.3E+02	N	5.3E–06	R2,3	1.7E–01	N	2.6E–11	R1-R3	1.3E–10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	R1	4.3E–03
Total		**2.7E+00**		**5.3E+02**		**1.4E–03**		**2.7E–01**		**1.1E–06**		**4.3E–03**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1	5.6E–05	C	1.0E–03	R1	2.8E–08	C	5.2E–07	R1	3.6E–11	N,C	4.1E–10
Low Level[a]	N	1.7E–08	C5	3.1E–03	N	8.6E–12	C5	1.5E–06	--	--	--	--
Transuranic	N	3.0E–07	R2,3	6.8E–03	N	1.5E–10	R2,3	3.4E–06	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	R1	1.4E–07
Total		**5.6E–05**		**1.1E–02**		**2.8E–08**		**5.4E–06**		**3.6E–11**		**1.4E–07**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck / Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	C	7,520 / 3,340	N	0.0E+00	C	1.2E–04	N	0.0E+00	C	5.4E–05
Low Level	D, R1-3	0 / 0	C1	242,730 / 91,440	D, R1-R3	0.0E+00	C1	3.9E–03	D, R1-R3	0.0E+00	C1	1.5E–03
Transuranic	N	0 / 0	R2-3	11,830 / 5,930	N	0.0E+00	R2-R3	1.8E–03	N	0.0E+00	R2-R3	1.8E–03
High Level	N, D, R1	15,000 / 3,000	C2	28,224 / 5,646	N, D, R1	6.0E–03	C2	1.1E–02	N, D, R1	1.2E–03	C2	2.3E–03
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**15,000 / 3,000**		**290,304 / 106,356**		**6.0E–03**		**1.7E–02**		**1.2E–03**		**5.7E–03**

Waste Type	Noninvolved Worker Health Risks											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D,R1	1.0E–01	C	6.6E–01	R1	5.2E–05	C	3.3E–04	R1	6.5E–07	N,C	7.3E–06
Low Level[a]	N	3.0E–05	C5	1.9E+00	N	1.5E–08	C5	9.7E–04	--	--	--	--
Transuranic	N	7.0E–04	R2,R3	1.6E+01	N	3.5E–07	R2,R3	8.2E–03	N	1.6E–11	R1	7.9E–11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,D,R2	0.0E+00	R1	2.6E–03
Total		**1.0E–01**		**1.8E+01**		**5.2E–05**		**9.5E–03**		**6.5E–07**		**2.6E–03**

Table 11.6–1. Hanford Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	C/PM_{10}	--	--	D, R1, R2, R4, C	U-238, 4 hazardous chemicals[c]	N	1.8	C	50.2
Low Level	All/None	All/None	--	--	N, D, R1-R6, C1, C3, C5	U-238	R7,C2	3.7	C5	86.4
Transuranic	All/None	All/None	--	--	--	--	N	0	R2,3	24.7
High Level	All/None	All/None	--	--	--	--	N	1	C	16.0
Hazardous	All/None	All/None	--	--	--	--	--	--	R1	1
Total	**None[d]**	**NO_2, PM_{10}**		**None**		**U-238, 4 hazardous chemicals[e]**		**6.5**		**178.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	3,038	C	87,637	N	2,573	C	43,085	N	1.14	C	8.33
Low Level	R7,C2	6,887	C5	199,473	R7,C2	1,615	C5	101,650	R7,C2	0.83	C3	34.62
Transuranic	N	2,796	R2,3	64,729	N	2,796	R2,R3	15,519	N	0.30	R2, 3	3.60
High Level	N	3,200	D-C	8,000	N	3,200	D-C	8,000	N	0.06	C	0.10
Hazardous	--	--	R1	1,366	--	--	R1	933	--	--	R1	0.28
Total		**15,921**		**361,205**		**10,184**		**169,187**		**2.33**		**46.93**

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.09	C	1.66	N	0.05	C	0.76	N	260	C	3,968
Low Level	R7,C2	0.10	C5	3.34	R7,C2	0.04	C5	1.50	R7,C2	238	C5	7,961
Transuranic	N	0.10	R2,3	1.05	N	0.14	R2,3	0.39	N	287	R2,3	2,491
High Level	N	0.06	R2,C	0.14	N	0.04	D-C	0.08	N	826	C	1,734
Hazardous	--	--	R1	0.03	N,D,R2	0.00	R1	0.01	N,D	0	R1	70
Total		**0.35**		**6.22**		**0.27**		**2.74**		**1,611**		**16,224**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

remediation activities) of the actions determined necessary to achieve desired future land-use objectives. Site-specific decisions regarding remediation technologies and remediation activities would not be made based on the Draft Hanford Remedial Action EIS, but rather by a process specified in the Comprehensive Environmental Response Compensation and Liability Act of 1980 and the Resource Conservation and Recovery Act of 1976.

To facilitate the establishment of future land-use objectives, the Hanford Site was divided into four geographic areas: (1) Columbia River, (2) Reactors on the River, (3) Central Plateau, and (4) All Other Areas. The future land-use alternatives considered in detail in the Hanford Remedial Action Draft EIS and for each of the geographic areas are as follows:

- Columbia River—Unrestricted and Restricted
- Reactors on the River—Unrestricted and Restricted
- Central Plateau—Exclusive
- All Other Areas—Restricted

The impacts of remediation in these areas at Hanford are included as reasonably foreseeable impacts in this section.

In addition to these programs being conducted at the Hanford Site, other non-DOE nuclear facilities at or near the Hanford Site contribute to radioactive releases and potentially to cumulative impact. These facilities include the commercial radioactive burial ground at the Hanford Site, the commercial nuclear generating station at the Hanford Site, a nuclear fuel production plant, a commercial low-activity radioactive waste compacting facility, and a commercial decontamination facility.

Table 11.6–2 identifies the range of cumulative impacts resulting from these other actions, the waste management alternatives, and current activities. To calculate the cumulative impacts of the alternatives for the Hanford Site, DOE used the impacts of the preferred alternative contained in the EISs mentioned above.

As identified in Table 11.6–2, the maximum annual radioactive releases to the atmosphere from the combined waste management activities (including transportation) would result in an increase in the dose to the offsite population. The maximum increase in radioactive releases under the combined alternatives primarily results from the Hanford Site being considered as the single candidate site for the treatment and disposal of all contact-handled LLMW and LLW under the Centralized Alternatives. Cumulative radioactive

Table 11.6–2. Hanford Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	6.00E+00	2.70E+00	5.30E+02	2.75E+00	2.74E+02	2.83E+02	8.10E+02	2.83+02
Number of cancer fatalities from collective dose	(2)	~0	~0	2.65E-01	~0	1.37E-01	1.41E-01	4.05E-01	1.41E-01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	3.70E-03	5.60E-03	1.10E+00	5.71E-03	1.91E+00	1.92E+00	3.01E+00	1.92E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.10E+03	3.53E+03	1.59E+04	1.31E+04	1.26E+04	1.82E+04	3.06E+04	2.78E+04
Number of cancer fatalities from collective dose	(1)	8.40E-01	1.41E+00	6.37E+00	5.23E+00	5.03E+00	7.29E+00	1.22E+01	1.11E+01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	1,310	15,000	290,304	275,510	830	17,140	292,444	277,650
Number of rail shipments (10 yr)		0	3,000	106,356	102,920	0	3,000	106,356	102,920
Annual dose (mrem) from truck transport		5.2E-01	6.0E-01	1.68E+00	1.12E+00	3.3E-02	1.16E+00	2.2E+00	1.68E+00
Annual dose (mrem) from rail transport		0.0E+00	1.2E-01	5.65E-01	3.95E-01	0.0E+00	1.2E-01	5.7E-01	3.95E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	11%	0.00%	0.09%	0.06%	0.98%	12%	12%	12%
Water use (% of total capacity)		12%	0.02%	0.46%	0.29%	0.94%	13%	13%	13%
Wastewater production (% of treatment capacity)		79%	5.09%	84.59%	39.68%	4.35%	88%	168%	123%
Power demand (% current load)		17%	0.66%	13.34%	12.52%	22.74%	40%	53%	52%
Employment									
Number of site workers	(7)	14,613	609	5,343	3,659	10,260	25,482	30,216	28,532
Air Quality Exceedances	(8)	None	None	NO_2, PM_{10}	None	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240
Groundwater Quality Exceedances	(9)	14 parameters exceeded	None	U-238, 4 hazardous chemicals[e]	U-238, 4 hazardous chemicals[e]	U-238	15 parameters exceeded	18 parameters exceeded	18 parameters exceeded

[a] Other reasonably foreseeable future actions include actions addressed in EISs related to spent nuclear fuel management (including spent nuclear fuel from foreign research reactors) (DOE, 1995d), tank waste remediation system (DOE, 1996d), management of spent nuclear fuel from the K Basin (DOE, 1996a), disposal of decommissioned Naval nuclear plants (Navy, 1996), storage and disposition of weapons-grade fissile materials (DOE, 1996c), plutonium finishing plant stabilization (DOE, 1996e), and remedial actions (DOE 1996j).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based in DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

releases, including the maximum releases associated with the combined WM PEIS alternatives and contributions estimated at 0.05 millirems per year from commercial nuclear facilities at or near the Hanford Site, would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

The Hanford Site is in an attainment region where criteria air pollutants do not exceed standards. In the alternatives that result in maximum atmospheric emissions, the standards for NO_2 and particulate (PM_{10}) emissions could be exceeded; mitigation measures would be necessary to reduce these emissions if these alternatives are chosen. The combined preferred alternatives are not expected to result in exceedance of any air quality standards. Remedial action at Hanford could result in temporary exceedances of standards for several additional compounds.

The combined alternatives would affect between 7 and 178 acres of land at the Hanford Site. This area is less than 1% of the total suitable acreage at Hanford and 3% of the area available for waste management facilities. Other actions could affect another 1,949 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of about 1% of the suitable acreage at the Hanford Site, the land affected may require detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts prior to disturbance.

Although the cumulative demand for water and power would not be greatly affected by the combined alternatives, a maximum cumulative increase of 169% in wastewater generation could require new or upgraded wastewater treatment facilities at the Hanford Site. The combined alternatives could add up to 5,343 jobs at the Hanford Site, while other actions could increase the number of jobs at the Hanford Site by 10,260. Cumulatively, the number of jobs at Hanford could increase by up to 107% over current employment levels, which could impact existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse impacts resulting from this increase in employment.

Disposal of LLMW at the Hanford Site under the Decentralized Alternative; Regionalized Alternatives 1, 2, and 4; and the Centralized Alternative could result in exceedances of drinking water standards in groundwater for benzene, carbon tetrachloride, 1,2-dichloroethane, methylene chloride, and U-238. Disposal of LLW at Hanford could result in concentrations of U-238 that exceed drinking water standards under the Decentralized Alternative; Regionalized Alternatives 1 through 6; and Centralized Alternatives 1,

3, and 5. Disposal under the combined preferred alternatives for LLMW and LLW would result in these same groundwater quality exceedances. To meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW and LLW.

11.7 Idaho National Engineering Laboratory

Idaho National Engineering Laboratory (INEL) would continue in the future to conduct programs that include building, testing, and operating various types of nuclear facilities, and focusing on environmental restoration, waste management, and technology development. The existing environmental conditions at INEL resulting from these ongoing activities are described in Chapter 4.

11.7.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at INEL. Table 11.7-1 lists the minimum and maximum combined impacts of the waste management alternatives considered for INEL. The most adverse impacts at INEL and in the INEL region would occur as a result of some Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for INEL to manage its own waste, in addition to accepting offsite LLMW and LLW for treatment and disposal and offsite TRUW for treatment. The least adverse impacts at INEL and in the INEL region generally would result from Decentralized and other Regionalized Alternatives for which INEL would primarily be responsible for its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at INEL are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

1.7.2 Cumulative Impacts

Aside from continuation of existing operations and the waste management activities presented in this PEIS, several additional actions are planned or being undertaken by DOE at INEL and are included as reasonably foreseeable future actions in this analysis. These actions are considered in several EISs and include continued management of spent nuclear fuel (including spent nuclear fuel from naval reactors and foreign

Table 11.7-1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	9.9E-03	R2-4	1.3E+00	C	4.9E-06	R4	6.7E-04	C	4.9E-09	N	1.9E-06
Low-Level[a]	D,R1,3, C5	1.6E-03	R5	8.2E-01	D,R1,3, C5	8.0E-07	R5	4.1E-04	--	--	--	--
Transuranic	N	1.3E-05	R3	8.2E+01	N	6.7E-09	R3	4.1E-02	N	1.7E-12	C	6.6E-09
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	--	R2	9.7E-04
Total		**1.2E-02**		**8.4E+01**		**5.7E-06**		**4.2E-02**		**4.9E-09**		**9.7E-04**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.2E-06	R4	1.7E-04	C	6.1E-10	R4	8.4E-08	C	6.7E-13	R2	2.6E-07
Low-Level[a]	D,R1,3, C5	2.0E-07	R5	1.0E-04	D,R1,3, C5	9.9E-11	R5	5.1E-08	--	--	--	--
Transuranic	N	1.7E-09	R3	1.0E-02	N	8.4E-13	R3	5.1E-06	N	<9.9E-14	C	9.1E-13
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	0.0E+00	R2	1.3E-07
Total		**1.4E-06**		**1.0E-02**		**7.1E-10**		**5.2E-06**		**6.7E-13**		**3.9E-07**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R4	1,740 / 760	N	0.0E+00	R4	2.80E-05	N	0.0E+00	R4	1.20E-05
Low-Level	N,D,R1-R4	0 / 0	R5	25,620 / 10,020	N,D,R1-R4	0.0E+00	R5	4.10E-04	N,D,R1-R4	0	R5	1.60E-04
Transuranic	N	0 / 0	R3	7,610 / 3,820	N	0.0E+00	R3	1.10E-03	N	0.0E+00	R3	1.10E-03
High-Level	N	0 / 0	D,R1,R2, C1,C2	1,700 / 340	N	0	D,R1,R2, C1,C2	6.80E-04	N	0	D,R1,R2, C1,C2	1.40E-04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**36,670 / 14,940**		**0.0E+00**		**2.2E-03**		**0.0E+00**		**1.4E-03**

Table 11.7–1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	6.9E-04	N	3.0E-01	C	3.5E-07	N	1.5E-04	C	6.4E-09	N	2.6E-06
Low-Level[a]	D,R1,3, C5	4.8E-04	R5	2.3E-01	D,R1,3, C5	2.4E-07	R5	1.2E-04	--	--	--	--
Transuranic	N	3.4E-06	R3	2.5E+01	N	1.7E-09	R3	1.2E-02	N	2.3E-12	C	8.7E-09
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	--	R2	1.3E-03
Total		**1.2E-04**		**2.5E+01**		**5.9E-07**		**1.2E-02**		**6.4E-09**		**1.3E-03**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	C	12.2	D,R1	55.6
Low Level	All/None	All/None	All	None	All	None	N	7.5	R5	26.5
Transuranic	All/None	All/None	--	--	--	--	N	0.0	R2-C	28.2
High Level	All/None	All/None	--	--	--	--	N	0	D-C	2.0
Hazardous	All/None	All/None	--	--	--	--	N	0.0	R2	3.0
Total	**None[d]**	**PM_{10}**		**None**		**None**		**19.7**		**115.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	21,517	D,R1	110,206	C	1,258	R4	13,239	C	0.32	N	10.34
Low Level	N	4,458	R5	63,961	N	4,458	R5	28,247	R6-C2,5	1.26	R5	7.30
Transuranic	N	3,206	R3	77,743	N	3,206	R3	16,872	N	0.53	R2-C	2.78
High Level	N	0	D-C	820	N	0	D-C	820	N	0.00	D-C	0.03
Hazardous	D	--	R2	1,823	D	--	R2	1,108	D	--	R2	0.42
Total		**29,181**		**254,553**		**8,922**		**60,286**		**2.11**		**20.87**

Table 11.7-1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.62	R4	2.04	C	0.07	R1-2	0.48	C	836	R4	2,377
Low Level	R6-C2,5	0.60	R5	2.99	R6-C2,5	0.26	R5	3.20	R6-C2,5	693	R5	3,484
Transuranic	N	0.17	R3	2.13	N	0.22	R3	0.91	N	246	R3	2,485
High Level	N	0.00	D-C	0.03	N	0.00	D-C	0.07	N	0	D-C	368
Hazardous	D	0.00	R2	0.13	N,D	0.00	R2	0.02	D	4	R2	137
Total		**1.39**		**7.32**		**0.55**		**4.68**		**1,779**		**8,851**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

research reactors; DOE, 1995d); other site projects such as processing and treatment of HLW, environmental restoration, and infrastructure improvements (DOE, 1995d); and storage and disposition of weapons-usable fissile materials (DOE, 1996b). Table 11.7–2 identifies the range of cumulative impacts resulting from these other actions, the WM PEIS alternatives, and existing activities. To calculate the cumulative impacts at INEL, DOE used the impacts of the preferred alternatives contained in the aforementioned EISs. While there are no other nuclear facilities in the vicinity of INEL, two commercial facilities in Pocatello, Idaho, release naturally occurring radionuclides from phosphate processing. Lack of inclusion of the impacts of these facilities would not affect the relative impacts of alternatives, and the current analysis is thought to be sufficient to make programmatic decisions.

The environmental restoration program at INEL will address cleanup of an estimated 849,700 m^3 of contaminated media and facilities (200,000 m^3, 640,000 m^3, and 9,700 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). The cumulative impacts analysis includes a number of environmental remediation and decontamination projects that have been evaluated in DOE (1995d), including remediation of groundwater, Pit 9 retrieval, and decontamination and decommissioning of facilities at the Chemical Processing Plant and reactor areas. Environmental analyses of future environmental restoration activities conducted at INEL under the authority of CERCLA will be incorporated into CERCLA documentation and will include NEPA values. These reports will be available for public review and comment through the CERCLA process.

As identified in Table 11.7–2, the cumulative radioactive releases from the combined alternatives and other actions would result in an increase in the radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would primarily result from environmental restoration activities at the site. However, maximum cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

INEL is in an attainment region where criteria air pollutants do not exceed standards. The emissions from the combined alternatives would not result in air quality standard exceedances, except for particulates. Maximum combined waste management alternatives are expected to result in exceedance of air quality standards for particulates (PM_{10}). Mitigation measures could be necessary to reduce these emissions if the maximum combined alternatives were chosen. The preferred alternatives are not expected to result in exceedance of the PM_{10} standard. No exceedances of drinking water standards in groundwater are expected for disposal of any waste type.

Table 11.7-2. Idaho National Engineering Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	3.00E-01	1.20E-02	8.40E+01	8.33E+01	2.70E+01	2.73E+01	1.11E+02	1.11E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.50E-03	1.40E-04	1.00E+00	1.00E+00	5.80E-01	5.82E-01	1.58E+00	1.58E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	7.50E+02	1.79E+03	5.07E+03	3.94E+03	4.20E+02	2.96E+03	6.24E+03	5.11E+03
Number of cancer fatalities from collective dose	(1)	3.00E-01	7.16E-01	2.03E+00	1.58E+00	1.68E-01	1.18E+00	2.50E+00	2.04E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	580	0	36,670	23,670	15,332	15,912	52,582	39,582
Number of rail shipments (10 yr)		0	0	14,940	9,770	5,932	5,932	20,872	15,702
Annual dose (mrem) from truck transport		2.3E-01	0.0E+00	2.2E-01	2.01E-01	6.1E-01	8.5E-01	1.1E+00	1.05E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.4E-01	1.32E-01	2.4E-01	2.4E-01	3.8-01	3.69E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	2%	0.00%	0.02%	0.01%	0.19%	2%	2%	2%
Water use (% of total capacity)		17%	0.09%	0.82%	0.49%	0.90%	18%	19%	18%
Wastewater production (% of treatment capacity)		25%	0.89%	6.03%	3.94%	0.62%	27%	32%	30%
Power demand (% current load)		76%	3.84%	37.95%	14.20%	38.45%	118%	152%	129%
Employment									
Number of site workers	(7)	12,422	513	4,687	1,913	1,452	14,387	18,561	15,787
Air Quality Exceedances	(8)	None	None	PM_{10}	None	PM_{10}	PM_{10}	PM_{10}	PM_{10}
Groundwater Quality Exceedances	(9)	1 parameter exceeded	None	None	None	None	1 parameter exceeded	1 parameter exceeded	1 parameter exceeded

[a] Other reasonably foreseeable future actions include actions addressed in EISs related to storage and disposition of weapons-usable fissile materials (DOE, 1996b), spent nuclear fuel management (including spent nuclear fuel from naval reactors and foreign research reactors), and INEL environmental restoration and waste management (DOE, 1995d).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and non-involved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined alternatives would affect between 20 and 117 acres of land at INEL. This area is less than 1% of the total suitable acreage at INEL and less than 1% of the area available for waste management facilities. Other actions could affect another 1,059 acres. Although existing operations, the combined alternatives, and other actions would only cumulatively affect a maximum of about 2% of the suitable acreage at INEL, any land to be disturbed may require detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts.

Although the demand for water, wastewater, and power would not be greatly affected by the combined alternatives, the capacities for these services at the INEL could require improvements (expansions or upgrades) as a result of the demands of other actions. The combined alternatives could add up to 4,687 jobs at INEL, while other actions could increase the number of jobs at INEL by 1,452. Cumulatively, the number of jobs at INEL could increase by up to 49% over current employment, which could impact existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse impacts.

11.8 Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) would continue in the future to conduct defense and related programs that include laser research, biomedical and environmental research, and environmental restoration and waste management activities. The existing environmental conditions at LLNL resulting from these ongoing activities are described in Chapter 4.

11.8.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at LLNL. Table 11.8-1 lists the minimum and maximum combined impacts of the waste management alternatives for LLNL. The most adverse impacts at LLNL and in the LLNL region would occur as a result of the Regionalized Alternatives for which treatment and disposal facilities would be constructed for LLNL to manage its own waste and accept LLMW and LLW from offsite facilities for treatment and disposal. The least adverse impacts at LLNL and in the LLNL region generally would result from those alternatives for which LLNL would either manage only its own waste or prepare, package, and ship its waste for offsite treatment and disposal. For most

Table 11.8–1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	8.8E-04	D,R1	3.1E+02	R2-C	4.4E-07	R1	1.6E-01	R2-C	4.5E-07	N	9.1E-05
Low Level[a]	N	7.1E-04	R2	7.7E+02	N	3.5E-07	R2	3.9E-01	--	--	--	--
Transuranic	N	2.2E-03	R1-C	7.3E-03	N	1.1E-06	R1-C	3.6E-06	N	1.4E-08	R1-C	2.2E-07
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.8E-03**		**1.1E+03**		**1.9E-06**		**5.5E-01**		**4.6E-07**		**9.1E-05**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.4E-08	R1	5.1E-03	R2-C	7.2E-12	R1	2.6E-06	R2-C	1.0E-11	N	2.0E-09
Low Level[a]	N	1.2E-08	R2	1.3E-02	N	6.0E-12	R2	6.3E-06	--	--	--	--
Transuranic	N	3.6E-08	R1-C	1.2E-07	N	1.8E-11	R1-C	5.9E-11	N	3.1E-13	R1-C	4.8E-12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**6.2E-08**		**1.8E-02**		**3.1E-11**		**8.9E-06**		**1.0E-11**		**2.0E-09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R1	310 / 180	N	0.0E+00	R1	5.00E-06	N	0.0E+00	R1	2.9E-06
Low Level	N	320 / 120	D,R1,R4, R5,C4 / D,R1-R2	570 / 230	N	5.20E-06	D,R1,R4, R5,C4	9.20E-06	N	1.9E-06	D,R1-R2	3.7E-06
Transuranic	N	0 / 0	D	260 / 130	N	0.0E+00	D	3.9E-05	N	0.0E+00	D	3.9E-05
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**320 / 120**		**1,140 / 540**		**5.2E-06**		**5.3E-05**		**1.9E-06**		**4.6E-05**

Table 11.8-1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	4.1E-05	R1	4.3E+00	R2-C	2.0E-08	R1	2.2E-03	R2-C	1.1E-07	N	2.2E-05
Low Level[a]	N	3.2E-05	R2	1.1E+01	N	1.6E-08	R2	5.3E-03	--	--	--	--
Transuranic	N	1.1E-04	R1-C	3.6E-04	N	5.3E-08	R1-C	1.8E-07	N	3.4E-09	R1-C	5.2E-08
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.8E-04**		**1.5E+01**		**8.9E-08**		**7.5E-03**		**1.1E-07**		**2.2E-05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	1.1	N	21.7
Low Level	All/None	All/None	All	None	All	None	N	1.0	R2	10.0
Transuranic	All/None	All/None	--	--	--	--	N	0.0	D-C	1.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**		**None**		**2.1**		**33.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1,277	N	70,507	R2-C	652	R1	7,769	R2-C	0.71	N	10.10
Low Level	N	1,224	R2	19,972	N	683	R2	4,025	N	0.12	R2	1.05
Transuranic	N	898	D-C	2,455	R1-C	809	D	1,345	N	0.1	D-C	0.21
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3,399**		**92,934**		**2,144**		**13,139**		**0.93**		**11.36**

Table 11.8-1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	0.01	R1	0.08	R2-C	0.00	R1	0.02	R2-C	77	R1	846
Low Level	N	0.01	R2	0.04	N	0.00	R2	0.02	R3-C5	214	R2	593
Transuranic	N,R3-C5	0.09	R2-C	0.36	N,R1	0.00	D, R2-C	0.01	N	87	R2-C	291
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.11**		**0.48**		**0.00**		**0.05**		**378**		**1,730**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Lawrence Livermore National Laboratory does not have high-level waste, and no new hazardous waste facilities are considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

impact categories, the combined impacts of the preferred alternatives at LLNL are well below the impacts of the maximum combined waste management alternatives at the site.

11.8.2 Cumulative Impacts

Aside from continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration activities, reasonably foreseeable future actions at LLNL include projects that have been evaluated in a previous sitewide EIS (DOE, 1992b) and in the stockpile stewardship and management EIS (DOE, 1996f). Table 11.8–2 identifies the range of cumulative impacts that could result from the combined waste management alternatives, additional planned actions, and current activities. In addition to these DOE actions, closures and realignment of military bases in the LLNL region could contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at LLNL will address soil and groundwater contamination; and while some cleanup actions will generate hazardous wastes, no LLW, LLMW, or TRUW is projected to be generated as a result of cleanup actions. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at LLNL have had no significant adverse environmental impacts based on the reviews completed to data under CERCLA, RCRA, and NEPA. Project-specific environmental evaluations that incorporate cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

As identified in Table 11.8–2, the annual radioactive releases that would result from the combined alternatives would result in an increase the current radiation dose to the offsite population. However, the maximum cumulative radioactive release would not exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite. LLNL is in an attainment region for all criteria air pollutants. Emissions from the combined alternatives would not exceed air quality standards, although other actions are expected to result in exceedance of the nitrogen dioxide standard. Disposal of LLMW or LLW at LLNL is not expected to result in exceedance of drinking water standards in groundwater under any of the alternatives. No disposal of LLMW or LLW would occur at LLNL under the preferred alternatives.

Table 11.8–2. Lawrence Livermore National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.70E+01	3.80E-03	1.10E+03	3.30E+02	5.20E+00	2.22E+01	1.12E+03	3.52E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	5.50E-01	1.65E-01	~0	~0	5.61E-01	1.76E-01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	6.90E-01	6.20E-06	1.80E+00	5.33E-01	1.45E-01	8.35E-01	2.64E+00	1.37E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.85E+02	4.42E+00	6.09E+02	2.77E+01	8.75E+01	3.77E+02	9.82E+02	4.00E+02
Number of cancer fatalities from collective dose	(1)	1.14E-01	~0	2.44E-01	~0	~0	1.51E-01	3.93E-01	1.60E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	140	320	1,140	1,090	2,755	3,215	4,035	3,985
Number of rail shipments (10 yr)		0	120	540	470	0	120	540	470
Annual dose (mrem) from truck transport		5.6E-02	5.2E-04	5.3E-03	5.24E-03	1.1E-01	1.7E-01	1.7E-01	1.7E-01
Annual dose (mrem) from rail transport		0.0E+00	1.9E-04	4.5E-03	4.44E-03	0.0E+00	1.9E-04	4.6E-03	4.4E-03
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	4%	0.03%	0.41%	0.22%	0.45%	4%	5%	5%
Water use (% of total capacity)		28%	0.13%	3.69%	0.96%	9.14%	38%	41%	39%
Wastewater production (% of treatment capacity)		24%	0.13%	0.78%	0.58%	3.02%	27%	28%	27%
Power demand (% current load)		61%	0.93%	11.36%	1.82%	26.00%	88%	98%	89%
Employment									
Number of site workers	(7)	8,964	141	530	387	2,495	11,600	11,989	11,709
Air Quality Exceedance	(8)	None	None	None	None	NO_2	NO_2	NO_2	NO_2
Groundwater Quality Exceedance	(9)	4 parameters exceeded	None	None	None	None	4 parameters exceeded	4 parameters exceeded	4 parameters exceeded

[a] Other reasonably foreseeable future actions include actions described in Continued Operations EIS (DOE, 1992b) and Stockpile Stewardship and Management EIS (DOE, 1996f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development and that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined alternatives would affect a maximum of about 33 acres of land, or a maximum of less than 1% of the suitable acreage at LLNL. This area is less than 1% of the area available for waste management facilities; other actions would affect an additional 37 acres (0.5%). Onsite infrastructure demands for water, wastewater treatment, and power would increase by a maximum of approximately 11% as a result of the combined alternatives but by as much as 26% as a result of future actions at the site. These infrastructure demands are all within the existing capacities of the site, and no upgrades should be required.

The combined alternatives could add up to 530 jobs at LLNL, while other actions could increase the number of jobs by 2,495. Cumulatively, the number of jobs could increase by up to 38% over existing employment, potentially offsetting approximately 2,220 jobs that will be lost within the region as a result of closures and the realignments of military bases (DBCRC, 1995). The maximum cumulative increase in employment is not expected to affect offsite community infrastructures or institutions.

11.9 Los Alamos National Laboratory

Los Alamos National Laboratory (LANL) would continue in the future to conduct programs in nuclear weapons research and development and related projects. The existing environmental conditions at LANL resulting from these ongoing activities are described in Chapter 4.

11.9.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HW at LANL. Table 11.9–1 lists the minimum and maximum combined impacts of the waste management alternatives for LANL. The most adverse impacts at LANL and in the LANL region would occur as a result of the Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for LANL to manage its own waste in addition to accepting offsite LLMW, LLW, and TRUW for treatment and LLMW and LLW for disposal. The least adverse impacts generally would result from the No Action Decentralized, and Centralized Alternatives for which LANL would either only manage its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at LANL are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

Table 11.9–1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	7.6E–02	R2,3	1.7E+00	R4,C	3.8E–05	R2,3	8.6E–04	C	1.6E–08	R2	6.9E–06
Low Level[a]	N	3.9E–01	R2,4,C3, 4	1.6E+01	N	1.9E–04	R2,4,C3, 4	7.8E–03	--	--	--	--
Transuranic	N	8.3E–03	R2	1.3E+03	N	4.1E–06	R2	6.4E–01	N	2.3E–11	R3,C	1.9E–09
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	R1	1.9E–02
Total		**4.7E–01**		**1.3E+03**		**2.3E–04**		**6.5E–01**		**1.6E–08**		**1.9E–02**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	8.0E–06	R2,3	1.8E–04	R4,C	4.0E–09	R2,3	9.1E–08	C	2.0E–12	R2	8.5E–10
Low Level[a]	N	4.1E–05	R2,4,C3, 4	1.6E–03	N	2.0E–08	R2,4,C3, 4	8.2E–07	--	--	--	--
Transuranic	N	8.7E–07	R2	1.3E–01	N	4.4E–10	R2	6.7E–05	D	8.3E–14	R3,C	2.3E–13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	R1	2.4E–06
Total		**5.0E–05**		**1.3E–01**		**2.4E–08**		**6.8E–05**		**2.0E–12**		**2.4E–06**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R2	2,610 / 1,020	N,D	0.0E+00	R2	4.20E–05	N,D	0.0E+00	R2	1.6E–05
Low Level	N,D	0 / 0	C3,C4	36,640 / 14,400	N,D	0.0E+00	C3,C4	5.90E–04	N,D	0.0E+00	C3,C4	2.3E–04
Transuranic	N	0 / 0	D	1,590 / 800	N	0.0E+00	D	2.4E–04	N	0.0E+00	D	2.4E–04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**40,840 / 16,220**		**0.0E+00**		**8.7E–04**		**0.0E+00**		**4.9E–04**

Table 11.9-1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.5E-03	R2,3	3.5E-02	R4,C	7.5E-07	R2,3	1.7E-05	C	8.1E-09	R2	3.4E-06
Low Level[a]	N	2.6E-02	R2,4,C3, 4	1.4E+00	N	1.3E-05	R2,4,C3, 4	7.0E-04	--	--	--	--
Transuranic	N	7.6E-04	R2	1.2E+02	N	3.8E-07	R2	5.8E-02	N	1.1E-11	R3,C	9.4E-10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	0.0E+00	R1	9.5E-03
Total		**2.8E-02**		**1.2E+02**		**1.4E-05**		**5.9E-02**		**8.1E-09**		**9.5E-03**

Waste Type	Air Quality Exceedances		Groundwater Quality Exceedances				Resource Requirements			
	Construction	Operation					Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2, 4	None	D, R1	Methylene chloride	R4,C	4.8	N	20.8
Low Level	All/None	All/None	All	None	All	None	R6-C2,5	3.3	R4	18.5
Transuranic	All/None	R2/Radiation	--	--	--	--	N	0	D	15.4
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous	All/None	R1/Vinyl Chloride	--	--	--	--	N,R2	--	D, R1	1.0
Total	**None[d]**	**Radiation and Vinyl Chloride**		**None**		**Methylene chloride**		**8.1**		**55.7**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	2,149	N	69,589	R4,C	597	R2	5,078	R4,C	0.61	N	10.00
Low Level	R6-C2,5	5,714	R4	35,601	R6-C2,5	1,739	R4	15,828	R5-C2	1.49	R4	3.89
Transuranic	N	1,850	R1	34,966	N	1,850	R2	6,974	N	0.25	R3,C	1.94
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N,R2	--	R1	1,777	N,R2	--	R1	907	N,R2	--	R1	0.26
Total		**9,713**		**141,933**		**4,186**		**28,787**		**2.35**		**16.09**

Table 11.9-1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R4,C	0.01	R2	0.05	C	0.05	R2	0.48	C	109	R2	869
Low Level	R6-C2,5	0.30	R4	2.36	R6-C2,5	0.14	R4	1.42	R6-C2,5	287	R4	2,270
Transuranic	N	0.09	R2	1.07	N	0.14	R2	0.49	N	110	R2	1,030
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N,R2	--	R1	0.07	N,R2	--	R1	0.03	N, R2	--	R1	66
Total		**0.40**		**3.55**		**0.33**		**2.42**		**506**		**4,235**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. The Los Alamos National Laboratory does not have high-level waste. Hazardous waste does not contain radioactive materials and, therefore, does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

11.9.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at LANL include construction and operation of the dual-axis hydrodynamic test facility (DOE, 1995e), medical isotope production project (DOE, 1996c), stockpile stewardship and management (DOE, 1996f), the transfer of non-nuclear functions (DOE, 1993), and environmental restoration activities. No other DOE or non-DOE actions are planned in the LANL region that would contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at LANL will address cleanup of an estimated 9,804,400 m^3 of contaminated media and facilities (500,000 m^3, 9,300,000 m^3, and 4,400 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the NEPA reviews completed to date. Project-specific environmental evaluations that incorporate cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.9–2 identifies the range of cumulative impacts at LANL resulting from the combined waste management alternatives, existing waste management activities, and planned actions described in the aforementioned EISs. The impacts of other projects being considered for LANL as part of a planned sitewide EIS currently in preparation (DOE, 1994a) are not yet available.

As identified in Table 11.9–2, the annual radioactive releases that would result from the combined waste management alternatives (including transportation) would result in an increase in the radiation dose to the offsite population. Without mitigation, the cumulative radioactive releases for the maximum combined waste management alternatives would exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite, almost entirely as a result of the treatment of TRUW. This exceedance would require mitigation should the maximum combined alternatives be chosen. The combined impacts of the preferred alternatives would not result in the exceedance of this standard.

LANL is in an attainment region where criteria air pollutants do not exceed standards. While minimum cumulative emissions and the cumulative emissions under the preferred alternatives would not exceed air quality standards, maximum cumulative emissions would result in vinyl chloride emissions above regulation

Table 11.9-2. Los Alamos National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.40E+01	4.70E-01	1.30E+03	1.73E+00	5.70E+00	2.02E+01	1.32E+03	2.14E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	6.50E-01	~0	~0	~0	6.60E-01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	7.90E+00	5.00E-03	1.30E+01	1.75E-02	2.00E-02	7.93E+00	2.09E+01	7.94E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	1.94E+03	3.53E+02	2.93E+03	2.64E+03	6.96E+02	2.99E+03	5.6E+03	5.28E+03
Number of cancer fatalities from collective dose	(1)	7.76E-01	1.41E-01	1.17E+00	1.06E+00	2.78E-01	1.20E+00	2.2E+00	2.11E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	270	0	40,840	22,600	720	990	41,830	23,590
Number of rail shipments (10 yr)		0	0	16,220	8,730	0	0	16,220	8,730
Annual dose (mrem) from truck transport		1.1E-01	0.0E+00	8.7E-02	5.72E-02	2.1E-02	1.3E-01	2.2E-01	1.86E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	4.9E-02	3.66E-02	0.0E+00	0.0E+00	4.9E-02	3.66E-02
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	41%	0.03%	0.20%	0.16%	0.04%	41%	41%	41%
Water use (% of total capacity)		41%	0.10%	1.42%	0.86%	0.31%	41%	43%	42%
Wastewater production (% of treatment capacity)		Not available	0.42%	2.88%	1.88%	0.16%	1%	3%	2%
Power demand (% current load)		57%	1.96%	13.41%	4.68%	11.58%	70%	82%	73%
Employment									
Numbers of site workers	(7)	6,546	243	1,742	1,017	559	7,348	8,847	8,122
Air Quality Exceedance	(8)	None	None	Vinyl chloride, radiation	None	None	None	Vinyl chloride, radiation	None
Groundwater Quality Exceedance	(9)	13 parameters exceeded	None	Methylene chloride	None	None	13 parameters exceeded	14 parameters exceeded	13 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to dual-axis radiographic hydrodynamic test facility (DOE, 1995e), medical isotope production (DOE, 1996c), transfer of non-nuclear functions (DOE, 1993), and stockpile stewardship and management (DOE, 1996f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

limits as a result of the treatment of hazardous waste under HW Regionalized Alternative 2. Mitigation would be needed to reduce vinyl chloride emissions to acceptable levels if this alternative is chosen.

The combined alternatives would affect a maximum of 56 acres of land. This area is less than 1% of the suitable acreage at LANL and less than 1% of the area available for waste management facilities. An additional 10 acres (0.04%) of land would be affected by other actions. Onsite infrastructure demands for water, wastewater treatment, and power would increase little as a result of the combined alternatives, and cumulative demands would be within existing capacities. The combined alternatives could add up to 1,742 jobs at LANL, or a maximum increase of approximately 27% over existing employment, while other actions would add another 559 jobs. The maximum increase in employment could affect offsite community infrastructures or institutions. Mitigation measures could be needed to reduce any adverse impacts resulting from these increases in employment.

Disposal of LLMW at LANL under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of standards for groundwater used as drinking water for methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should either of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at LANL, nor are there any expected exceedances for other waste types. Disposal of LLMW and LLW under the preferred alternatives is not expected to result in any groundwater quality exceedances.

11.10 Nevada Test Site

Nevada Test Site (NTS) has been the nation's primary location for testing nuclear explosive devices, although current U.S. policy prohibits underground testing of nuclear weapons. NTS is a LLW disposal site. The existing environmental conditions at NTS resulting from these ongoing activities are described in Chapter 4.

11.10.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at NTS. Table 11.10–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for NTS. The most

Table 11.10–1. Nevada Test Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.3E–05	N	1.2E–02	R1-C	6.4E–09	N	5.8E–06	R1-C	1.5E–11	N	4.7E–08
Low Level[a]	N	2.6E–09	R2,4,5, 6,C1,3, 4,5	3.2E–09	N	1.3E–12	R2,4,5, 6,C1,3, 4,5	1.6E–12	--	--	--	--
Transuranic	N	0.0E+00	R1-C	3.0E–07	--	0.0E+00	R1-C	1.5E–10	N	0.0E+00	R1-C	1.1E–12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.3E–05**		**1.2E–02**		**6.4E–09**		**5.8E–06**		**1.5E–11**		**4.7E–08**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	3.2E–09	N	3.0E–06	R1-C	1.6E–12	N	1.5E–09	R1-C	<9.9E–14	N	1.2E–11
Low Level[a]	N	6.7E–13	R2,4,5, 6,C1,3, 4,5	8.1E–13	All	<9.9E–14	All	<9.9E–14	--	--	--	--
Transuranic	N	0.0E+00	R1-C	7.8E–11	N	0.0E+00	R1-C	3.9E–14	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.2E–09**		**3.0E–06**		**1.6E–12**		**1.5E–09**		**0.0E+00**		**1.2E–11**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R3	9,640 / 3,690	N	0.0E+00	R3	1.50E–04	N	0.0E+00	R3	5.9E–05
Low Level	D,R1,R2, C3	0 / 0	C2	257,270 / 96,880	D,R1, R2,C3	0	C2	4.10E–03	D,R1,R2, C3	0.0E+00	C2	1.6E–03
Transuranic	N	0 / 0	D	90 / 90	N	0.0E+00	D	1.40E–05	N	--	D	1.5E–05
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**267,000 / 100,620**		**0.0E+00**		**4.3E–03**		**0.0E+00**		**1.7E–03**

Table 11.10–1. Nevada Test Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.7E–05	N	3.1E–02	R1-C	8.7E–09	N	1.5E–05	R1-C	2.1E–10	N	6.2E–07
Low Level[a]	N	6.0E–09	R2,4,5, 6,C1,3, 4,5	7.2E–09	N	3.0E–12	R2,4,5, 6,C1,3, 4,5	3.6E–12	--	--	--	--
Transuranic	N	0.0E+00	R1-C	8.4E–07	--	0.0E+00	R1-C	4.2E–10	N	0.0E+00	R1-C	1.5E–11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.7E–05**		**3.1E–02**		**8.7E–09**		**1.5E–05**		**2.1E–10**		**6.2E–07**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2, R4	None	R3	3 hazardous chemicals[c]	R2,4,C	5.7	D	25.2
Low Level	C2,4/CO	C2-5/CO	All	None	--	--	R6,C1,3,5	0.5	C4	15.2
Transuranic	All/None	All/None	All	None	--	--	N,R1-C	0.0	D	1.2
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**CO[d]**	**CO**		**None**		**3 hazardous chemicals[c]**		**6.2**		**40.4**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2,4,C	6,593	D	52,725	R2,4,C	936	D	9,352	R1,2,4,C	0.46	D	6.52
Low Level	R6,C1,3,5	553	C2	54,787	R6,C1,5	251	C2	22,196	R6,C1,3,5	0.5	C4	15.2
Transuranic	R1-C	38	D	1,465	R1-C	38	D	609	N,R1-C	0.02	D	0.12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**7,184**		**107,512**		**1,225**		**32,157**		**0.98**		**21.84**

Table 11.10–1. Nevada Test Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.02	R3	0.13	N	0.01	R3	0.07	N	120	R3	702
Low Level	R2,6,C1, 3,5	0.01	C2	0.57	R2,6, C1,3,5	<0.01	C2	0.25	R6,C1,3,5	55	C2	2,986
Transuranic	R1-C	0.00	D	0.02	R1-C	0.00	N,D	0.01	R1-C	7	D	96
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.03**		**0.72**		**0.01**		**0.33**		**182**		**3,784**

Notes: Alt. = alternative; C = Centralized Alternative; CO = carbon monoxide; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Nevada Test Site does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Hazardous chemicals include 1,2-dichloroethane, methylene chloride, and benzene. The NTS EIS (DOE 1996g) did not indicate groundwater quality exceedances. Waste management values overestimate groundwater exceedances for NTS since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

adverse impacts at NTS and in the NTS region generally would occur as a result of the No Action and Regionalized 3 Alternatives for LLMW, Regionalized and Centralized Alternatives for LLW, and Regionalized and Centralized Alternatives for TRUW. The least adverse impacts at NTS and in the NTS region generally would result from the Centralized Alternative for LLMW; the No Action Alternative for LLW; and the No Action Alternative for TRUW. For most impact categories, the combined impacts of the preferred alternatives at NTS are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

11.10.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at NTS include stockpile stewardship and management (DOE, 1996f); storage and disposition of weapons-usable fissile materials (DOE, 1996b); and environmental restoration activities and a number of other actions evaluated in a draft sitewide EIS (DOE, 1996g). In addition, the Yucca Mountain Site (located on a portion of NTS) is the candidate site for the nation's geological repository for spent nuclear fuel and HLW under the Nuclear Waste Policy Act (42 USC 10101–10270). No other DOE or non-DOE actions are planned in the NTS region that would contribute to the cumulative impact of waste management alternatives.

Table 11.10–2 identifies the range of cumulative impacts at NTS resulting from the combined waste management alternatives (including transportation), current activities, and planned actions described in the aforementioned EISs. The impacts of a geologic repository for spent nuclear fuel and HLW are not included in this cumulative impact analysis because that information is not yet available.

As identified in Table 11.10–2, the maximum radioactive releases from the combined waste management alternatives would not measurably increase the existing radiological releases from NTS to the offsite population. Maximum cumulative radioactive releases would be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

The NTS is adjacent to a nonattainment region in Clark County for breathable particulates and carbon monoxide. Maximum cumulative emissions are predicted to exceed applicable air emissions standards for carbon monoxide as a result of the maximum combined alternatives and preferred alternatives, and, as a

Table 11.10-2. Nevada Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.90E-01	1.30E-05	1.20E-02	3.60E-05	4.30E-05	2.90E-01	3.02E-01	2.90E-01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.20E-02	3.20E-07	3.00E-04	3.26E-07	9.10E-06	1.20E-02	1.23E-02	1.20E-02
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.00E+01	7.94E+00	6.49E+03	6.49E+03	6.60E+02	6.88E+02	7.17E+03	7.17E+03
Number of cancer fatalities from collective dose	(1)	~0	~0	2.60E+00	2.60E+00	2.64E-01	2.75E-01	2.87E+00	2.87E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	4,540	0	267,000	267,000	35,134	39,674	306,674	306,674
Number of rail shipments (10 yr)		0	0	100,620	100,620	0	0	100,620	100,620
Annual dose (mrem) from truck transport		1.8E+00	0.0E+00	4.3E-01	4.26E-01	1.4E+00	3.2E+00	3.6E+00	3.65E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.7E-01	1.67E-01	0.0E+00	0.0E+00	1.7E-01	1.67E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	26%	0.00%	0.00%	0.00%	2%	28%	28%	28%
Water use (% of total capacity)		49%	0.26%	3.87%	3.18%	300%	349%	353%	352%
Wastewater production (% of treatment capacity)		41%	0.36%	9.51%	9.32%	59%	101%	110%	110%
Power demand (% current load)		67%	2.18%	48.53%	17.76%	44%	113%	160%	129%
Employment									
Number of site workers	(7)	7,086	53	1,544	1,535	8,561	15,700	17,191	17,182
Air Quality Exceedance	(8)	PM_{10}, CO	None	CO	CO	None	PM_{10}, CO	PM_{10}, CO	PM_{10}, CO
Groundwater Quality Exceedance	(9)	8 parameters exceeded	None	3 hazardous chemicals[e]	3 hazardous chemicals[e]	None	8 parameters exceeded	11 parameters exceeded[e]	11 parameters exceeded[e]

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996d), storage and disposition of weapons-usable fissile materials (DOE, 1996b), and the NTS sitewide EIS, which incorporates the impacts of environmental restoration activities (DOE 1996g). Shipment numbers and shipment MEI values do not include those related to stockpile stewardship and management because these were not presented in that EIS.

[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.

[c] Cumulative impacts, including minimum combined waste management impacts.

[d] Cumulative impacts, including maximum combined waste management impacts.

[e] Hazardous chemicals include 1,2-dichloroethane, methylene chloride, and benzene. The NTS EIS did not indicate groundwater quality exceedances. Waste management values overestimate groundwater exceedances for NTS since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

Notes

(1) Assumes all facilities operate concurrently for the same 10-year period.

(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).

(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.

(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.

(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.

(6) Suitable land includes land that is available for development or that is currently developed.

(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.

(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.

(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

consequence, mitigation measures may be necessary to reduce these emissions. Note that the NTS sitewide EIS (DOE, 1996g) predicted no exceedances of air quality standards.

The NTS EIS found that maximum cumulative emissions in the Clark County nonattainment region (primarily from the Las Vegas Valley) exceed standards for carbon monoxide; however, this is not a direct result of NTS activities. Under the NTS EIS combined alternatives, the incremental contribution of carbon monoxide from NTS-related activities would not present a significant addition to the nonattainment status of the adjacent region. In addition, the NTS EIS found that breathable particulates and total suspended particulates, which also exceed standards in the region, are not and would not be directly attributed to NTS activities under the combined alternatives. Therefore, mitigation measures may not be necessary to reduce these emissions due to the insignificance of the contribution from NTS-related activities to the existing pollutant burden.

The combined alternatives would affect up to 40 acres of land at NTS. This area is less than 1% of the total suitable acreage and less than 1% of the area available for waste management facilities. Other actions could affect another 14,481 acres. Although the combined alternatives and other actions would cumulatively affect a maximum of about 2% of the suitable acreage at NTS, the land affected may have to be subjected to detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts.

The cumulative demand for water, wastewater treatment capacity, and power is expected to increase substantially at NTS. Infrastructure improvements (expansion or upgrades) will likely be required to meet these increased demands, and wastewater capacity could require expansion as a result of demands of other planned actions at NTS.

The combined alternatives could add up to of 1,544 jobs at NTS, while other actions could also increase the number of jobs by 8,561. Cumulatively, the number of jobs at the NTS could more than double, which could affect existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at NTS under Regionalized Alternative 3 and under the preferred alternative could result in exceedances of drinking water standards in groundwater for benzene, 1,2-dichloroethane, and methylene chloride. The Decentralized Alternative and Regionalized Alternative 1 are not expected to result

in an exceedance for benzene but could result in exceedances for 1,2-dichloroethane and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at NTS, nor are there any expected exceedances for disposal of LLW. Note that the NTS EIS (DOE, 1996g) predicted no exceedances of drinking water standards in the groundwater from disposal of LLMW or LLW at NTS, and the waste management values are thought to overestimate groundwater exceedances for NTS. Travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

11.11 Oak Ridge Reservation

Oak Ridge Reservation (ORR) would continue in the future to conduct environmental restoration activities and programs that include applied research and development in support of conservation and energy technologies, environmental management activities, and defense programs. The existing environmental conditions at ORR resulting from these ongoing activities are described in Chapter 4.

11.11.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HW at ORR. Table 11.11-1 lists the minimum and maximum combined impacts of the waste management alternatives considered. The most adverse impacts at ORR and in the ORR region would occur as a result of the No Action Alternative for LLMW and Regionalized Alternatives for which treatment and disposal facilities would be constructed for ORR to manage its own waste, in addition to accepting offsite LLMW and LLW for treatment and disposal, and offsite TRUW and HW for treatment. The least adverse impacts at ORR and in the ORR region generally would result from those alternatives for which ORR would only be responsible for its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at ORR are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

Table 11.11-1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.4E-02	N	2.3E+02	C	6.8E-06	N	1.1E-01	C	1.1E-06	N	4.1E-05
Low Level[a]	N	9.2E-03	R5	6.0E+02	N	4.6E-06	R5	3.0E-01	--	--	--	--
Transuranic	N	1.3E-04	R2-C	9.2E+01	N	6.6E-08	R2-C	4.6E-02	N	7.8E-09	D,R1	1.6E-07
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	7.4E-03	R2	9.5E-02
Total		**2.3E-02**		**9.2E+02**		**1.1E-05**		**4.6E-01**		**7.4E-03**		**9.5E-02**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	4.2E-07	N	7.0E-03	C	2.1E-10	N	3.5E-06	C	5.8E-11	N	2.1E-09
Low Level[a]	N	2.9E-07	R5	1.9E-02	N	1.4E-10	R5	9.3E-06	--	--	--	--
Transuranic	N	4.1E-09	R2-C	2.8E-03	N	2.1E-12	R2-C	1.4E-06	N	4.0E-13	D,R1	8.1E-12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	3.9E-07	R2	5.0E-06
Total		**7.1E-07**		**2.9E-02**		**3.5E-10**		**1.4E-07**		**3.9E-07**		**5.0E-06**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D,R1	0 / 0	R3	2,100 / 790	N,D,R1	0	R3	3.40E-05	N,D,R1	0	R3	1.3E-05
Low Level	N / N, D,R1,R2	20 / 20	R3	64,590 / 24,470	N	3.20E-07	R3	1.00E-03	N,D,R1, R2	3.2E-07	R3	3.9E-05
Transuranic	N	0 / 0	R1	2,440 / 1,230	N	0.0E+00	R1	3.60E-04	N	0.0E+00	R1	3.7E-04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	--	--	--	--	--	--	--	--	--	--	--	--
Total		**20 / 20**		**69,130 / 26,490**		**3.2E-07**		**1.4E-03**		**3.2E-07**		**7.7E-04**

Table 11.11-1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	4.5E-04	N	9.6E+00	C	2.3E-07	N	4.8E-03	C	3.7E-07	N	1.4E-05
Low Level[a]	N	3.1E-04	R5	8.7E+00	N	1.5E-07	R5	4.3E-03	--	--	--	--
Transuranic	N	4.6E-06	R2-C	3.1E+00	N	2.3E-09	R2-C	1.6E-03	N	2.6E-09	D,R1	5.2E-08
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	2.5E-03	R2	3.2E-02
Total		**7.6E-04**		**2.1E+01**		**3.8E-07**		**1.1E-02**		**2.5E-03**		**3.2E-02**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R3, C	4 radionuclides	D,R1-C	2 hazardous chemicals, 4 radionuclides[c]	C	5.3	R4	19.1
Low Level	All/None	All/None	All	None	All	None	R6-C2,5	11.6	R3	137.6
Transuranic	All/None	All/None	--	--	--	--	N	0.0	D	6.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous	All/None	R1,2/Vinyl Chloride	--	--	--	--	N	0.0	R2	2.0
Total	**None[d]**	**NO_2, PM_{10}, Vinyl Chloride**		**4 radionuclides**		**2 hazardous chemicals, 4 radionuclides[e]**		**22.8**		**165.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	7,888	R4	32,846	C	4,686	R4	20,085	C	0.74	R4	6.65
Low Level	N	13,701	R3	539,756	R6-C2,5	7,328	R5	47,608	R6-C2,5	2.86	R3	80.69
Transuranic	N	1,425	R2-C	14,448	N	1,425	D	3,929	N	0.14	D	0.69
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N	168	R2	2,438	N	168	R2	2,101	N	0.13	R2	0.58
Total		**23,014**		**589,488**		**13,439**		**73,723**		**3.9**		**88.61**

Table 11.11-1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts—Continued								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.25	R4	0.76	C	0.15	R4	0.38	N	934	R4	2,233
Low Level	R6-C2,5	0.34	R5	1.82	R6-C2,5	0.16	R5	0.96	R6-C2,5	1,001	R5	5,331
Transuranic	N	0.07	R2-C	0.23	N	0.05	R1-C	0.09	N	243	R2-C	677
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N	0.01	R2	0.04	N,D	0.00	R1, R2	0.01	N	18	R2	135
Total		**0.67**		**2.85**		**0.36**		**1.44**		**2,196**		**8,376**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable; scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. High-level waste is not present at the Oak Ridge Reservation. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards include 1,2-dichloroethane and methylene chloride; radionuclides that could exceed standards include Pu-239, Pu-240, Tc-99, and U-238.

11.11.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at ORR include stockpile stewardship and management activities (DOE, 1996f), storage and disposition of weapons-usable fissile materials (DOE, 1996b), the disposition of highly enriched uranium (DOE, 1995f), interim storage of enriched uranium (DOE, 1994i), the transfer of non-nuclear functions (DOE, 1993), and environmental restoration activities. No other DOE or non-DOE actions are planned in the ORR region that would contribute to the cumulative impact of waste management activities.

The environmental restoration program at ORR will address cleanup of an estimated 1,402,400 m^3 of contaminated media and facilities (460,000 m^3, 940,800 m^3, and 1,600 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and soil and decontamination and decommissioning of facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the CERCLA and NEPA reviews completed to date. Project-specific environmental evaluations under CERCLA will be performed prior to implementation of all future environmental restoration activities.

Table 11.11-2 identifies the range of cumulative impacts resulting from the waste management alternatives (including transportation), existing activities, and planned actions described in the aforementioned EISs.

As identified in Table 11.11-2, the maximum annual radioactive releases would increase as a result of maximum radiological releases from the combined alternatives and radioactive releases from other possible actions. Maximum cumulative radioactive releases, however, would not exceed the EPA standard of 10 millirems per year to the maximally exposed individual.

ORR is in an attainment region where criteria air pollutants do not exceed standards. The maximum emissions from the combined waste management alternatives could exceed air quality standards for nitrogen dioxide, breathable particulates, and vinyl chloride. Mitigation measures would be necessary to reduce these emissions to acceptable levels should these alternatives be chosen. No exceedances of air quality standards are anticipated for the preferred alternatives at ORR.

Table 11.11-2. Oak Ridge Reservation Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	4.30E+02	2.50E-02	9.20E+02	2.41E+00	1.90E+01	4.49E+02	1.37E+03	4.51E+02
Number of cancer fatalities from collective dose	(2)	2.15E-01	~0	4.60E-01	~0	~0	2.25E-01	6.85E-01	2.26E-01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.40E+00	7.00E-05	2.90E+00	7.34E-03	5.00E-01	1.90E+00	4.80E+00	1.91E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	6.80E+02	2.40E+02	3.37E+03	2.09E+03	1.11E+03	2.03E+03	5.16E+03	3.88E+03
Number of cancer fatalities from collective dose	(1)	3.40E-01	~0	1.35E+00	8.35E-01	4.44E-01	8.12E-01	2.06E+00	1.55E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	10,400	20	69,130	69,180	1,704	12,124	81,234	81,284
Number of rail shipments (10 yr)		80	20	26,490	26,510	0	100	26,570	26,590
Annual dose (mrem) from truck transport		4.2E+00	3.2E-05	1.30E-01	1.30E-01	6.8E-02	4.2E+00	4.4E+00	4.4E+00
Annual dose (mrem) from rail transport		3.22E-02	3.2E-05	6.83E-02	6.83E-02	0.0E+00	3.2E-02	1.1E-01	1.0E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	67%	0.13%	0.97%	0.91%	0.8%	68%	69%	69%
Water use (% of total capacity)		46%	0.06%	1.47%	1.43%	–0.9%	45%	46%	46%
Wastewater production (% of treatment capacity)		70%	1.46%	8.01%	4.25%	13%	84%	91%	87%
Power demand (% current load)		18%	0.59%	13.43%	13.02%	8.8%	27%	40%	39%
Employment									
Number of site workers	(7)	23,597	621	3,453	1,658	754	24,972	26,009	26,009
Air Quality Exceedance	(8)	None	None	NO_2, PM_{10}, vinyl chloride	None	None	None	NO_2, PM_{10}, vinyl chloride	None
Groundwater Quality Exceedance	(9)	17 parameters exceeded	None	2 hazardous chemicals, 4 radionuclides[e]	2 hazardous chemicals, 4 radionuclides[e]	None	17 parameters exceeded	22 parameters exceeded	22 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996f), storage and disposition of weapons-usable fissile materials (DOE, 1996b), transfer of non-nuclear functions (DOE, 1993), interim storage of enriched uranium (DOE, 1994i), and disposition of surplus highly enriched uranium (DOE, 1995f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts
[e] Hazardous chemicals that could exceed drinking water standards include 1,2-dichloroethane and methylene chloride; radionuclides that could exceed standards include Pu-239, Pu-240, Tc-99, and U-238.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined waste management alternatives would affect between 23 and 165 acres of land at ORR. This area is about 1% of the total suitable acreage and 3% of the area available for waste management facilities. Other actions could affect another 144 acres. Together, the combined alternatives and other actions would affect a maximum of 1.8% of the suitable acreage at ORR and could result in impacts to sensitive land. Detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts may be required prior to any new land disturbance.

The demand for water, wastewater, and power at ORR would not be greatly affected by the combined alternatives. Cumulatively, water, wastewater, and power capacities at ORR would probably not require major improvements (expansions or upgrades) as a result of the construction and operation of planned facilities.

The combined waste management alternatives could add up to 2,453 jobs at ORR, while other actions could also increase the number of jobs at ORR by 754. Cumulatively, the number of jobs at ORR could increase by up to 18%, which could affect existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at ORR under the Decentralized Alternative and Regionalized Alternatives 1, 2 (the preferred alternative), and 4 could result in exceedances of drinking water standards in groundwater for 1,2-dichloroethane, methylene chloride, Pu-239, Pu-240, Tc-99, and U-238. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at ORR, nor are there any expected exceedances for other waste types.

11.12 Paducah Gaseous Diffusion Plant

Paducah Gaseous Diffusion Plant (PGDP) would continue in the future to produce enriched uranium. The existing environmental conditions at PGDP resulting from these ongoing activities are described in Chapter 4.

11.12.1 COMBINED WASTE MANAGEMENT IMPACTS

DOE considered the management of LLMW, LLW, and TRUW at the PGDP. Table 11.12-1 lists the minimum and maximum combined impacts of the waste management alternatives for PGDP. The most adverse impacts at PGDP and in the PGDP region would occur as a result of the No Action Alternative for LLMW and Regionalized and Centralized Alternatives for LLW and TRUW. The least adverse impacts at PGDP and in the region generally would result from the Regionalized and Centralized Alternatives for LLMW for which PGDP would only prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at PGDP are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.12.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration actions, DOE has no other actions planned at PGDP. No other DOE or non-DOE actions are planned in the PGDP region that would contribute to the cumulative impact of the waste management alternatives.

The environmental restoration program at PGDP will address cleanup of an estimated 1,220,000 m^3 of contaminated media and facilities (450,000 m^3, 770,000 m^3, and 7 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and eventual decontamination and decommissioning of uranium enrichment facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at PGDP have had no significant adverse environmental impacts based on the CERCLA, NEPA, and RCRA reviews completed to date. Project-specific environmental evaluations under CERCLA, RCRA, or NEPA will be performed prior to implementation of all future environmental restoration activities.

Table 11.12-1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.6E-03	N	3.6E+00	R2-C	8.1E-07	N	1.8E-03	R2-C	9.7E-09	N	1.1E-06
Low Level[a]	N	4.0E-05	R2	3.8E-03	N	2.0E-08	R2	1.9E-06	--	--	--	--
Transuranic	N	--	R1-C	1.1E-05	N	--	R1-C	5.3E-09	N	--	R1-C	9.5E-13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.6E-03**		**3.6E+00**		**8.3E-07**		**1.8E-03**		**9.7E-09**		**1.1E-06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.8E-07	N	4.0E-04	R2-C	9.0E-11	N	2.0E-07	R2-C	1.3E-12	N	1.5E-10
Low Level[a]	N	4.5E-09	R2	4.2E-07	N	2.3E-12	R2	2.1E-10	--	--	--	--
Transuranic	N	--	R1-C	1.2E-09	N	--	R1-C	5.9E-13	All	<9.9E-14	All	<9.9E-14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.8E-07**		**4.0E-04**		**9.3E-11**		**2.0E-07**		**1.3E-12**		**1.5E-10**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2-R4,C	50 / 30	N	0.0E+00	R2-R4,C	8.1E-07	N	0.0E+00	R2-	4.8E-07
Low Level	D,R1,R2	10 / 10	N	6,420 / 2,400	D,R1,R2	1.6E-07	N	1.0E-04	D,R1,R2	1.6E-07	R4,C	3.9E-05
Transuranic	N	0 / 0	D-C	10 / 10	N	0.0E+00	D-C	1.5E-06	N	0.0E+00	N	3.0E-06
High Level[a]	--	--	--	--	--	--	--	--	--	--	D-C	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**10 / 10**		**6,480 / 2,440**		**1.6E-07**		**1.0E-04**		**1.6E-07**		**4.2E-05**

Table 11.12-1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.3E-04	N	2.8E-01	R2-C	6.4E-08	N	1.4E-04	R2-C	5.1E-09	N	5.9E-07
Low Level[a]	N	3.2E-06	R2	3.0E-04	N	1.6E-09	R2	1.5E-07	--	--	--	--
Transuranic	N	--	R1-C	8.2E-07	N	--	R1-C	4.1E-10	N	--	R1-C	5.0E-13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.3E-04**		**1.9E-02**		**6.6E-08**		**9.7E-06**		**5.1E-09**		**3.4E-08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	0.3	D,R1	2.3
Low Level	All/None	All/None	All	None	D,R1,2	Np-237	N	2.9	D,R1	11.2
Transuranic	All/None	All/None	--	--	--	--	N	0	D-C	0.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[b]**	**None**		**None**		**Np-237**		**3.8**		**14.1**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	116	D,R1	2,963	R2-C	176	D,R1	1,541	R2-C	0.25	D,R1	0.45
Low Level	N	2,968	R2	67,852	N	1,682	R2	5,847	N	0.38	D,R1	11.31
Transuranic	N	171	R2-C	880	N	171	D-C	200	N	0.17	R1	0.26
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3,613**		**71,695**		**2,058**		**7,588**		**0.81**		**12.02**

Table 11.12-1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.04	D,R1	0.24	N,R2-C	0.02	D,R1	0.11	N	41	D,R1	221
Low Level	N	0.27	R2	0.88	N	0.14	R2	0.44	R3-C5	276	R2	797
Transuranic	N	0.03	R2-C	0.07	N	0.01	R2-C	0.03	N	32	R2-C	59
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.38**		**1.19**		**0.18**		**0.58**		**349**		**1,077**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Paducah Gaseous Diffusion Plant does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.12-2 identifies the range of cumulative impacts that would result from the combined waste management alternatives (including transportation) and current activities at PGDP. As identified in Table 11.12-2, the maximum annual radioactive releases that would result from the waste management alternatives would result in a slight increase in the dose to the offsite population; however, PGDP cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

PGDP is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under various alternatives could increase the levels of these emissions, the increases would be below the regulated levels in the nonattainment region. Disposal of LLW at PGDP under the Decentralized and Regionalized Alternatives 1 and 2 could result in exceedance of drinking water standards in groundwater for Np-237. No disposal of LLW would occur at PGDP under the preferred alternative.

The combined alternatives could affect between 4 and 14 acres of land at PGDP. This area is less than 1% of the total suitable acreage and less than 1% of the area available for waste management facilities. Onsite infrastructure demands for water, wastewater treatment, and power would not measurably increase from the combined alternatives. The combined alternatives could add up to 378 jobs at PGDP, or a maximum increase of approximately 20% over existing employment. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the PGDP region.

11.13 Pantex Plant

The Pantex Plant would continue in the future to disassemble, assemble, and conduct quality evaluation and maintenance of the nation's nuclear weapons stockpile. The existing environmental conditions at the Pantex Plant resulting from these ongoing activities are described in Chapter 4.

Table 11.12–2. Paducah Gaseous Diffusion Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.70E-01	1.60E-03	3.60E+00	1.65E-03	--	1.72E-01	3.77E+00	1.72E-01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	4.50E-03	1.80E-05	4.00E-02	1.85E-05	--	4.52E-03	4.45E-02	4.52E-03
Worker Population									
Collective dose, 10 years (person-rem)	(4)	5.19E+01	4.07E+00	1.26E+01	4.07E+00	--	5.60E+01	6.45E+01	5.60E+01
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	9,960	10	6,480	6,330	--	9,970	16,440	16,290
Number of rail shipments (10 yr)		0	10	2,440	2,410	--	10	2,440	2,410
Annual dose (mrem) from truck transport		4.0E+00	1.6E-05	1.0E-02	1.02E-02	--	4.0E+00	4.0E+00	4.0E+00
Annual dose (mrem) from rail transport		0.0E+00	1.6E-05	4.2E-03	4.15E-03	--	1.6E-05	4.2E-03	4.2E-03
Resources and Infrastructure									
Land area (% of available area)	(6)	79%	0.40%	1.48%	0.53%	--	79%	80%	79%
Water use (% capacity)		50%	0.01%	0.24%	0.02%	--	50%	50%	50%
Wastewater treatment (% capacity)		23%	0.12%	0.43%	0.13%	--	23%	23%	23%
Power demand (% current load)		51%	0.03%	0.40%	0.03%	--	51%	52%	51%
Employment									
Number of site workers	(7)	1,869	115	378	125	--	1,984	2,247	1,994
Air Quality Exceedance	(8)	Ozone	None	None	None	--	Ozone	Ozone	Ozone
Groundwater Quality Exceedance	(9)	15 parameters exceeded	None	Np-237	None	--	15 parameters exceeded	16 parameters exceeded	15 parameters exceeded

[a] Aside from continuation of existing operations, waste management, and environmental restoration activities, no other actions are planned by DOE at the Paducah Gas Diffusion Plant.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.13.1 Combined Waste Management Impacts

DOE considered the management of LLMW and LLW at the Pantex Plant. Table 11.13-1 lists the minimum and maximum combined impacts of the waste management alternatives considered for the Pantex Plant. The most adverse impacts at the Pantex Plant and in the Pantex Plant region would occur as a result of the Decentralized and Regionalized Alternatives for which treatment and disposal facilities would be constructed for LLMW and LLW. The least adverse impacts at the Pantex Plant and in the Pantex Plant region generally would result from the No Action Alternative and other Regionalized and Centralized Alternatives for which the Pantex Plant would prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at Pantex are expected to be lower than the impacts of the maximum combined waste management alternatives at the site.

11.13.2 Cumulative Impacts

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at the Pantex Plant are described in separate EISs and include the storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and continued operations (including environmental restoration activities) as described in a sitewide EIS (DOE, 1996i). In addition to these DOE actions, closures and realignment of military bases in the region could contribute to the cumulative impact of waste management alternatives. Table 11.13-2 identifies the range of cumulative impacts resulting from other actions described in the aforementioned EISs, the combined waste management alternatives, and existing activities.

As identified in Table 11.13-2, the maximum annual radioactive releases from the combined waste management alternatives (including transportation) would result in a slight increase in the dose to the offsite population from the Pantex Plant. However, maximum cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.13–1. Pantex Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population Health from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	2.2E-03	D,R1	6.9E-02	N	1.1E-06	D,R1	3.5E-05	R2-C	3.6E-10	N	7.0E-08
Low Level[a]	D-C5	8.8E-04	N	1.8E-03	D-C5	4.4E-07	N	8.8E-07	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.1E-03**		**7.1E-02**		**1.5E-06**		**3.5E-05**		**3.6E-10**		**7.0E-08**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	1.8E-07	D,R1	5.9E-06	N	9.2E-11	D,R1	2.9E-09	R2-C	3.0E-14	N	5.8E-12
Low Level[a]	D-C5	7.5E-08	N	1.5E-07	D-C5	3.7E-11	N	7.5E-11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.6E-07**		**6.1E-06**		**1.3E-10**		**2.9E-09**		**3.0E-14**		**5.8E-12**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D1,R1	0 / 0	R2-R4,C	40 / 30	N,D,R1	0.0E+00	R2-R4,C	6.4E-07	N,D,R1	0.0E+00	R2-R4,C	4.8E-07
Low Level	D,R1,R2	0 / 0	R5,C3,C4	430 / 170	D,R1,R2	0.0E+00	R5,C3,C4	6.9E-06	D,R1,R2	0.0E+00	R5,C3,C4	2.7E-06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**470 / 200**		**0.0E+00**		**7. 5-06**		**0.0E+00**		**3.2E-06**

Table 11.13-1. Pantex Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	4.7E-04	D,R1	6.9E-03	R2-C	2.3E-07	D,R1	3.5E-06	R2-C	4.1E-10	N	8.0E-08
Low Level[a]	D-C5	8.7E-05	N	1.7E-04	D-C5	4.4E-08	N	8.7E-08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.6E-04**		**7.1E-03**		**2.8E-07**		**3.5E-06**		**4.1E-10**		**8.0E-08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	0.3	D.R1	3.7
Low Level	All/None	All/None	All	None	All	None	N,R3-C5	1.7	R2	4.5
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**		**None**		**2.0**		**8.2**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	387	D,R1	4,499	N	305	D,R1	1,457	R2-C	0.16	D,R1	0.45
Low Level	N,R3-C5	1,977	R2	4,599	N,R3-C5	671	R2	3,691	N,R3-C5	0.19	R2	0.79
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2,364**		**9,098**		**976**		**5,148**		**0.35**		**1.24**

Table 11.13–1. Pantex Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.03	D,R1	0.17	N,R2-C	0.02	D,R1	0.07	N	38	D,R1	192
Low Level	N,R3-C5	0.12	R2	0.20	All	0.09	All	0.09	N,R3-C5	135	R2	222
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.15**		**0.37**		**0.11**		**0.16**		**173**		**414**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Pantex Plant does not have transuranic and high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.13-2. Pantex Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	0	3.10E-03	7.10E-02	6.99E-02	5.80E-03	8.90E-03	7.68E-02	7.57E-02
Number of cancer fatalities from collective dose	(2)	0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.00E-04	2.60E-05	6.10E-04	5.98E-04	5.00E-05	1.76E-04	7.60E-04	7.48E-04
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.00E+02	2.32E+00	5.00E+00	2.74E+00	4.93E+02	7.95E+02	7.98E+02	7.96E+02
Number of cancer fatalities from collective dose	(1)	1.50E-01	~0	~0	~0	2.47E-01	3.18E-01	3.19E-01	3.18E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	2,350	0	470	460	830	3,180	3,650	3,640
Number of rail shipments (10 yr)		0	0	200	190	0	0	200	190
Annual dose (mrem) from truck transport		9.4E-01	0.0E+00	7.5E-04	7.34E-04	3.3E-02	9.7E-01	9.7E-01	9.74E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	3.2E-04	3.08E-04	00E+00	0.0E+00	3.2E-04	3.08E-04
Resources and Infrastructure									
Land area (% of available area)	(6)	21%	0.02%	0.08%	0.06%	2%	23%	23%	23%
Water use (% capacity)		33%	0.16%	0.61%	0.43%	13%	46%	47%	47%
Wastewater treatment (% capacity)		50%	0.18%	0.94%	0.39%	24%	75%	75%	75%
Power demand (% current load)		0.8%	0.02%	0.08%	0.04%	0.77%	2%	2%	2%
Employment									
Number of site workers	(7)	3,011	77	125	107	968	4,056	4,104	4,086
Air Quality Exceedance	(8)	None	None	None	None	Alcohols	Alcohols	Alcohols	Alcohols
Groundwater Quality Exceedance	(9)	10 parameters exceeded	None	None	None	None	10 parameters exceeded	10 parameters exceeded	10 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and continuation of sitewide operations (including the impacts of environmental restoration activities) (DOE, 1996i). Shipment numbers and shipment MEI values do not include those related to stockpile stewardship and management and continuation of sitewide operations because these were not presented in those EISs.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The Pantex Plant is in an attainment region where criteria air pollutants do not exceed standards. Although no air quality exceedances are expected for combined waste management activities, cumulative emissions for all activities at the site could result in the exceedance of the air quality standard for alcohols. Disposal of LLMW and LLW at Pantex are not expected to result in exceedance of standards for groundwater used as drinking water under any of the alternatives. No disposal of LLMW or LLW would occur at Pantex under the preferred alternatives.

The combined alternatives would affect between 2 and 8 acres of land at the Pantex Plant. This area is less than 1% of the total suitable acreage at Pantex and less than 1% of the area available for waste management facilities. Other actions could affect another 222 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of 2% of the suitable acreage at the Pantex Plant, detailed characterization studies and evaluations of the land may be required to ensure protection of wildlife habitats and cultural artifacts prior to development.

The demand for water and wastewater treatment would not be greatly affected nor would it exceed existing capacities because of the combined alternatives or the cumulative effects of other planned actions. Although cumulative power demand would increase as a result of other planned actions at the Pantex Plant, this increase would be well within current capacity, and no expansions or upgrades would be needed.

The combined alternatives could add up to 125 jobs at the Pantex Plant, while other actions could increase the number of jobs by 968. Cumulatively, the maximum number of jobs at the Pantex Plant would increase about 36%. Within the Pantex Plant region, about 2,080 jobs will be lost as a result of military base closures and realignments (DBCRC, 1995), and the potential employment increases at the Pantex Plant could offset some of these job losses. Mitigation measures may be required to reduce any adverse impacts to offsite community infrastructures and institutions.

11.14 Portsmouth Gaseous Diffusion Plant

Portsmouth Gaseous Diffusion Plant (PORTS) would continue in the future to produce enriched uranium. The existing environmental conditions at PORTS resulting from these ongoing activities are described Chapter 4.

11.14.1 COMBINED WASTE MANAGEMENT IMPACTS

DOE considered the management of LLMW and LLW at PORTS. Table 11.14–1 lists the minimum and maximum combined impacts of the waste management alternatives for PORTS. The most adverse impacts at PORTS and in the PORTS region would occur as a result of Regionalized Alternatives for which treatment and disposal facilities would be constructed for PORTS to manage its own waste, as well as accept offsite LLMW and LLW for treatment and disposal. The least adverse impacts at PORTS and in the PORTS region generally would result from other Regionalized and Centralized Alternatives for which PORTS would only prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at PORTS are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.14.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration actions, DOE has no other actions planned at PORTS. No other DOE or non-DOE actions are planned in the PORTS region that would contribute to the cumulative impact of the waste management alternatives.

The environmental restoration program at PORTS will address cleanup of an estimated 1,000,000 m^3 of contaminated media and facilities (270,000 m^3, 730,000 m^3 of LLMW and LLW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and soils and eventual decontamination and decommissioning of uranium enrichment facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at PORTS have had no significant adverse environmental impacts based on the NEPA and RCRA reviews completed to date. Future environmental evaluations will continue to be performed on a project-specific basis under RCRA and NEPA.

Table 11.14–2 identifies the range of cumulative impacts that would result from the combined waste management alternatives (including transportation) and current activities at PORTS. As identified in Table 11.14–2, the maximum annual radioactive releases that would result from the waste management alternatives would result in a very slight increase in the radiation dose to the offsite population; however,

Table 11.14–1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	3.6E-05	R2,3	2.1E-01	R4,C	1.8E-08	R2,3	1.1E-04	R4,C	4.9E-08	N	5.9E-05
Low Level[a]	D,R1	4.9E-07	R4, C3,4	3.8E+01	D,R1	2.4E-10	R4,C3,4	1.9E-02	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.6E-05**		**3.8E+01**		**1.8E-08**		**1.9E-02**		**4.9E-08**		**5.9E-05**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	4.5E-09	R2,3	2.6E-05	R4,C	2.2E-12	R2,3	1.3E-08	R4,C	8.2E-12	N	9.8E-09
Low Level[a]	D, R1	6.2E-11	R4,C3,4	4.6E-03	D,R1	3.1E-14	R4,C3,4	2.3E-06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4.9E-09**		**4.6E-03**		**2.E-12**		**2.3E-06**		**8.2E-12**		**9.8E-09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2,R3	2,260 / 960	N	0.0E+00	R2-R3	3.6E-05	N	0.0E+00	R2-R3	1.5E-05
Low Level	D	23,320 / 4,770	R4	47,610 / 18,410	D	3.7E-04	R4	7.7E-04	D	1.4E-04	R4	3.0E-04
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**23,320 / 4,770**		**49,870 / 19,370**		**3.7E-04**		**8.1E-04**		**1.4E-04**		**3.2E-04**

Table 11.14–1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	3.7E-06	R2,3	1.6E-02	R4,C	1.9E-09	R2,3	8.0E-06	R4,C	2.8E-08	N	3.3E-05
Low Level[a]	D,R1	5.1E-08	R4,C3,4	1.2E+00	D,R1	2.6E-11	R4,C3,4	5.9E-04	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.8E-06**		**1.2E+00**		**1.9E-09**		**6.0E-04**		**2.8E-08**		**3.3E-05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2-4,C	None	R1	2 hazardous chemicals[c]	N	1.3	R1	12.2
Low Level	All/None	All/None	All	None	All	None	R3,5-C2,5	2.0	R2	44.7
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[d]**	**None**		**None**		**2 hazardous chemicals[c]**		**3.3**		**56.9**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	2,190	R1	19,863	R4,C	1,888	R1	6,787	R4,C	0.37	R1	1.84
Low Level	R3,5-C2,5	3,997	R1	178,908	R3,5-C2,5	1,094	N	22,144	R3,5-C2,5	0.44	R1	26.84
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**6,187**		**198,771**		**2,982**		**28,931**		**0.81**		**28.68**

Table 11.14-1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.20	R1	0.98	N,R4,C	0.09	R1	0.36	N	210	R1	838
Low Level	R3,5-C2,5	0.20	R2	1.69	R3,5-C2,5	0.08	R2	0.62	R3,5-C2,5	169	R2	1,436
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.40**		**2.67**		**0.17**		**0.98**		**379**		**2,274**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Portsmouth does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Hazardous chemicals that could exceed standards for groundwater used as drinking water include 1,2-dichloroethane and methylene chloride.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.14-2. Portsmouth Gaseous Diffusion Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	3.00E-01	3.60E-05	3.80E+01	5.40E-03	--	3.00E+01	6.80E+01	3.00E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.60E-01	4.90E-07	4.60E-01	6.80E-05	--	2.60E-01	7.20E-01	2.60E-01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	1.71E+03	1.31E+01	4.35E+02	1.46E+01	--	1.72E+03	2.15E+03	1.72E+03
Number of cancer fatalities from collective dose	(1)	6.84E-01	~0	1.74E-01	~0	--	6.89E-01	8.58E-01	6.90E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	2,600	23,320	49,870	34,090	--	25,920	52,470	36,690
Number of rail shipments (10 yr)		2,150	4,770	19,370	13,000	--	6,920	21,520	15,150
Annual dose (mrem) from truck transport		1.0E+00	3.7E-02	8.1E-02	5.50E-02	--	1.1E+00	1.1E+00	1.1E+00
Annual dose (mrem) from rail transport		8.6E-01	1.4E-02	3.2E-02	2.14E-02	--	8.7E-01	8.9E-01	8.8E-01
Resources and Infrastructure									
Land area (% of available area)	(6)	20%	0.08%	1.42%	0.31%	--	21%	21%	20%
Water use (% capacity)		38%	0.02%	0.54%	0.06%	--	38%	38%	38%
Wastewater treatment (% capacity)		29%	0.25%	2.41%	0.65%	--	29%	32%	30%
Power demand (% current load)		80%	0.04%	1.49%	0.11%	--	80%	81%	80%
Employment									
Number of site workers	(7)	2,582	153	927	400	--	2,582	3,509	2,982
Air Quality Exceedance	(8)	None	None	None	None	--	None	None	None
Groundwater Quality Exceedance	(9)	8 parameters exceeded	None	2 hazardous chemicals[e]	None	--	8 parameters exceeded	9 parameters exceeded	8 parameters exceeded

[a] Aside from the continuation of existing operations, waste management, and environmental restoration activities, no other actions are planned by DOE at the PORTS site.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed standards for groundwater used as drinking water include 1,2-dichloroethane and methylene chloride.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

PORTS is in an attainment region where criteria air pollutants do not exceed standards, and cumulative emissions are not expected to result in air quality standard exceedances. The combined alternatives would affect between 3 and 57 acres of land at PORTS. This area is about 1% of the total suitable acreage at PORTS and 2% of the area available for waste management facilities. Onsite infrastructure demands for water, wastewater treatment, and power would not greatly increase from the combined waste management alternatives and would remain within existing capacities. The combined alternatives could add up to 927 jobs, or a maximum employment increase of approximately 36%. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the region.

Disposal of LLMW at PORTS under Regionalized Alternative 1 could result in exceedances of standards for groundwater used as drinking water for 1,2-dichloroethane and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at PORTS, nor are there any expected exceedances for other waste types. No disposal of LLMW would occur at PORTS under the preferred alternative.

11.15 Rocky Flats Environmental Technology Site

Rocky Flats Environmental Technology Site (RFETS) would continue in the future to conduct decontamination and decommissioning and cleanup. The existing environmental conditions at RFETS resulting from these ongoing activities are described in Chapter 4.

11.15.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at RFETS. Table 11.15-1 lists the minimum and maximum combined impacts of the waste management alternatives for RFETS. The most adverse impacts at RFETS and in the RFETS region would occur as a result of the No Action Alternative for LLMW and Regionalized Alternatives for which LLW treatment and disposal facilities would be

Table 11.15–1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.3E–02	N	2.6E+01	R4,C	6.3E–06	N	1.3E–02	R4,C	2.4E–06	N	1.0E–03
Low Level[a]	N	2.4E–04	R2,4,C3,4	3.7E–01	N	1.2E–07	R2,4,C3,4	1.9E–04	--	--	--	--
Transuranic	N	6.0E–03	R2	2.2E+02	N	3.0E–06	R2	1.1E–01	N	1.0E–10	R3,C	1.1E–09
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.9E–02**		**2.5E+02**		**9.4E–06**		**1.2E–01**		**2.4E–06**		**1.0E–03**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.7E–07	N	3.6E–04	R4,C	8.5E–11	N	1.8E–07	R4,C	1.9E–11	N	8.0E–09
Low Level[a]	N	3.3E–09	R2,4,C3,4	5.1E–06	N	1.6E–12	R2,4,C3,4	2.5E–09	--	--	--	--
Transuranic	N	8.2E–08	R2	3.0E–03	N	4.1E–11	R2	1.5E–06	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.5E–07**		**3.4E–03**		**1.3E–10**		**1.7E–06**		**1.9E–11**		**8.0E–09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2,R3	2,560 / 980	N	0.0E+00	R2,R3	4.1E–05	N	0.0E+00	R2,R3	1.6E–05
Low Level	D,R1, R2	0 / 0	R3,R6,R7, C1,C2 / R3, R5-R7 C1, C2	3,570 / 1,330	D,R1,R2	0.0E+00	R3,R6,R7, C1,C2	5.7E–05	D,R1,R2	0.0E+00	R3,R5-R7, C1,C2	2.1E–05
Transuranic	N	0 / 0	D	830 / 420	N	0.0E+00	D	1.2E–04	N	0.0E+00	D	1.3E–04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**6,960 / 2,730**		**0.0E+00**		**2.2E–04**		**0.0E+00**		**1.7E–04**

Table 11.15-1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	6.4E-04	N	7.3E+00	R4,C	3.2E-07	N	6.7E-04	R4,C	4.8E-07	N	2.0E-04
Low Level	N	1.2E-05	R2,4,C3,4	1.9E-02	N	6.2E-09	R2,4,C3,4	9.5E-06	--	--	--	--
Transuranic	N	3.1E-04	R2	1.1E+01	N	1.5E-07	R2	5.6E-03	N	2.1E-11	R3,C	2.3E-10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.6–03**		**1.1E+01**		**8.0E-07**		**5.6E-03**		**4.8E-07**		**1.0E-05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D-R3/CO;D-R1/NO_2	All/None	N,R2-4,C	None	D,R1	3 hazardous chemicals[c]	R4,C	6.2	D.R1	32.9
Low Level	All/None	All/None	All	None	All	None	N	1.1	R2	11.4
Transuranic	All/None	All/None	--	--	--	--	N	0	R2	2.8
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**CO, NO_2[d]**	**CO**		**None**		**3 hazardous chemicals[c]**		**8.5**		**47.1**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	7,271	D,R1	89,025	R4,C	3,478	D,R1	11,099	R4,C	0.86	D,R1	11.49
Low Level	N	2,490	R2	17,980	N	914	R2	11,997	N	0.20	D,R2	1.67
Transuranic	R3,C	2,173	R2	8,223	R3,C	708	R2	4,866	N	0.12	R2	0.87
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**11,934**		**115,228**		**5,100**		**27,962**		**1.51**		**14.03**

Table 11.15-1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	0.05	D,R1	0.14	R4,C	0.02	D,R1	0.07	R4,C	627	D,R1	1,826
Low Level	N,R3,5-C2,5	0.02	R2	0.08	N,R3,5-C2,5	0.01	R2	0.05	R3,5-	228	R2	1,044
Transuranic	R3,C	0.01	R2	0.04	R3,C	0.00	R1,2	0.02	C2,5	127	R2	531
High Level[a]	--	--	--	--	--	--	--	--	R3,C	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
									--			
Total		**0.08**		**0.26**		**0.03**		**0.14**		**982**		**3,401**

Notes: Alt. = alternative; C = Centralized Alternative; CO = carbon monoxide; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. The Rocky Flats Environmental Technology Site does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Hazardous chemicals that could exceed drinking water standards include carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

constructed to allow RFETS to manage its own waste. The least adverse impacts at RFETS and in the RFETS region generally would result from the Regionalized and Centralized Alternatives for which RFETS would only prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at RFETS are expected to be well below the impact of the maximum waste management alternatives at the site.

11.15.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operation and waste management activities addressed in this PEIS, reasonably foreseeable future actions at RFETS include the transfer of certain Nuclear Weapons Complex nonnuclear functions from RFETS to other sites (DOE, 1993); the operation of a supercompactor and TRUW shredder (DOE, 1990a); and environmental restoration activities. The impacts of the supercompactor and TRUW shredder are not included as future activities in the table because the operation of the supercompactor is considered part of the TRUW alternatives. In addition to these DOE actions, closure and realignment of military bases in the RFETS region could contribute to the cumulative impact of waste management alternatives. Table 11.15–2 identifies the range of cumulative impacts resulting from the combined waste management alternatives (including transportation), other actions, and current activities.

The environmental restoration program at RFETS will address cleanup of an estimated 480,900 m^3 of contaminated media and facilities (380,000 m^3, 96,000 m^3, and 4,900 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future and ongoing cleanup actions include remediation of contaminated groundwater, solidification and disposition of solar pond sludge, and decontamination and decommissioning of facilities. The impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, but project-specific environmental evaluations will be performed prior to implementation.

As identified in Table 11.15–2, the annual radioactive releases that would result from the combined waste management alternatives (including transportation) would increase the radiation dose to the offsite population. However, the maximum cumulative radioactive release would be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.15-2. Rocky Flats Environmental Technology Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.40E+00	1.90-02	2.50E+02	2.00E-01	--	1.42E+00	2.51E+02	1.60E+00
Number of cancer fatalities from collective dose	(2)	~0	~0	1.25E-01	~0	--	~0	1.26E-01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.00E-04	2.50E-05	3.40E-01	2.66E-04	--	2.25E-04	3.40E-01	4.66E-04
Worker Population									
Collective dose, 10 years (person-rem)	(4)	Not available	5.61E+00	9.23E+01	2.44E+01	--	5.61E+00	9.20E+01	2.44E+01
Number of cancer fatalities from collective dose	(1)		~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	210	0	6,960	6,920	--	210	7,170	7,130
Number of rail shipments (10 yr)		0	0	2,730	2,690	--	0	2,730	2,690
Annual dose (mrem) from truck transport		8.4E-02	0.0E+00	2.2E-02	2.17E-02	--	8.4E-02	1.1E-01	1.1E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.7E-02	1.66E-02	--	0.0E+00	1.7E-02	1.7E-02
Resources and Infrastructure									
Land area (% of available area)	(6)	15%	0.13%	0.69%	0.56%	--	15%	16%	16%
Water use (% capacity)		27%	1.19%	11.52%	9.89%	--	28%	39%	37%
Wastewater treatment (% capacity)		30%	1.02%	5.59%	3.16%	--	31%	36%	33%
Power demand (% current load)		53%	4.38%	40.67%	36.00%	--	57%	94%	89%
Employment									
Number of site workers	(8)	7,962	272	1,369	774	-715	7,519	8,616	8,736
Air Quality Exceedance	(9)	PM_{10}, CO, ozone	None	CO, NO_2	CO, NO_2	--	PM_{10}, CO, ozone	PM_{10}, CO, NO_2, ozone	PM_{10}, CO, NO_2, ozone
Groundwater Quality Exceedance	(6)	12 parameters exceeded	None	3 hazardous chemicals[e]	None	--	13 parameters exceeded	14 parameters exceeded	13 parameters exceeded

[a] Other reasonably foreseeable future actions include the transfer of non-nuclear functions from RFETS to other sites (DOE, 1993). Impacts of proposed TRUW supercompactor are included within waste management alternatives for TRUW.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed standards for groundwater used as drinking water include carbon tetrachloride, 1,2-dichloroethane, and methylene chloride,

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

RFETS is in a nonattainment region where criteria air pollutants are exceeded for particulates, carbon monoxide, and ozone. While minimum cumulative emissions would not exceed air quality standards, cumulative emissions with maximum combined alternatives or the preferred alternatives are expected to result in exceedances of both carbon monoxide and nitrogen dioxide emission limits as a result of the construction of LLMW facilities and for carbon monoxide alone for operation of facilities. Measures to mitigate these emissions would be necessary if these alternatives were chosen.

The combined alternatives would affect between 9 and 47 acres of land. This area is less than 1% of the total suitable acreage at RFETS and less than 1% of the area available for waste management facilities. Although the combined alternatives would result in increases in the demands for water, wastewater treatment, and power, the existing capacities for these utilities are expected to be sufficient.

The combined alternatives could add up to 1,369 jobs at RFETS, while the transfer of nonnuclear functions from RFETS would reduce employment by 715 jobs. Within the RFETS region, about 2,900 jobs will be lost as a result of military base closures and realignments (DBCRC, 1995). The potential employment increase at RFETS would offset some of the job losses, and no mitigation is expected to be necessary to reduce adverse impacts to offsite infrastructures and institutions.

Disposal of LLMW at RFETS under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of drinking water standards in groundwater for carbon tetrachloride, 1,2-dichloroethane, and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at RFETS, nor are there any expected exceedances for other waste types. No disposal of LLMW would occur at RFETS under the preferred alternatives.

11.16 Sandia National Laboratories

Sandia National Laboratories in New Mexico (SNL-NM) would continue in the future to develop, engineer, and test nonnuclear components of nuclear weapons. The existing environmental conditions at SNL-NM resulting from these ongoing activities are described in Chapter 4.

11.6.1 COMBINED WASTE MANAGEMENT IMPACTS

DOE considered the management of LLMW, LLW, and TRUW at SNL-NM. Table 11.16–1 lists the minimum and maximum combined impacts of the waste management alternatives for SNL-NM. As noted in Table 11.16–1, SNL-NM has a very small quantity of TRUW, and impacts are expected to be minimal for all TRUW alternatives affecting SNL-NM. The most adverse impacts at SNL-NM and in the SNL-NM region would occur as a result of the Decentralized Alternatives for which treatment and disposal facilities would be constructed to allow SNL-NM to manage its own waste. The least adverse impacts would result from the Regionalized and Centralized Alternatives for which SNL-NM would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at SNL-NM are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

11.16.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at SNL-NM include the transfer of certain Nuclear Weapons Complex nonnuclear functions to SNL-NM (DOE, 1993), stockpile stewardship and management (DOE 1996f), medical isotope production (DOE, 1996c), and environmental restoration activities (DOE, 1996k). Table 11.16–2 identifies the range of cumulative impacts resulting from the combined alternatives, the confirmed transfer of nonnuclear functions to SNL-NM, and current activities.

As identified in Table 11.16–2, the annual radioactive releases that would result from the combined waste management alternatives would result in a slight increase in the current radiation dose to the offsite population. However, the maximum cumulative radioactive release would remain well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

SNL-NM is in a nonattainment region for carbon monoxide; however, both minimum and maximum combined emissions would not exceed air quality standards. The combined alternatives would affect between 1 and 5 acres of land. This area is approximately 1% of the total suitable acreage at SNL-NM and about 2% of the area available for waste management facilities. Other future actions could affect another 1,123 acres. Onsite infrastructure demands for water, wastewater treatment, and power would not

Table 11.16-1. Sandia National Laboratories-New Mexico Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	3.6E-05	D	2.8E-01	R1-C	1.8E-08	D	1.4E-04	R1-C	5.4E-10	N	7.3E-07
Low Level[a]	N	3.4E-03	D-C5	3.6E-03	N	1.7E-06	D-C5	1.8E-06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.4E-03**		**2.8E-01**		**1.7E-06**		**1.4E-04**		**5.4E-10**		**7.3E-07**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.4E-09	D	1.1E-05	R1-C	7.1E-13	D	5.4E-09	R1-C	2.3E-14	N	3.1E-11
Low Level[a]	All	1.4E-07	All	1.4E-07	N	6.8E-11	R1-C5	7.2E-11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.4E-07**		**1.1E-05**		**6.9E-11**		**5.5E-09**		**2.3E-14**		**3.1E-11**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R1-R4, C	20 / 20	N,D	0.0E+00	R1-R4,C	3.20E-07	N,D	0.0E+00	R1-R4,C	3.2E-07
Low Level	D	0 / 0	N,R5,C3, C4 / N	240 / 120	D	0.0E+00	N,R5,C3, C4	3.90E-06	D	0.0E+00	N	1.9E-06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**260 / 140**		**0.0E+00**		**4.2E-06**		**0.0E+00**		**2.2E-06**

Table 11.16-1. Sandia National Laboratories (New Mexico) Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.9E-07	D	1.6E-03	R1-C	3.5E-10	D	7.8E-07	R1-C	6.0E-11	N	8.1E-08
Low Level[a]	N	5.8E-05	D-C5	6.1E-05	N	2.9E-08	D-C5	3.0E-08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.9E-05**		**1.7E-03**		**2.9E-08**		**8.1E-07**		**6.0E-11**		**8.1E-08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	N,R1-C	None	D	Pu-240	N,R1-C	0.0	D	1.7
Low Level	All/None	All/None	N,R1-C5	None	D	5 radionuclides[c]	N	0.9	D	3.0
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[d]**	**None**		**None**		**5 radionuclides[c]**		**0.9**		**4.7**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R1-C	18	D	2,079	N,R1-C	18	D	289	N,R1-C	0.01	D	0.15
Low Level	N	1,077	D	3,675	N	622	D	1,146	N	0.12	D	0.39
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1,095**		**5,754**		**640**		**1,435**		**0.13**		**0.54**

Table 11.16-1. Sandia National Laboratories (New Mexico) Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	0.00	D	0.02	N,R1-C	0.00	D	0.07	R1-C	6	D	73
Low Level	N	0.02	D	0.06	N,R1-C	0.01	D	0.03	R1-C5	108	D	243
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.02**		**0.08**		**0.01**		**0.10**		**114**		**316**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Sandia National Laboratories, which includes the Inhalation Toxicology Research Institute, has a de minimis quantity of transuranic waste and does not have high-level waste. No new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Radionuclides that could exceed drinking water standards in groundwater include Pu-239, Pu-240, Tc-99, U-234, and U-238.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.16-2. Sandia National Laboratories-New Mexico Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.00E-01	3.44E-03	2.84E-01	2.84E-01	1.30E+02	1.30E+02	1.30E+02	1.30E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	3.40E-03	1.40E-05	1.11E-03	1.11E-03	1.75E-01	1.78E-01	1.80E-01	1.80E-01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.50E+01	1.04E+00	2.15E+02	1.82E+00	2.50E+02	2.86E+02	5.00E+02	2.87E+02
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0	1.00E-01	1.14E-01	2.00E-01	1.15E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	60	0	380	370	16,100	16,160	16,540	16,530
Number of rail shipments (10 yr)		0	0	200	180	0	0	200	180
Annual dose (mrem) from truck transport		2.4E-02	0.0E+00	7.5E-04	7.28E-04	6.1E-01	6.3E-01	6.3E-01	6.3E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	6.0E-04	5.72E-04	0.0E+00	0.0E+00	6.0E-04	5.7E-04
Resources and Infrastructure									
Land area (% of available area)	(6)	6%	0.04%	0.18%	0.13%	40%	46%	46%	46%
Water use (% capacity)		25%	0.03%	0.14%	0.11%	17%	42%	42%	42%
Wastewater treatment (% capacity)		95%	0.11%	0.25%	0.16%	36%	131%	131%	131%
Power demand (% current load)		69%	0.26%	1.08%	0.78%	18%	87%	88%	88%
Employment									
Number of site workers	(7)	8,596	23	107	46	1,726	10,345	10,429	10,368
Air Quality Exceedances	(8)	CO	None	None	None	None	CO	CO	CO
Water Quality Exceedances	(9)	5 parameters exceeded	None	5 radionuclides[e]	None	None	5 parameters exceeded	10 parameters exceeded	5 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996f), transfer of non-nuclear functions (DOE, 1993), medical isotope production (DOE, 1996c) and environmental restoration activities (DOE, 1996k).

[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.

[c] Cumulative impacts, including minimum combined waste management impacts.

[d] Cumulative impacts including maximum combined waste management impacts.

[e] Radionuclides that could exceed drinking water standards in groundwater include Pu-239, Pu-240, Tc-99, U-234, and U-238.

Notes:

(1) Assumes all facilities operate concurrently for the same 10-year period.

(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).

(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.

(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.

(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.

(6) Suitable land includes land that is available for development or land that is currently developed.

(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.

(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements.

(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

measurably increase from the combined waste management alternatives, but wastewater treatment capacity would be exceeded as a result of other actions planned at SNL-NM and would require upgrades.

The combined waste management alternatives could add up to 107 jobs at SNL-NM, while other actions would add an additional 1,726 jobs. The cumulative increase would be about 21% over existing employment at SNL-NM, which is not expected to affect offsite community infrastructures and institutions.

Disposal of LLW at SNL-NM under the Decentralized Alternative could result in exceedances of standards for groundwater used as drinking water for Pu-239, Pu-240, Tc-99, U-234, and U-238. For disposal of LLMW, the Decentralized Alternative could also result in an exceedance for Pu-240. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLW or LLMW are expected to result in exceedances for any contaminant at SNL-NM, nor are there any expected exceedances for other waste types. No disposal of LLMW or LLW would occur at SNL-NM under the preferred alternatives.

11.17 Savannah River Site

Savannah River Site (SRS) would continue in the future to conduct defense program missions, including those for tritium and special nuclear materials. The existing environmental conditions at SRS resulting from these ongoing activities are described in Chapter 4.

11.17.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at SRS. Table 11.17-1 lists the minimum and maximum combined impacts of the waste management alternatives considered for SRS. The most adverse impacts at SRS and in the SRS region would occur as a result of some Centralized and Regionalized Alternatives for which treatment and disposal facilities would be constructed for SRS to manage its own LLW and LLMW, in addition to accepting offsite LLMW and LLW for treatment and disposal, offsite TRUW for treatment, and offsite HLW canisters for storage. The least adverse impacts generally would result from other Regionalized and Centralized Alternatives for which SRS would only prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the

Table 11.17-1. Savannah River Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed Low Level[a]	C C5	2.7E-03 2.5E-02	D-R4 N,R2,4,5, C3,4	3.5E+00 1.2E+00	C C5	1.3E-06 1.2E-05	R1-R4 R2,4,5, C3,4	1.8E-03 6.1E-04	C --	6.1E-08 --	N --	2.9E-06 --
Transuranic High Level[a]	N --	4.3E-02 --	R2,3 --	4.5E+00 --	N --	2.2E-05 --	R2,3 --	2.3E-03 --	N --	7.2E-13 --	R1 --	3.1E-11 --
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	D	1.3E-03
Total		**7.1E-02**		**9.2E+00**		**3.5E-05**		**4.7E-03**		**6.1E-08**		**1.3E-03**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed Low Level[a]	C C5	2.5E-08 2.3E-07	D-R4 N,R2,4,5	3.3E-05 1.1E-05	C C5	1.3E-11 1.2E-10	D-R4 R2,4,5, C3,4	1.7E-08 5.7E-09	C --	7.9E-13 --	N --	3.7E-11 --
Transuranic High Level[a]	N --	4.1E-07 --	R2,3 --	4.2E-05 --	N --	2.0E-10 --	R2,3 --	2.1E-08 --	All --	<9.9E-14 --	All --	<9.9E-14 --
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	D	1.7E-08
Total		**6.7E-07**		**8.6E-05**		**3.3E-10**		**4.4E-08**		**7.9E-13**		**1.7E-08**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed Low Level	N D,R1-R5	0 / 0 20 / 10	R3 R6,R7	710 / 330 130,030 / 49,340	N D,R1-R5	0.0E+00 3.2E-07	R3 R6,R7	1.1E-05 2.1E-03	N D,R1-R5	0.0E+00 1.6E-07	R3 R6,R7	5.3E-06 7.9E-04
Transuranic High Level	N N,D,R2,C1,C2	0 / 0 4,572 / 915	D R1	2,370 / 1,190 5,252 / 1,051	N N,D,R2, C1,C2	0.0E+00 1.8E-03	D R1	3.5E-04 2.1E-03	N N,D,R2, C1,C2	0.0E+00 3.7E-04	D R1	3.6E-04 4.2E-04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4,592 / 925**		**138,362 / 51,911**		**1.8E-03**		**4.6E-03**		**3.7E-04**		**1.6E-03**

Table 11.17–1. Savannah River Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.3E–04	N	1.3E–01	C	6.5E–08	N	6.5E–05	C	3.1E–08	N	1.4E–06
Low Level[a]	C5	2.2E–03	C3,4	6.7E–02	C5	1.1E–06	R2,4,5, C3,4	3.3E–05	--	--	--	--
Transuranic	N	4.7E–03	R2,3	4.8E–01	N	2.3E–06	R2,3	2.4E–04	N	3.6E–13	R1-3	1.5E–11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	0.0E+00	D	6.5E–04
Total		**6.9E–03**		**6.8E–01**		**4.1E–06**		**3.4E–04**		**3.1E–08**		**6.5E–04**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements				
	Construction	Operation	Number and Type of Exceedances				Acres Required				
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	
Low-Level Mixed	All/None	All/None	R3,C	None	D,R1,2,4	4 hazardous chemicals[c]	R3,C	12.8	N	24.9	
Low Level	All/None	All/None	C1-C5	--	N,D,R1-7	U-238	C1,2,5	12.5	R6,7	82.5	
Transuranic	All/None	All/None	--	--	--	--	N	0	R2,3	8.2	
High Level	All/None	All/None	--	--	--	--	N,D,R2,C	2.0	R1	4.0	
Hazardous	All/None	All/None	--	--	--	--	N,R2	--	R1	1.0	
Total	**None[d]**	**None**		**None**		**4 hazardous chemicals,[e] U-238**		**27.3**		**120.6**	

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	2,832	N	74,593	C	1,053	R1,2	8,980	R3,C	1.41	N	10.46
Low Level	N	13,690	R6,7	174,220	C1,2,5	7,911	R6,7	40,247	N	5.31	R6,7	9.77
Transuranic	N	1,973	R2,3	22,118	C	847	R2,3	7,366	N	0.07	R2,3	1.17
High Level	N,C	1,900	D-R2	1,930	N,C	1,900	D-R2	1,930	All	0.05	All	0.05
Hazardous	N,R2	--	R1	593	N,R2	--	R1	371	N,R2	--	D,R1	0.13
Total		**20,395**		**273,454**		**11,711**		**58,894**		**6.84**		**21.58**

Table 11.17–1. Savannah River Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	0.09	R1,2,4	0.46	C	0.04	R1,2,4	0.32	C	253	R1,2,4	1,245
Low Level	C1,2,5	0.40	R6,7	2.48	C1,2,5	0.19	R6,7	1.33	C1,2,5	1,066	R6,7	6,630
Transuranic	N	0.05	R2,3	0.38	N	0.02	R2,3	0.16	N	161	R2,3	1,024
High Level	C	0.06	D-R2	0.13	All	0.03	All	0.03	C	283	R1	594
Hazardous	N,R2	--	R1	0.01	N,R2	--	R1	0.00	R2	--	R1	32
Total		**0.60**		**3.46**		**0.25**		**1.84**		**1,763**		**9,525**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

combined impacts of the preferred alternatives at SRS are expected to be lower than the impacts of the maximum combined management alternatives at the site.

11.17.2 CUMULATIVE IMPACTS

Aside from the waste management activities addressed in this PEIS, reasonably foreseeable future actions at SRS include continued management of spent nuclear fuels (DOE, 1995d), tritium supply and recycling (DOE, 1995a), transfer of Nuclear Weapons complex nonnuclear functions to SRS (DOE, 1993), processing of F-Canyon plutonium solutions to plutonium metal (DOE, 1994g), interim management of nuclear materials (DOE, 1995b), operation of the Defense Waste Processing Facility (DOE, 1994h), other site projects for the management of waste (including environmental restoration activities) (DOE, 1995c), storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and disposition of surplus highly enriched uranium (DOE, 1995f).

Table 11.17–2 identifies the range of cumulative impacts resulting from these other actions, the combined waste management alternatives, and current activities that include atmospheric radiological releases from the Vogtle Nuclear Power Plant, located near SRS. Table 11.17–2 does not include, under the category of Other Actions, the impacts of waste management projects considered in the SRS Waste Management EIS (DOE, 1995c) because these are also included in the alternatives in this WM PEIS. Table 11.17–2 includes the impacts of SRS managing aluminum-clad spent nuclear fuel, as recently decided by DOE and evaluated in DOE (1995d).

As identified in Table 11.17–2, the maximum annual cumulative radioactive releases would result in an increase in the radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would primarily result from the treatment of TRUW and releases associated with tritium production and recycling. Maximum cumulative radioactive releases would continue to be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

SRS is in an attainment region where criteria air pollutants do not exceed standards. The cumulative emissions resulting from the existing operations, combined waste management alternatives, and other future actions are not expected to result in air quality standard exceedances.

Table 11.17-2. Savannah River Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	6.40E+01	7.10E-02	9.20E+00	3.81E+00	2.90E+03	2.96E+03	2.97E+03	2.96E+03
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	1.45E+00	1.48E+00	1.48E+00	1.48E+00
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.40E-01	6.70E-05	8.60E-03	3.59E-03	3.76E+00	3.90E+00	3.91E+00	3.90E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.50E+03	2.65E+03	5.76E+03	4.93E+03	1.16E+04	1.77E+04	2.08E+04	2.00E+04
Number of cancer fatalities from collective dose	(1)	1.40E+00	1.06E+00	2.30E+00	1.97E+00	4.63E+00	7.09E+00	8.33E+00	8.00E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	580	4,592	138,362	74,862	1,349	6,521	140,291	76,791
Number of rail shipments (10 yr)		0	925	51,911	27,275	422	1,347	52,333	27,697
Annual dose (mrem) from truck transport		2.3E-01	1.8E-01	4.6E-01	3.10E-01	5.2E-02	4.6E-01	7.4E-01	5.9E-01
Annual dose (mrem) from rail transport		0.0E+00	3.7E-02	1.6E-01	9.75E-02	1.6E-02	5.3E-02	1.7E-01	1.1E-01
Resources and Infrastructure									
Land area (% of available area)		10%	0.02%	0.07%	0.05%	0.31%	10%	10%	10%
Water use (% capacity)	(6)	32%	0.41%	5.47%	3.23%	103%	136%	141%	139%
Wastewater treatment (% capacity)		67%	1.56%	7.85%	5.79%	50%	119%	125%	123%
Power demand (% current load)		74%	3.91%	12.33%	5.69%	213%	291%	300%	293%
Employment									
Number of site workers	(7)	19,201	483	3,216	2,406	3,499	23,183	25,916	25,106
Air Quality Exceedances	(8)	None	None	None	None	None	None	None	None
Water Quality Exceedances	(9)	42 parameters exceeded	None	4 hazardous chemicals,[e] U-238	4 hazardous chemicals,[e] U-238	None	42 parameters exceeded	43 parameters exceeded	43 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to defense waste processing (DOE, 1994h), tritium supply and recycle (DOE, 1995a), spent nuclear fuel management (including spent nuclear fuel form foreign research reactors) (DOE, 1995d), other site-specific waste management actions (including environmental restoration activities) (DOE, 1994c), F-Canyon (DOE, 1994g), interim management of nuclear materials (DOE, 1995b), storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), transfer of non-nuclear functions (DOE, 1993), and disposition of highly enriched uranium (DOE 1995f).

[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.

[c] Cumulative impacts, including minimum combined waste management impacts.

[d] Cumulative impacts, including maximum combined waste management impacts.

[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

Notes:

(1) Assumes all facilities operate concurrently for the same 10-year period.

(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).

(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.

(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.

(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.

(6) Suitable land includes land that is available for development or that is currently developed.

(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.

(8) Impacts indicate whether emissions would result in nonattainment.

(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined waste management alternatives would affect between 25 and 119 acres of land at SRS. This area is less than 1% of the total suitable acreage at SRS and less than 1% of the area available for waste management facilities. Other actions could affect another 500 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of less than 1% of the suitable acreage at SRS, detailed characterization studies and evaluations of that land may be required to ensure protection of wildlife habitats and cultural artifacts.

The maximum demand for water, wastewater treatment, and power resulting from the combined alternatives would not exceed 13% of existing capacities and would not require upgrades or expansion of existing capacities. Cumulatively, water, wastewater, and power capacities at SRS would require improvements (expansions or upgrades) from the increased demands resulting from other actions planned at SRS.

The combined alternatives could add up to 3,216 jobs at SRS, while other actions could also increase the number of jobs at SRS by up to 3,499. Cumulatively, the number of jobs at SRS could increase by 35%, which could affect existing offsite community infrastructures and institutions. Such an increase could require mitigation to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at SRS under the Decentralized Alternative and Regionalized Alternatives 1, 2, and 4 (including the preferred alternative for LLMW) could result in exceedances of drinking water standards for groundwater for U-238, benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride. The No Action Alternative, Decentralized Alternative, and Regionalized Alternatives 1 through 7 (including the preferred alternative for LLW) could, in addition, result in exceedances in U-238 for disposal of LLW. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. Other alternatives for LLMW or LLW are not expected to result in exceedances for any contaminants at SRS.

11.18 Waste Isolation Pilot Plant

The only alternative being considered for the Waste Isolation Pilot Plant (WIPP) is the possible treatment of all contact-handled TRUW under the TRUW Centralized Alternative. Table 11.18-1 lists the impacts of this alternative for WIPP. The preferred alternative for WIPP would have treatment of TRUW occurring elsewhere.

Table 11.18–1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	5.2E+02	N,D-R3	--	C	2.6E-01	N,D-R3	--	C	5.5E-10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**5.2E+02**		**0**		**2.6E-01**		**0**		**5.5E-10**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	1.4E-01	N,D-R3	--	C	6.9E-05	N,D-R3	--	C	2.1E-13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**1.4E-01**		**0**		**6.9E-05**		**0**		**2.1E-13**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses in Person-Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N	0 / 0	D	23,860 / 11,970	N	0.0E+00	D	3.1E-03	N	0.0E+00	D	3.1E-03
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**23,860 / 11,970**		**0.0E+00**		**3.1E-03**		**0.0E+00**		**3.1E-03**

Table 11.18–1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	4.2E+01	N,D-R3	--	C	2.1E-02	N,D-R3	--	C	2.8E-10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**4.2E+01**		**0**		**2.1E-02**		**0**		**2.8E-10**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements				
	Construction	Operation	Number and Type of Exceedances				Acres Required				
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	
Low Level[a]	--	--	--	--	--	--	--	--	--	--	
Transuranic	All/None	All/None	--	--	--	--	N,D-R3	--	C	8.8	
High Level[a]	--	--	--	--	--	--	--	--	--	--	
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	
Total	**None[c]**	**None**		**None**		**None**		**0**		**8.8**	

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	41,429	N,D-R3	--	C	15,204	N,D-R3	--	C	3.5
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**41,429**		**0**		**15,204**		**0**		**3.5**

Table 11.18–1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	2.05	N,D-R3	--	C	0.64	N,D-R3	--	C	2,346
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**2.05**		**0**		**0.64**		**0**		**2,346**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001

[a] The Waste Isolation Pilot Plant does not have low-level mixed, low-level, or high-level waste, and no hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

WIPP is the candidate location for a geologic repository for DOE TRUW. The potential impacts of TRUW disposal at WIPP have been assessed in previous EISs (DOE, 1980; DOE, 1990b) and in the supplemental EIS that is currently being prepared by DOE (DOE, 1996m). Table 11.18–2 identifies the range of cumulative impacts resulting from the possible treatment and disposal of TRUW at WIPP. No other DOE or non-DOE actions are planned at WIPP or in the WIPP vicinity that would contribute to the cumulative impact of waste management alternatives.

As identified in Table 11.18–2, the annual cumulative radioactive releases could result in an increase in radiation dose to the offsite population and, without mitigation, the maximum increase in radioactive releases could exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite. The preferred alternative would not result in such an exceedance.

WIPP is located an attainment region where criteria air pollutants do not exceed standards. The maximum air emissions, other than radioactive emissions, are not expected to result in air quality standard exceedances.

Treatment of contact-handled TRUW at WIPP would affect 9 acres of land. This area is less than 1% of the total suitable acreage at WIPP and less than 1% of the area available for waste management facilities. Facilities for disposal could affect 150 acres. These actions cumulatively would affect about 2% of the suitable acreage at WIPP, and detailed characterization studies and evaluations of this land may be required to ensure protection of wildlife habitats and cultural resources.

The maximum cumulative demand for water would not measurably affect existing usage or capacity. The treatment and disposal of TRUW would individually and cumulatively require increases in wastewater treatment capacity, however. In addition, treatment of TRUW could add up to 459 jobs at WIPP and could impact existing offsite community infrastructures and institutions. Such an increase could require mitigation to reduce any adverse offsite infrastructure and institutional impacts.

Table 11.18-2. Waste Isolation Pilot Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	0.0E+00	0.0E+00	5.20E+02	0.00E+00	2.00E-01	2.00E-01	5.20E+02	2.00E-01
Number of cancer fatalities from collective dose	(2)	0	0	2.60E-01	0.00E+00	~0	~0	2.60E-01	1.00E-04
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	0.0E+00	0.0E+00	1.40E+01	0.00E+00	2.00E-02	2.00E-02	1.4E+01	2.00E-02
Worker Population									
Collective dose, 10 years (person-rem)	(4)	0.0E+00	0.0E+00	4.10E+01	0.00E+00	3.00E+02	3.00E+02	3.41E+02	3.00E+02
Number of cancer fatalities from collective dose	(1)	0	0	~0	0.00+00	1.20E-01	1.20E-01	1.36E-01	1.20E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	0	0	23,860	23,860	0	0	23,860	23,860
Number of rail shipments (10 yr)		0	0	11,970	11,970	0	0	11,970	11,970
Annual dose (mrem) from truck transport		0.0E+00	0.0E+00	3.1E-01	3.10E-01	0.0E+00	0.0E+00	3.1E-01	3.10E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	3.1E-01	3.10E-01	0.0E+00	0.0E+00	3.1E-01	3.10E-01
Resources and Infrastructure									
Land area (% of available area)	(6)	0.34%	0.00%	0.09%	0.00%	1.46%	1.81%	1.89%	1.81%
Water use (% capacity)		0.87%	0.00%	0.48%	0.00%	0.0%	0.87%	1.35%	0.87%
Wastewater treatment (% capacity)		65%	0.00%	82.20%	0.00%	0.0%	65%	147%	65%
Power demand (% current load)		49%	0.00%	37.02%	0.00%	0.0%	49%	86%	49%
Employment									
Number of site workers	(7)	932	22	459	22	163	1,117	1,554	1,117
Air Quality Exceedances	(8)	None	None	Radiation	None	None	None	Radiation	None
Groundwater Quality Exceedances	(9)	6 parameters exceeded	None	None	None	None	6 parameters exceeded	6 parameters exceeded	6 parameters exceeded

[a] Other reasonably foreseeable future actions include startup of disposal operations as described in the draft WIPP Supplemental EIS (DOE, 1996m).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts including maximum combined waste management impacts.

Notes:
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers.
(5) Maximum exposed individual to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. For the WIPP site, all six constituents are naturally high and do not result from any activities at the site. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.19 West Valley Demonstration Project

The West Valley Demonstration Project (WVDP) began operations as a nuclear fuel reprocessing plant in 1966 and was shut down in the late 1970s. DOE plans to decommission WVDP in the near future. The existing environmental conditions at WVDP resulting from past activities are described in Chapter 4.

11.19.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HLW at WVDP. Table 11.19–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for WVDP. WVDP has very small quantities of both LLW and TRUW, and impacts associated with these two waste types are expected to be minimal. The most adverse impacts at WVDP and in the WVDP region would occur as a result of the No Action and Decentralized Alternatives for which treatment and disposal facilities would be located at WVDP to manage its own waste. The least adverse impacts at WVDP and in the WVDP region generally would result from the Regionalized and Centralized Alternatives for which WVDP would only prepare, package, and ship its waste for offsite treatment and disposal.

11.19.2 Cumulative Impacts

Additional actions to occur at WVDP include the vitrification of HLW, which was previously assessed in an EIS (DOE, 1982a), and completion and closure activities that have been assessed in a separate EIS (DOE, 1996h). No other DOE or non-DOE actions are planned at WVDP or in the WVDP region. Table 11.19–2 identifies the range of cumulative impacts at WVDP.

As identified in Table 11.19–2, the maximum annual cumulative radioactive releases would result in an increase in radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would continue to be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.19–1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts[a]

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1,2,3	3.4E-04	N	2.7E-01	R1,2,3	1.7E-07	N	1.4E-04	R1-C	4.5E-09	N	1.5E-07
Low Level[a]	D	2.5E-03	N	7.1E-03	D	1.2E-06	N	3.5E-06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.8E-03**		**2.8E-01**		**1.4E-06**		**1.4E-04**		**4.5E-09**		**1.5E-07**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	5.2E-09	N	4.1E-06	R1-C	2.6E-12	N	2.1E-09	R1-C	1.5E-13	N	5.0E-12
Low Level[a]	D	3.7E-08	N	1.1E-07	D	1.9E-11	N	5.3E-11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4.2E-08**		**4.2E-06**		**2.2E-12**		**2.1E-09**		**1.5E-13**		**5.0E-12**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	D	100 / 100	N	0.0E+00	D	1.60E-06	N	0.0E+00	D	1.6E-06
Low Level	D	0 / 0	R1,R3,R6, R7,C1,C2	6,620 / 2,480	D	0.0E+00	R1,R3,R6, R7,C1,C2	1.10E-04	D	0	R1,R3,R6, R7,C1,C2	4.0E-05
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	All	340 / 68	All	340 / 68	All	1.40E-04	All	1.40E-04	All	2.7E-05	All	2.7E-05
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**340 / 68**		**7,060 / 2,648**		**1.40E-04**		**2.5E-04**		**2.7E-05**		**6.9E-05**

Table 11.19–1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1,2,3	4.4E–07	N	6.7E–04	R1,2,3	2.2E–10	N	3.4E–07	R1,2,3	8.9E–11	N	3.0E–09
Low Level[a]	D	5.1E–06	N	1.5E–05	D	1.5E–11	N	7.5E–09	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.6E–06**		**6.9E–04**		**2.4E–10**		**3.5E–07**		**8.9E–11**		**3.0E–09**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements				
	Construction	Operation	Number and Type of Exceedances				Acres Required				
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	
Low-Level Mixed	All/None	All/None	--	--	--	--	N	0.4	D	1.5	
Low Level	--	--	--	--	--	--	N,R1-C5	4.0	D	18	
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	
High Level	All/None	All/None	--	--	--	--	All	--	All	--	
Hazardous[a]	--	--	--	--	--	--	--	--		--	
Total	**None[c]**	**None**		**None**		**None**		**4.4**		**19.5**	

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	229	D	1,925	N	18	D	240	N	0.02	D	0.26
Low Level	N,R1-C5	6,447	D	58,800	N,R1-C5	2,588	D	5,618	N,R1-C5	0.70	D	8.49
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level	N,C	1,000	D-R2	1,010	N,C	1,000	D-R2	1,010	All	0.04	All	0.04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**7,676**		**61,735**		**3,606**		**6,868**		**0.76**		**8.79**

Table 11.19-1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All	0.00	All	0.00	All	0.00	All	0.00	R1-C	7	N	26
Low Level	N,R1-C5	0.06	D	0.11	N,R1-C5	0.02	D	0.05	N,R1-C5	330	D	614
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level	N,D	0.00	R1-C	0.01	All	0.00	All	0.00	D-C	29	N	30
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.06**		**0.11**		**0.02**		**0.05**		**366**		**670**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. West Valley has de minimis quantities of transuranic waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.19–2. West Valley Demonstration Project Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.10E–01	2.80E–03	2.80E–01	4.44E–03	9.10E+01	9.11E+01	9.14E+01	9.11E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	3.00E–04	4.20E–06	4.20E–04	6.62E–06	2.50E+00	2.50E+00	2.50E+00	2.50E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	1.40E–01	1.52E+02	3.00E+02	2.22E+02	1.50E+03	1.65E+03	1.80E+03	1.72E+03
Number of cancer fatalities from collective dose	(1)	~0	~0	1.20E–01	~0	6.00E–01	6.61E–01	7.20E–01	6.89E–01
Transportation Effects on Offsite Maximum Exposed Individual	(5)								
Number of truck shipments (10 yr)		0	340	7,060	6,990	21,000	21,340	28,060	27,990
Number of rail shipments (10 yr)		0	68	2,648	2,578	13,300	13,368	15,948	15,878
Annual dose (mrem) from truck transport		0.0E+00	1.4E–02	2.5E–02	2.50E–02	8.4E–01	8.5E–01	8.7E–01	8.7E–01
Annual dose (mrem) from rail transport		0.0E+00	2.7E–03	6.9E–03	6.75E–03	5.3E–01	5.4E–01	5.4E–01	5.4E–01
Resources and Infrastructure									
Land area (% of available area)		25%	2.00%	8.86%	2.11%	0%	27%	34%	27%
Water use (% capacity)		64%	6.98%	56.12%	7.11%	0%	71%	120%	71%
Wastewater treatment (% capacity)		100%	5.15%	9.81%	5.39%	0%	105%	110%	105%
Power demand (% current load)		45%	11.69%	135.23%	11.85%	61%	117%	241%	117%
Employment									
Number of site workers	(7)	1,100	123	276	142	1,368	2,591	2,744	2,610
Air Quality Exceedances	(5)	None	None	None	None	None	None	None	None
Groundwater Quality Exceedances	(6)	2 parameters exceeded	None	None	None	None	2 parameters exceeded	2 parameters exceeded	2 parameters exceeded

[a] Includes impacts of HLW vitrification (as identified in DOE, 1982a) and completion and closure of the WVDP (as identified in DOE, 1996f). The alternatives analyzed in the WVDP completion and closure EIS include WVDP waste volumes analyzed in the WM PEIS.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes:
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

WVDP is in an attainment region where criteria air pollutants do not exceed standards. The cumulative emissions are not expected to result in air quality standard exceedances. Disposal is considered at WVDP only under the Decentralized Alternative (not the preferred alternative) for LLMW; no drinking water standards are expected to be exceeded in groundwater for this alternative.

The combined alternatives would affect between 4 and 20 acres of land. This area is about 9% of the total suitable acreage at WVDP and 12% of the area available for waste management facilities. The maximum cumulative demand for wastewater treatment and power are expected to exceed existing capacities and will require expansion or upgrading. The combined waste management alternatives could add up to 276 jobs at WVDP, which would not affect existing offsite community infrastructures and institutions. Completion and closure activities could result in an additional 1,368 jobs at WVDP.

11.20 Transportation

In addition to the combined and cumulative impacts of the alternatives at and in the region of each of the major sites, combined and cumulative impacts could also occur regionally and nationally from the transportation of waste. Tables 11.20-1 and 11.20-2 summarize the range of combined impacts that could occur from the routine transport of waste by truck and rail for the alternatives.

For the combination of alternatives that would involve the fewest shipments of waste, the transport of HLW would have the highest number of shipments and shipment miles, while the transport of HLW and TRUW would result in the highest radiological consequences and risks to transport crew members and the population along transportation routes. For the combination of alternatives that would involve the largest number of shipments, the transport of LLW would result in the highest number of shipments, shipment miles, and radiological consequences and risks to transport crew members and the population along transportation routes.

The transport of waste by truck is expected to result in a combined total of between 12 and 69 fatalities for the shipment of LLMW, LLW, TRUW, HLW, and HW. The majority of these fatalities would result from physical trauma directly related to potential accidents and truck fuel emissions. The transport of LLMW,

Table 11.20–1. Combined Waste Management Alternative Truck Transportation Impacts[a]

Waste Type	Waste Transport Shipments and Mileage										
	Number of Waste Shipments				Millions of Miles of Shipments				Maximum Shipments To or From a Site		
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Site	Shipments
Low-Level Mixed	D	480	R3	10,990	D	0.3	R3	14.9	R3	Nevada Test Site	9,650
Low Level	D	24,420	C4	264,060	D	8.6	C1	563.0	C2	Nevada Test Site	257,270
Transuranic	R2	18,640	D	23,900	R2	34.0	D	42.4	D	Waste Isolation Pilot Plant	23,680
High Level	D	19,912	C	28,224	D	29.4	C	39.5	C	Hanford Site	28,224
Hazardous	R2	1,685	R1	2,483	R2	30.0	R1	55.7	R1	Hanford Site	423
Total		**65,137**		**329,657**		**102.3**		**715.5**			**b**

Waste Type	Radiological Doses from Waste Transport								Waste Transport Fatalities			
	Routine Occupational Dose in Person-Rem				Routine Population Dose in Person-Rem				Vehicle Emission Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	8.2E+00	R3	4.3E+02	D	4.7E+00	R3	5.1E+02	D	4.6E–03	R3	1.0E–01
Low Level	D	3.2E+02	C1	1.6E+04	D	3.4E+02	C1,5	1.9E+04	D	8.8E–02	C2	2.9E+00
Transuranic	R2	2.9E+03	D	3.7E+03	R2	2.9E+03	D	3.9E+03	R2	1.8E–01	D	2.2E–01
High Level	D	2.6E+03	C	3.5E+03	D	3.5E+03	C	4.7E+03	D	2.1E–01	C	2.7E–01
Hazardous[c]	--	--	--	--	--	--	--	--	D,R2	1.0E–01	R1	1.8E–01
Total		**5.8E+03**		**2.4E+04**		**6.7E+03**		**2.8E+04**		**5.8E–01**		**3.7E+00**

Waste Type	Waste Transport Fatalities—Continued											
	Number of Occupational Radiation Fatalities				Number of Population Radiation Fatalities				Vehicle-Related Accident Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	3.3E–03	R3	1.7E–01	D	5.5E–03	C	2.9E–01	D	1.8E–02	R3	1.0E+00
Low Level	D-R2	1.0E–01	C1	6.3E+00	D	1.7E–01	C1	9.7E+00	D	4.3E–01	C2	3.5E+01
Transuranic	R2	1.2E+00	D	1.5E+00	R2	1.5E+00	D	1.9E+00	R2	2.4E+00	D	3.0E+00
High Level	D	1.0E+00	C	1.4E+00	D	1.8E+00	C	2.3E+00	D-R2	1.8E+00	C	2.3E+00
Hazardous[c]	--	--	--	--	--	--	--	--	D	2.7E–01	R1	5.3E–01
Total		**2.3E+00**		**9.4E+00**		**3.5E+00**		**1.4E+01**		**4.9E+00**		**4.2E+01**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 7.7E+00 = 7.7 and 2.3E+02 = 230.

[a] Range of impacts does not include the impacts of the No Action Alternatives for low-level mixed waste, transuranic waste, and high-level waste. Transport impacts listed are those that would occur over a 20-year period except for HLW, which would occur over about 40 years.

[b] No combined total indicated as different sites involved.

[c] Shipments of hazardous waste do not result in external exposure to radiation and latent cancer fatalities from exposure to radiation.

Table 11.20–2. Combined Waste Management Alternative Rail Transportation Impacts[a]

Waste Type	Waste Transport Shipments and Mileage										
	Number of Waste Shipments				Millions of Miles of Shipments				Maximum Shipments To or From a Site		
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Site	Shipments
Low-Level Mixed	D	350	R3	4,540	D	0.2	R3	6.8	R3	Nevada Test Site	3,700
Low Level	D	9,210	C2	96,880	D	3.5	C2	219.0	C2	Nevada Test Site	96,880
Transuranic	R2	9,360	D	12,010	R2	15.8	D	20.3	D	Waste Isolation Pilot Plant	11,970
High Level	D	3,983	C	5,646	D	6.7	C	8.7	C	Hanford Site	5,646
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--
Total		**22,903**		**119,076**		**26.2**		**254.8**			**b**

Waste Type	Radiological Doses from Waste Transport								Waste Transport Fatalities			
	Routine Occupational Dose in Person-Rem				Routine Population Dose in Person-Rem				Vehicle Emission Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	2.0E+00	R3	4.1E+01	D	5.8E+00	R3	7.6E+01	D	5.7E-03	R3	5.5E-02
Low Level	D	4.1E+01	C1-3,5	1.2E+03	D	1.3E+02	C1,2	2.3E+03	D	1.2E-01	C1,2,4,5	1.8E+00
Transuranic	R2	6.6E+02	D	8.4E+02	R2	8.2E+02	D	1.1E+03	R2,3	8.0E-02	D,R1,C	1.0E-01
High Level	D	1.5E+02	C	2.1E+02	D	1.7E+02	C	2.2E+02	D	4.1E-02	C	5.0E-02
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**8.5E+02**		**2.3E+03**		**1.1E+03**		**3.7E+03**		**2.5E-01**		**2.0E+00**

Waste Type	Waste Transport Fatalities—Continued											
	Number of Occupational Radiation Fatalities[d]				Number of Population Radiation Fatalities				Vehicle-Related Accident Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	8.1E-04	R3	1.7E-01	D	3.1E-03	R3	3.8E-02	D	5.0E-04	R3,C	1.4E-02
Low Level	D	1.6E-02	C1,3	4.8E-01	D	6.4E-02	C1,2,4,5	1.2E+00	D	7.3E-03	C1,5	4.7E-01
Transuranic	R2	2.6E-01	D	3.3E-01	R2	4.1E-01	D	5.7E-01	R2	3.3E-02	D	4.3E-02
High Level	D	6.1E-02	C	8.2E-02	D	8.4E-02	C	1.1E-01	D	1.4E-02	C	1.8E-02
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.4E-01**		**1.1E+00**		**5.6E-01**		**1.9E+00**		**5.5E-02**		**5.5E-01**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 7.7E+00 = 7.7 and 2.3E+02 = 230.

[a] Range of impacts does not include the impacts of the No Action Alternatives for low-level mixed waste, transuranic waste, and high-level waste. Transport impacts listed are those that would occur over a 20-year period except for HLW, which would occur over about 40 years.

[b] No combined total indicated as different sites involved.

[c] All shipments of hazardous waste were analyzed on the basis of transport by truck.

[d] Rail crew values are expected to range from impacts listed in this table (for dedicated shipments) to slightly higher than the truck crew impacts identified in the previous table. See Section 5.4.1.1 for a more detailed explanation.

LLW, TRUW, and HLW by rail would result in approximately the same number of fatalities from radiological causes as from vehicle-related causes. HW transportation by truck does not contribute to the potential radiological fatalities but does contribute to physical trauma fatalities. A major difference between truck and rail transport is the number of potential fatalities from physical trauma. All truck transport could potentially result in 5 to 42 physical trauma fatalities, while all rail transport could potentially result in up to one physical trauma fatality. These fatalities from physical trauma for both truck and rail accidents are independent of the shipment contents. Comparatively, from 1971 through 1993, over one million persons were killed in vehicular accidents in the United States (DOE, 1995d). A discussion of the uncertainties involved when comparing the truck and rail transportation impacts is presented in Appendix E, Section E.8.5.

The largest number of shipments to or from a single site could occur at the Nevada Test Site as a result of shipments LLMW and LLW, and the shipments of HLW if Yucca Mountain is found to be suitable for the emplacement of defense HLW. A combined total of more than 295,000 truck shipments or more than 106,000 rail shipments of waste could occur at the Nevada Test Site, or about 118 truck shipments or 42 rail shipments per day (assuming receipt of shipments during 250 days per year).

The transport of each of the waste types under the alternatives is only one source of potential risk associated with the shipment of radioactive materials. Other sources of risk include the shipments of DOE and commercial spent nuclear fuel, other DOE nuclear materials, radioisotopes used in medicine and other activities, and commercial waste. Table 11.20–3 summarizes existing and reasonably foreseeable shipments of radioactive materials that have been included in the assessment of cumulative transportation impacts but that are not a part of the alternatives. A discussion of these other shipments is contained in DOE (1995d).

Table 11.20–4 summarizes the potential cumulative transportation-related radiological collective doses and latent cancer fatalities. Over the 93-year period from 1943 through about 2035, the total number of radiation-related cancer fatalities is estimated at 315, or about three latent cancer fatalities per year on average. Cumulatively, the non-DOE transport of radioactive material accounts for approximately 80% of the collective dose to workers and the public and therefore radiation-related latent cancer fatalities. The total number of potential radiation-related latent cancer fatalities associated with the alternatives in this WM PEIS are about 7% of the cumulative radiation-related latent cancer fatalities.

Table 11.20–3. Other Activities Considered in the Cumulative Transportation Assessment

Activity	Description
Existing activities	
Historical spent nuclear fuel	Historical shipments of DOE spent nuclear fuel to Hanford Site, Idaho National Engineering Laboratory, Savannah River Site, Oak Ridge Reservation, and Nevada Test Site
General transportation	Nationwide transport of radioactive materials for medical, industrial, fuel cycle, and disposal purposes
Reasonably foreseeable activities	
Interim spent nuclear fuel Management	Shipments to and between locations for the storage and interim management of DOE spent nuclear fuel
Geologic repository	Shipments of commercial spent nuclear fuel to the candidate geologic repository at Yucca Mountain, Nevada[a]
Naval reactor components	Shipments of reactor compartments from Puget Sound Naval Shipyard to Hanford
Return of isotope capsules	Shipments of cesium-137 isotope capsules to the Hanford Site
Uranium billets	Shipment of low-enriched uranium billets from the Hanford Site to the United Kingdom

[a] Transportation of TRUW to WIPP is incorporated in the waste management alternatives presented in Section 11.18.

Table 11.20–4. Cumulative Transportation-Related Radiological Collective Doses and Latent Cancer Fatalities[a]

Category	Collective Occupational Dose in Person-Rem	Collective General Population Dose in Person-Rem
Historical DOE spent nuclear fuel shipments (1943-1993)	265.4	106.3
Interim management of DOE spent nuclear fuel shipments		
Naval (truck and train)	1.5 to 15	0.34 to 12
DOE (100% truck 1995 to 2035)	0.0 to 1,000	0.0 to 2,300
DOE (100% train 1995 to 2035)	0.0 to 130	0.0 to 170
Reasonably foreseeable shipments		
Commercial spent nuclear fuel and defense high-level waste to geologic repository[b]	8,600	48,000
Submarine reactor component disposal	--	0.053
Return of cesium-137 isotope capsules	0.42	5.7
Uranium billets	0.50	0.014
Non-DOE shipments of radioactive materials		
1943 to 1982	220,000	170,000
1983 to 2035	89,000	98,000
Waste management alternatives		
Low-level mixed waste	7.7 to 430	9.2 to 510
Low-level waste	230 to 16,000	240 to 19,000
Transuranic waste[c]	2,900 to 3,700	2,900 to 3,900
High-level waste[b]	3,200 to 3,500	4,300 to 4,800
Hazardous waste	--	--
Total collective dose	342,510	346,630
Total latent cancer fatalities	140	175

[a] Estimated occupational and general population doses for all categories except waste management alternatives are based on DOE (1995d).
[b] Shipments to geologic repository and HLW alternatives both include the shipment of HLW from DOE sites to the candidate geologic repository at Yucca Mountain.
[c] TRUW alternatives include the shipment of TRUW to the Waste Isolation Pilot Plant.

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CHAPTER 12
Mitigation Measures and Unavoidable Adverse Impacts and Irreversible and Irretrievable Commitments of Resources

This chapter discusses possible programmatic and other mitigation measures that could be implemented to reduce or eliminate some adverse environmental impacts. The chapter also addresses unavoidable adverse impacts, the relationship between short-term uses of the environment and the maintenance of long-term productivity, and any irreversible and irretrievable commitments of resources that would occur because of waste management activities.

The regulations promulgated by the Council on Environmental Quality to implement the procedural provisions of the National Environmental Policy Act (42 USC 4321 *et seq.*) (NEPA) require that an environmental impact statement (EIS) include a discussion of appropriate mitigation measures (see 40 CFR 1502.14(f); 40 CFR 1502.16(h)). The term "mitigation" includes the following:

- Avoiding an impact by not taking an action
- Minimizing impacts by limiting the degree or magnitude of an action
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time
- Compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20)

In addition, NEPA mandates that an EIS address any adverse environmental effects that cannot be avoided should the proposal be implemented, the relationship between short-term uses of the environment and maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented (NEPA, 102(2)(C)). This chapter describes possible mitigation measures, unavoidable impacts, and irreversible and irretrievable commitments of resources that could result from waste management activities.

12.1 Programmatic Mitigation Measures

The potential human health risks, environmental impacts, and costs associated with the waste management alternatives could be reduced or mitigated through the implementation of programmatic and other mitigation measures. Such programmatic measures to reduce or eliminate potential risks, impacts, and costs are described below. Other mitigation measures are described in Section 12.2.

Pollution Prevention: DOE has a pollution prevention policy that requires DOE sites to employ pollution prevention strategies. To implement these requirements, DOE issued the *1994 Waste Minimization/Pollution Prevention Crosscut Plan* (DOE, 1994) that establishes a DOE-wide goal to meet pollution reduction targets (Executive Order 12856): a 50% reduction in total releases and offsite shipments of toxic chemicals and pollutants by December 31, 1999. The 1994 Crosscut Plan calls for each DOE site to establish site-specific reduction goals for hazardous, radioactive, radioactive mixed, and sanitary wastes and pollutants. Currently, site-specific goals are being prepared. Future implementation of pollution prevention may result in the reduction of future quantities of wastes that require storage, treatment, and disposal, thereby reducing the impacts associated with the construction and operation of these facilities.

Implementing Waste Acceptance Criteria and/or Performance Assessments at low-level mixed waste (LLMW) and low-level waste (LLW) disposal sites: Under DOE Order 5820.2a (DOE, 1988), DOE sites must establish performance objectives for the management of LLW to protect human health and the environment. Each site is responsible to implement and maintain performance assessment documentation. Waste Acceptance Criteria for LLW are imposed to ensure that the dose limitations are not exceeded. The Waste Management Programmatic Environmental Impact Statement (WM PEIS) did not factor the LLW Waste Acceptance Criteria into the analysis, but rather made the general assumption that all waste slated to be transported to a particular site could be accepted by the receiving site. In reality, this may not be the case. Application of LLW Waste Acceptance Criteria could potentially reduce estimated risk and impacts at a given site. It is anticipated that appropriate LLMW Waste Acceptance Criteria will be developed.

Selecting treatment and disposal facility locations within the fenceline based upon site-specific geology and demographics: The analysis required that a specific location be identified to conduct the human health risk and air quality and ecological impact assessments at each site. DOE chose the location of existing facilities to conduct these analyses; however, when no facilities existed onsite, a central location was selected for the placement of the waste management facility. The estimates of human health risk and air quality and ecological impacts may be reduced or mitigated if alternative locations are selected based on site-specific data and considerations. The potential for natural hazards such as floods, erosion, tornadoes, earthquakes, and volcanoes will be considered in selecting the exact locations of facilities.

Changing treatment and disposal technologies based upon site-specific waste criteria, or applying emerging technologies not considered during this study: A base technology was selected for all alternatives. The various processes, identified in the process flow diagrams, reflect only currently existing, proven

technologies. They are also generic in the sense that the same technologies have been applied at all sites. Risk and impacts may be reduced or mitigated in the future by applying technologies that may not have been developed prior to this study, or by implementing tailored technologies based on site-specific and waste-specific needs.

Modifying the engineering facility design to reduce or eliminate risk or impacts: For consistency, the design parameters for each treatment process were the same, regardless of the site or specific waste characteristics (although alpha and remote-handled wastes were treated in engineered facilities designed specifically to meet their special treatment and handling needs). The generic models were developed to meet DOE's General Design Criteria. However, the actual design would be refined to reflect unique, site-specific environmental parameters and operational parameters (e.g., differences in waste loads, chemical and radionuclide composition, and facility age). Tailored designs could reduce anticipated impacts.

Transporting waste based on treatment need rather than geographic proximity, similar to and in close coordination with arrangements specified in the Federal Facility Compliance Act (FFCAct) Site Treatment Plans (STPs): Geographic proximity was used to assign shipping routes for LLMW between DOE sites. This assumption eliminated subjective judgments on where to ship and handle waste and minimized transportation miles. However, the FFCAct (42 USC 6961 *et seq.*) site treatment plan process has established site-specific treatment and shipping arrangements in which DOE's LLMW is transported based upon mutual agreement by the shipping and receiving sites. In addition, the STPs usually consolidate waste for treatment based upon treatment needs of specific waste streams, rather than on geographic proximity. This would reduce total construction requirements and result in fewer impacts and costs at the sites, although impacts from transporting waste between sites may increase.

Using a mix of truck and rail transport based on shipment location, size, and availability: Both truck and rail transport of wastes were analyzed on a DOE-wide basis. However, a more appropriate mix of truck and rail could be chosen to minimize potential risk and impacts at both the receiving and shipping locations, and along the transportation route. Selection of transportation means will be based on human health risks, environmental impacts, and costs.

Combining facilities for various waste types and waste streams, such as the collocation of LLW and LLMW treatment: Although the DOE analyzed the risks, impacts, and costs associated with facilities dedicated to a specific waste type, combining facilities to take advantage of similar processing technologies and units,

infrastructure requirements, and skilled labor could reduce adverse impacts. Combining or locating more than one treatment facility at a site may reduce the risks, impacts, and costs associated with the construction of multiple, new facilities across DOE sites.

Adjusting timing and scheduling of both the analytical time frame of 20 years and the construction and work-off periods for all waste types except HLW: DOE used uniform assumptions for scheduling the construction and treatment periods for inventoried and annually generated wastes (called work-off periods) for all waste types except HLW. This assumption was required to compare impacts and waste loads for a given time period. However, adjustment of the timing and work-off schedules could result in reduced risk and impacts. For example for LLW, LLMW, TRUW and HW under all alternatives except No Action, all facilities were sized according to an averaged throughput over a 10-year period, after assuming a 10-year construction period when wastes were accumulated in a storage facility awaiting treatment. If, however, construction could be completed in a shorter time frame, less waste would accumulate, providing the opportunity for a decreased annual throughput. Additionally, if the work-off period were longer (e.g., 20 years, as opposed to 10), the annual throughput and emissions rates would be reduced.

Implementing strict and mandatory safety programs for all facility and transportation workers: Most of the worker risk associated with treatment and transportation of waste results from industrial type accidents, which were based on actual industrial accident and transportation statistics. The implementation of an intensive and comprehensive training program has reduced the industrial accidents experienced at DOE facilities, resulting in less risk and a more highly skilled, experienced workforce.

Providing retraining opportunities for experienced, skilled DOE workers to move between facilities and jobs within DOE: Good training and experienced workers will likely result in fewer work-related injuries. The WM PEIS assumes the in-migration of workers for each new treatment and disposal facility; however, arrangements might be made to utilize special teams of experienced DOE workers thereby creating a dedicated workforce, redistributing and optimizing employment demands at any given location and potentially reducing risk caused by inexperience.

Future Technology Development: The waste management technologies analyzed in the WM PEIS are those technologies that have been approved by regulators. Other, emerging technologies, however, have not been widely accepted by regulators or are not yet demonstrated and available. Such technologies, while believed

to be sound in theory, may require significant development prior to becoming proven, demonstrated, and acceptable to regulators.

Technology is a major factor in DOE's waste management decisions. The availability, or the projected availability, of appropriate technologies will govern what can be effectively managed with the least risk to health, safety, and the environment. While the selection of technologies is most appropriate to project-specific implementation decisions, technology selection could mitigate the environmental impacts and the economic costs of future waste management activities.

DOE manages an aggressive national program of applied research, development, demonstration, testing, and evaluation for environmental cleanup, waste management, and related technologies. The primary objective of this effort is to achieve compliance with applicable regulations, while lowering human health risks, environmental impacts, and costs. In many cases, the development of new technology presents a greater hope for ensuring a substantial reduction in risk to the environment and improved worker and public safety within realistic financial constraints. DOE is currently pursuing three emerging technologies that could mitigate the potential impacts and costs of implementing the alternatives. These technologies are: treatment of organic contaminants (e.g., nonthermal destruction), monitoring of emissions from treatment (e.g., real-time, continuous emission monitoring), and current transportation development activities (e.g., hazardous materials packagings).

12.2 Other Mitigation Measures

Potential mitigation measures that DOE could implement to reduce human health risks and environmental impacts at each site are summarized in Table 12–1. These measures may be considered in greater detail in sitewide or project-specific NEPA reviews conducted prior to decisions to construct waste management facilities at particular locations at DOE sites. The extent to which risks and impacts may be reduced or eliminated depends on conditions at individual DOE sites.

12.3 Unavoidable Adverse Environmental Effects

Regardless of the alternatives selected by DOE, and despite implementation of the mitigation measures described above, there would be some adverse environmental impacts caused by treating, storing,

Table 12-1. Potential Mitigation Measures

Impact Area	Mitigation Measures
Air Quality—Construction	
Fugitive Dust	• Use of water or chemicals for dust control during road grading or site clearing • Application of asphalt, water, grass seed, or suitable chemical treatments on dirt roads, fill stockpiles, and other surfaces that can give rise to airborne dust • Covering of open bed trucks
Equipment Exhaust	• No unnecessary idling of equipment
Air Quality—Operation	
Thermal Treatment Unit (Incinerator)	• Implementing a potentially cleaner alternative organic treatment technology • Changing incinerator design (e.g., using additional filters to remove particulates, building taller stack to provide greater dispersion, using higher operating temperature to attain more complete destruction of organic contaminants) • Changing composition of waste incinerated (e.g., change waste acceptance criteria to limit amount of certain materials in waste such as radionuclides) • Selecting cleaner burning fuels (e.g., natural gas and low sulfur fuel oils) • Limiting rate of waste introduced into the incinerator (known as the charging rate) • Compensating emissions from new facilities with reduced emissions from existing facilities
Transportation	• Implementing transportation control programs that reduce work-related and vehicle miles traveled such as: ▸ Ridesharing, transit programs, parking management, compressed work weeks, flextime, telecommuting
Water Resources—Construction	
Availability	• Reducing amount of water used for dust suppression and design changes to reduce concrete requirements • Use of alternate water source to minimize impacts to onsite water resources, such as alternatives to water for use in dust suppression and concrete mixing, or mixing concrete offsite and transporting to the site in mixing trucks
Water Resources—Operation	
Availability	• Changing engineering design to increase recycle and reuse of water within facility such as zero discharge facility design • Switching surface water use to groundwater or municipal water supply and vice versa depending upon which resource is more limited • Returning water to source if adequate quality is maintained • Compensating water use requirements for new facilities with reduced water use from existing facilities
Water Resources—Disposal	
Groundwater Quality	• Limiting disposal of problem isotopes or storing waste containing problem isotopes until radioactive decay lessened their concentration • Changing waste form (e.g., vitrification or encasement of waste in polymer resin) • Changing disposal facility design to provide greater isolation (e.g., change shallow land burial to greater confinement disposal) • Increase the institutional control period and the environmental monitoring period to reduce the chance of an undetected release

Table 12-1. Potential Mitigation Measures—Continued

Impact Area	Mitigation Measures
Ecological Resources	
Habitat	• Minimize land area requirements and maintain flexible site design and facility placement to help avoid sensitive habitats • Use engineering control practices during construction to minimize direct discharges to aquatic resource habitats • Consider use of native species for mitigation and/or restoration of habitat impacts • Compensate wetland loss or other habitat loss with creation of new habitat
Economic and Population	• Maintain consistent level of funding throughout the life of the project to provide stable economic environment • Assist community to compensate for situations where existing resources may fall short of demand (e.g., return of land suitable for development to local community) • Close coordination with appropriate agencies (public and private) in local community to anticipate future demand and plan necessary facilities • Staggering start and shut-down dates to extend the period over which the complex employs waste management workers • Job training and retraining (to help reduce demand for new employees who would in-migrate into regions and place additional demands on local infrastructure) • Cooperation and communication with existing industries to identify and take advantage of opportunities for diversification
Infrastructure	• Expansion of water supply, wastewater treatment, and power supply capacity or allotment to meet new demand and anticipated long term regional growth; consideration of burden payments may be necessary, depending upon severity of impacts • Implementation of or strengthening of site resource conservation measures (e.g., reducing landscaping irrigation, using reclaimed greywater for irrigation and other uses where possible, installing energy-efficient fluorescent lights) • Implementation of or strengthening of community resource conservation measures and education (e.g., rating homes and businesses for energy-efficiency and providing incentives for improvements) • Working with local and regional planners to prepare for additional road traffic, water, wastewater treatment, and power supply requirements to enhance ability of affected jurisdictions to plan effectively • Compensate infrastructure requirements for new facilities with reduced infrastructure requirements from existing facilities
Cultural Resources	• Use of surveys to ensure adherence with the National Historic Preservation Act and associated regulations • Involvement of stakeholders concerned about cultural resources in decision making

Table 12-1. Potential Mitigation Measures—Continued

Impact Area	Mitigation Measures
Public and Worker Safety	• Use of safety analyses to establish safety limits within which a facility can operate while limiting risks and adequately protecting the environment • Review and modification, as appropriate, of existing emergency action plans at DOE sites to ensure appropriate response to accidents and other emergencies that might arise from operation of new waste management facilities • Planning of specific transportation routes to minimize risk using DOT routing guidelines • Training to ensure that emergency response personnel are knowledgeable of emergency response procedures

disposing, and transporting wastes. The location and severity of these impacts will depend on which of the alternatives is implemented for a given waste type. In general, more sites will experience unavoidable impacts under the Decentralized Alternative for any of the waste types than under the Regionalized or Centralized alternatives. Aggregate transportation impacts, in contrast, will increase under the Regionalized and Centralized alternatives because more shipments would be required to treat and dispose the total aggregate waste load. This section includes discussion of adverse effects that potential mitigation measures could not reduce or avoid.

Health Risk to Workers and the Public. Some health risks to workers and the public will be unavoidable at the time selected management strategies are implemented. Workers at facility construction sites, operating waste management facilities, and involved in truck or rail shipments are subject to the same types and frequencies of injuries and accidental deaths that workers experience across the industrial sector of the nation. Workers would also be exposed to the specific health risks of exposures to radiation and hazardous chemicals. The public would generally be at a lower risk than any of the workers involved in waste management activities. Risks would be higher at those sites where waste management activities are concentrated; where the largest waste loads are treated and disposed of under the Regionalized and Centralized alternatives. The Decentralized alternatives would tend to spread the public health risks more evenly across the sites. Although more individuals are likely to be at risk, their exposure levels are likely to be lower. Transportation risks too would tend to be lower under the Decentralized alternatives because the bulk of the wastes would remain at their site of origin.

Air Quality. Construction activities at each site would result in short term, elevated levels of particulate matter in localized areas. During the operational phases of facilities, air quality would be affected unavoidably through the introduction of criteria and hazardous and toxic air pollutant emissions at the sites and from worker vehicles and truck or rail waste shipment vehicles. In general, these impacts would be greater under those alternatives where activities are concentrated at a single site (Centralized) or group of sites (Regionalized). Criteria air pollutants in particular would increase where worker vehicle traffic, waste shipments by truck or rail, and fuel burning by waste management facilities all are at their highest levels at the Centralized sites. Effects at any single site would reflect the specific attainment status of the site's air quality control region for each criteria air pollutant. These effects would increase if one site is chosen as the Centralized location for management of two or more waste types.

Habitats. Portions of nonsensitive terrestrial habitats would be lost when waste management facilities are constructed. A greater amount of habitat acreage will be lost in aggregate under the Decentralized Alternative because each site must build facilities to manage its own wastes. At any single site, however, the greatest habitat loss would be in the Centralized Alternative where facilities to treat and dispose of all the waste of a particular type would be built at one site. Based on the WM PEIS analyses, none of these habitat losses is expected to constitute a significant impact to the resident plant and animal species because these species have broad ranges and the amount of lost habitat would comprise only a small fraction of these communities. Impacts to sensitive species and their habitats may be avoidable because decisions on specific facility locations at a site are yet to be made.

Economic Effects. The economic effects of the waste management alternatives would generally be considered beneficial, adding jobs and infusing monies to the regional economy at each site. The major sites would benefit more under the Centralized alternatives. However, at those sites where waste may be shipped offsite for treatment or disposal, there could be economic impacts, due to the relocation of jobs or reduced expenditures in the region of influence. These effects are partially offset by the increased potential for economic diversification that may result from alternate economic uses of the land.

Infrastructure Impacts. Infrastructure impacts are unavoidable at sites where existing systems are currently nearing capacity. At sites where DOE's decisions to implement waste management activities require construction of additional water supply, electrical power supply, waste water treatment, or transportation infrastructure, the environmental impacts of such construction projects would be unavoidable. Also, use of energy and water resources to support operation would be unavoidable.

Cultural Resource Impacts. In most instances, project requirements for available land at sites are sufficiently small to allow DOE to avoid impacts to cultural resources. As was the case with sensitive species and environmental justice concerns, decisions on specific facility locations are yet to be made. However, the cultural resource surveys and impacts analysis that would be part of the NEPA reviews at the site and project level should provide sufficient data to enable DOE to site required facilities with minimal or no effect on existing cultural resources.

12.4 Relationship Between Short-Term Use of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Short-term impacts are those that would occur during waste management facility construction and operation. Impacts that extend beyond the period of waste management facility operations are considered to be long-term.

The implementation of each of the waste management alternatives would require short-term use of the environment and a variety of resources such as land, fuel, construction materials, and labor. Development of new waste management treatment and storage facilities would commit lands to those uses from the beginning of the construction period through the duration of the operation period and until such facility is fully decommissioned. Depending upon the specific locations at sites selected for treatment and storage facilities, some terrestrial habitat may be lost when the area is cleared for construction. Disturbance of this acreage would eliminate the natural productivity of the land. At the end of the operational period, these waste management facilities could be converted to other industrial uses or decontaminated and decommissioned and the land returned to its original use or a condition compatible with future uses.

Since certain DOE wastes contain long-lived radionuclides, disposal actions are expected to commit resources for an indefinite period of time, resulting in the potential long-term loss of resources and productivity. The loss of land for disposal may be especially important at sites with small land areas. Proper disposal of wastes, however, has the benefit or providing long-term isolation of wastes from the environment while not incurring the use of additional land areas, costs, and labor resources for indefinite storage of wastes.

Wetlands, threatened or endangered species habitats, wildlife preserves, parklands, rare habitats, and other specially designated sites are considered to be ecologically sensitive areas. The analysis of ecological

resource impacts assumes that significant impacts to ecologically sensitive areas as a result of new treatment, storage and disposal facility construction can generally be avoided because DOE will have flexibility in locating waste management facilities at particular sites.

Ecological resources would be affected mainly through disturbance or loss of habitat resulting from site clearing and construction. Terrestrial resources would be directly affected by land clearing, which would adversely affect the habitat of terrestrial animals. These changes may be significant for individual animals of certain species with limited home ranges, such as small mammals and songbirds, and lead to direct mortality and higher susceptibility to predation. Given the amount of land area required for waste management facilities and the expected availability of locally similar habitat, the overall effect should be displacement of individual organisms with limited impact on local populations.

Aquatic resources may be indirectly affected through increased runoff and sedimentation in surface waters from disturbed land areas. However, the use of various mitigation techniques could minimize potential waste management facility construction impacts to aquatic ecological resources. Direct discharges of contaminants to surface waters from the routine operation of waste management facilities are expected to be limited by engineering control practices. Therefore, long-term impacts to aquatic organisms are expected to be minimal.

12.5 Irreversible and Irretrievable Commitments of Resources

This section describes the major irreversible and irretrievable commitments of resources that can be identified at this programmatic level of analysis. A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for future use.

The programmatic decisions resulting from this PEIS will select waste management strategies that could lead to the commitment of resources to new construction and renovation of treatment, storage, and disposal facilities at identified sites. This section discusses three major resource categories that could be committed irreversibly or irretrievably to the proposed action at the time strategy is implemented: land, materials, and energy.

Land Use. The land that is currently occupied by treatment and storage facilities could ultimately be returned to open space uses if buildings, roads, and other structures were removed, areas cleaned up, and the land revegetated. Alternatively, the facilities could be modified for use in other DOE programs. Therefore, the commitment of such land is not necessarily irreversible.

However, land rendered unfit for other purposes, such as that set aside for disposal facilities, represents an irreversible commitment of resources. The land could not be restored to its original condition, nor could the site feasibly be used for any other purposes following closure of the disposal facility. This land would be perpetually unusable because it would not be available for other potential intrusive uses such as mining, utilities, or foundations for other buildings.

The value of any land set aside for waste management operations, whether calculated in market terms or as the value of other social or economic land uses that may be forgone, is a site-specific consideration. Because the actual locations of WM facilities on sites will not be determined by this PEIS, it is not possible to discuss the potential for lost value of any land designated for WM use nor the potential change in value of any adjacent land. These will be more appropriately addressed in tiered, sitewide or project-specific NEPA analyses where the importance of specific land areas and uses to stakeholder groups in the region can be considered.

In the environmental impact statement for FEMP, for instance, it was stated that DOE expected to irreversibly commit some 220 acres of the approximately 1,000-acre site for long-term disposal. Under current law, such commitments documented in an environmental impact statement or comparable environment analysis are immunized from natural resource damage liability. Similar commitments could occur in siting facilities based on decisions that result from this PEIS. In addition, DOE will attempt to identify sensitive resources prior to siting in order to minimize the impact that long-term disposal may have on natural resources of value to humans and the environment.

Material. The irreversible and irretrievable commitment of material resources during the life-cycle of treatment, storage, and disposal facilities includes construction materials that cannot be recovered or recycled, materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Where construction is necessary, materials required include wood, concrete, sand, gravel, plastics, steel, aluminum, and other metals. These construction resources, except for those that can be recovered and recycled with present technology, would be irretrievably lost.

However, none of those identified construction resources is in short supply, and all are readily available in the vicinity of locations being considered for new waste management facilities.

The commitment of materials in new equipment that cannot be recycled at the end of the project's useful lifetime is irretrievable. Consumption of operating supplies, chemicals, and gases, while irretrievable, is not expected to involve any material in critically short supply in the United States.

Materials reduced to unrecoverable forms of waste, such as uranium, are also irretrievably lost. However, strategic and critical materials, or resources having small natural reserves, are of such value that economics promotes recycling. Plans to recover and recycle as much of these valuable, depletable resources as is practical depend on need, and each item would be considered individually at the time a recovery decision is required.

Energy. The irretrievable commitment of resources during construction and operations of facilities would include the consumption of fossil fuels used to generate heat and electricity. Energy would also be expended in the form of diesel fuel, gasoline, and oil for construction equipment and transportation vehicles. The amount of energy required to operate treatment, storage and disposal facilities, and construction equipment and transportation vehicles would be irretrievable.

Chapter 12
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CHAPTER 13
List of Preparers

Those who filled primary roles in the preparation of this Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS) are noted in this chapter.

The WM PEIS project manager is David Hoel of DOE's Office of Environmental Management.

For preparation of the WM PEIS, primary assistance was provided to DOE by Argonne National Laboratory (ANL), and its subcontractors, Maria Elena Toraño Associates, Inc. (META), Louis Berger and Associates, Inc. (Berger), Lamb Associates, Inc. (Lamb) and Brown and Root Environmental (BRE). The DOE WM PEIS Team provided direction to the WM PEIS contractors through ANL. ANL and its subcontractors were responsible for developing analytical methodology and alternatives, and for work coordination, impact analysis, and production of the WM PEIS. DOE was responsible for data quality, for the scope and content of the WM PEIS, and for providing issue resolution and direction to ANL and its subcontractors.

Several of the national laboratories assisted in preparing supporting information and documentation. These included Argonne National Laboratory-East (ANL); Oak Ridge National Laboratory (ORNL); Battelle Pacific Northwest National Laboratory (PNNL); Los Alamos National Laboratory (LANL); and Idaho National Engineering Laboratory (INEL). These laboratories worked closely throughout the WM PEIS development process. Their interrelationships and contributions are illustrated in Figure 13-1. The supporting information and documentation prepared by the national laboratories were evaluated by DOE. The DOE was responsible for determining the appropriateness and adequacy of incorporating into the WM PEIS any data, analyses, and results of other work performed by the national laboratories before incorporating the information into this PEIS.

Argonne National Laboratory was responsible for integrating the effort of all required contractors and national laboratories, and was the primary responsible organization for producing the Final WM PEIS for DOE.

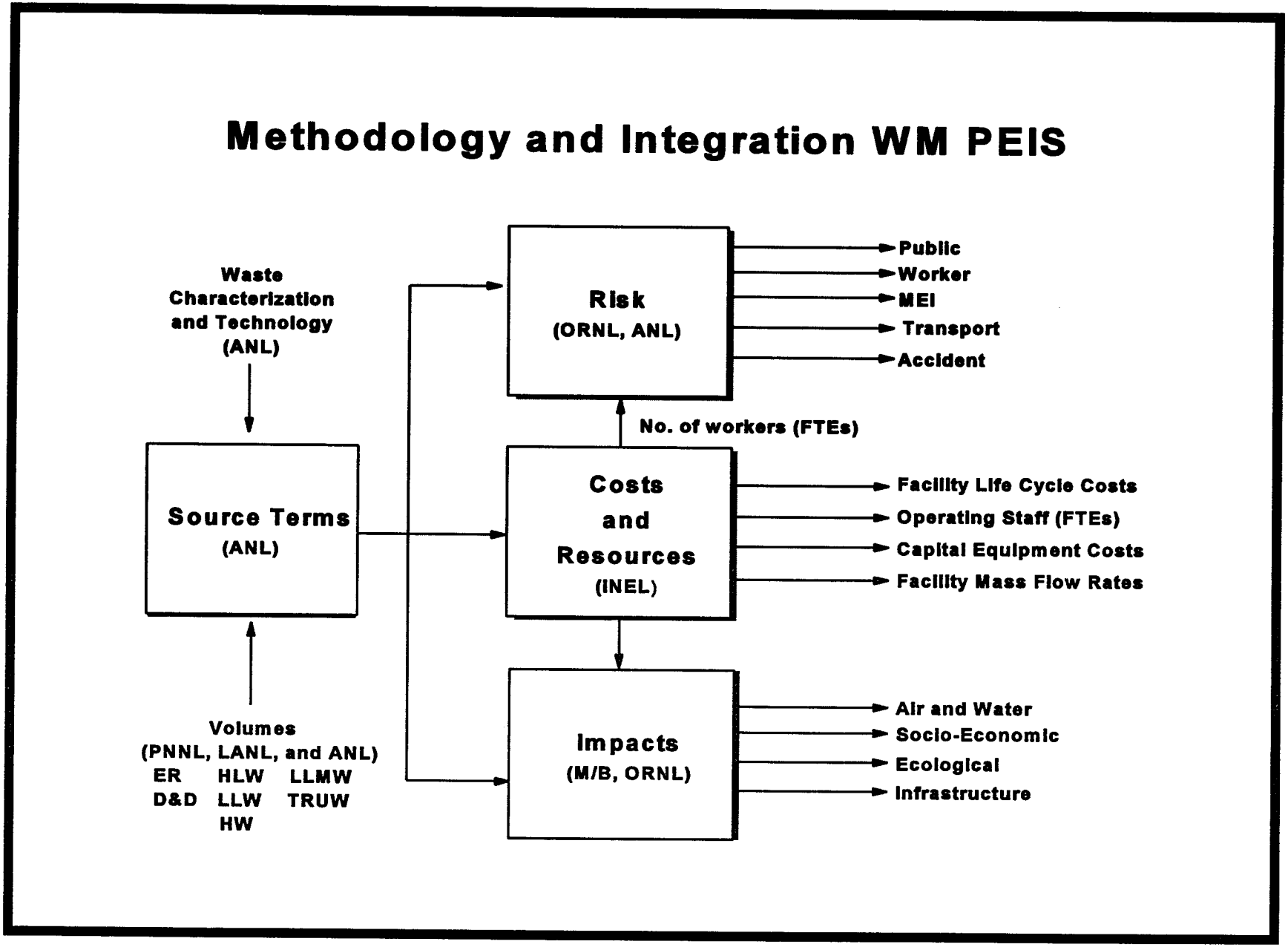

Figure 13–1. WM PEIS Analytical Relationships

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CHAPTER 14
Glossary

100-Year Flood. A flood event of such magnitude it occurs, on average, every 100 years (equates to a 1% probability of occurring in any given year).

500-Year Flood. A flood event of such magnitude it occurs, on average, every 500 years (equates to a 0.2% probability of occurring in any given year).

Absorbed Dose. The energy imparted to matter (such as tissue) by ionizing radiation per unit mass or irradiated material at the place of interest in that material (such as a specific internal organ). The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

Accident, Transportation. In a mobile environment, the harmful effects of an unplanned event on the human environment with respect to both safety and health.

Accident, Treatment, Storage and Disposal [TSD] Facility. Within a stationary environment, the harmful effects of an unplanned event on the human environment (effects on buildings and equipment are relevant only to the degree that human safety and/or health are affected). TSD facility accidents are concerned with safety and health effects arising from both radiological and hazardous sources (contamination, inhalation, or radiation) and from physical phenomena (fire, flood, earthquake, or other mechanical or thermal forces).

Adsorption. The adhesion of a substance to the surface of a solid or solid particles.

Affected Environment. As used in the preparation of an Environmental Impact Statement (EIS), a description of the existing environment (e.g., site descriptions) covering information that directly relates to the scope of the proposed actions and alternatives whose impacts are to be analyzed; i.e., the information necessary to assess or understand the impacts. Often referred to as the baseline for the EIS concerned. Must be in sufficient detail to support the impact analysis including cumulative impact analysis (see "Cumulative Impact"). This information must highlight "environmentally sensitive resources," if present. These include floodplains and wetlands, threatened and endangered species, prime and unique agricultural lands, and property of historic, archaeological, or architectural significance.

Air Pollutant. Any substance, including but not limited to dust fume, gas, mist, odor, smoke, vapor, pollen, soot, carbon, or particulate matter, that is regulated.

Air Quality. The specific measurement in the ambient air of a particular air pollutant at any given time.

Air Quality Control Region (AQCR). An interstate or intrastate area designated by the U.S. Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

Air Quality Criteria. The varying amounts of pollution and lengths of exposure at which specific adverse effects to health and welfare take place.

ALARA. *See* **As Low as Reasonably Achievable.**

Alluvia/Alluvium. Material deposited by running water, such as clay, silt, sand, and gravel.

Alpha-Low-Level Waste. This waste is not a different waste type per se, but rather, low-level radioactive waste materials contaminated with alpha-emitting (helium nuclei) radionuclides not listed under uranium/thorium or low levels (< 100 nanocuries per gram) of transuranic isotopes. Special handling and additional levels of containment are required to protect workers from ingesting this waste into the respiratory system. It is normally disposed similar to low-level waste, except for the precautionary measures for the workers involved (see "Radiation, Alpha Particle").

Alpha Particle. A positively charged subatomic particle emitted from a nucleus during radioactive decay. It is made up of two neutrons and two protons bound together, and hence is identical with the nucleus of a helium atom. It is the least penetrating of the three common types of radiation emitted by radioactive material, and can be stopped by a sheet of paper. It is not dangerous to plants, animals, or humans unless the emitting substance has entered the body.

Alternative. As used in the preparation of an Environmental Impact Statement (EIS), one of the range of reasonable alternatives to the proposed action (see "Action"). For a Programmatic EIS, one of the range of reasonable alternatives for achieving the program's goal or meeting a legislative requirement (i.e., a

specific proposed action (project) is not necessarily specified). Reasonable alternatives are those that are practical or feasible from a common sense, technical, *and* economic standpoint.

Alternative, No Action. The No Action Alternative must be considered in a U.S. Department of Energy Environmental Impact Statement. It need not be a reasonable alternative. "No Action" can mean doing nothing or it can mean continuing with an existing course of action. It also can mean discontinuing the present course of action by phasing out operations in the near term. The No Action Alternative is meant to provide an environmental baseline against which impacts of the proposed action (and its alternatives) can be compared (see "Affected Environment").

Alternative, Preferred. The alternative that the U.S. Department of Energy believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors.

Alternatives, Centralized. Alternatives that would result in transporting wastes to one or two sites for treatment, storage, or disposal. As with the Regionalized Alternatives, those sites that have the largest volumes of a given waste type were generally considered as sites for Centralized treatment, storage, or disposal.

Alternatives, Decentralized. Alternatives that would result in managing waste where it is or where it will be generated, treated, or disposed of in the future. Unlike the No Action Alternative, the Decentralized Alternatives may require the siting, construction, and operation of new facilities or the modification of existing facilities. Under the Decentralized Alternatives, the waste management facilities would be located at a larger number of sites than under the Regionalized or Centralized Alternatives.

Alternatives, Regionalized. Alternatives that would result in transporting wastes to various numbers of sites (fewer than the number of sites considered for the Decentralized Alternatives but greater than the number of sites considered for the Centralized Alternatives). In general, those sites that now have the largest volumes of a given waste type are considered as regional sites for treatment, storage, or disposal. More than one Regionalized Alternative is considered for all waste types.

Ambient Air Quality Standard. The prescribed level of a pollutant in the outside air that cannot be exceeded during a specified time in a specified geographical area. Established by both Federal and state governments (see "Air Pollutants, Hazardous").

American Indian Religious Freedom Act of 1978. This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

Anticline. A convex upward fold of rock.

Applicable or Relevant and Appropriate Requirements (ARARs). Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances as specified under Federal and state law and regulations, that must be met when complying with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

Aquifer. A body of rock or sediment sufficiently permeable to conduct groundwater and to yield significant quantities of water to wells and springs.

Aquitard. A less-permeable geologic unit in a stratigraphic sequence. The unit is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

Arroyo. A gully or channel cut by an intermittent stream.

As Low As Reasonably Achievable (ALARA). An approach to control or manage radiation exposures (both individual and collective to the workforce and the public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit. It is a process that has as its objective the attainment of dose levels as far below applicable limits as possible.

Atomic Energy Act of 1954. A Federal statute that, along with other related legislation (including the Energy Reorganization Act of 1974 and the Department of Energy Organization Act of 1977), provides

U.S. Department of Energy with the authority for developing generally applicable standards for protecting the environment from radioactive materials.

Atomic Energy Commission (AEC). A five-member commission, established by the Atomic Energy Act of 1946, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the U.S. Nuclear Regulatory Commission and the Administrator of the Energy Research and Development Administration (ERDA). ERDA was later terminated and its functions vested by law in the Administrator were transferred to the Secretary of Energy.

Attainment Area. An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the Clean Air Act. An area may be an attainment area for one pollutant and a nonattainment area for others (see "Nonattainment Area").

Background Level. The value assigned to the quantity of particulate or gaseous material in ambient air that originates from natural sources uninfluenced by the activity of man.

Background Radiation. Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices.

Baseline. *See* **Affected Environment.** *See* **Alternative, No Action.**

Basement Rocks. The undifferentiated complex of rocks that underlies the rocks of interest in an area. In many places the rocks of the complex are igneous and metamorphic and of Precambrian Age.

Best Available Technology (BAT). The preferred technology for treating a particular process liquid waste containing radioactive material so that the final waste stream will contain radionuclide concentrations no greater than the Derived Concentration Guide reference values at the point of discharge to a surface waterway.

Best Demonstrated Available Technology (BDAT). Earlier demonstrations have shown that incineration, vitrification, and aqueous treatment are effective in reducing the concentration of hazardous materials in

waste shipments to levels acceptable for land disposal technologies. Concentration levels are set by the Land Disposal Restrictions standards stipulated in the Hazardous and Solid Waste Disposal Act of 1984. The U.S. Environmental Protection Agency established the Land Disposal Restrictions standards on the basis of BDATs rather than risk-based or health-based standards.

Beta Particle. An elementary subatomic particle emitted from a nucleus during radioactive decay, with a single electrical charge and a mass equal to 1/1,837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta particle radiation may cause skin burns, and beta particle emitters are harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal or plastic.

Bounding. In the context of accident analysis, bounding is a term used to identify conservative assumptions that will likely overestimate actual risks or consequences.

Calcination. An inorganic material is heated in a calciner to high temperatures but without fusing in order to drive off volatile matter (to remove organic material) or to effect changes (as oxidation or pulverization or to convert it to nodular form). Calciners and nodulizing kilns are considered to be similar units.

Cancer. A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation or chemicals at sufficient concentrations and exposure durations.

Candidate Species. Plant or animal species that are not yet officially listed as threatened or endangered but are undergoing status review by the U.S. Fish and Wildlife Service. They are candidates for possible addition to the list of threatened and endangered species.

Canister. A metal receptacle surrounding the waste form that facilitates handling, storage, transportation, and/or disposal.

Carbon Monoxide (CO). A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

Case. With respect to an Environmental Impact Statement, a case is analogous to an alternative (see "Alternative"). The term "case" is used when several alternatives are predominantly similar; e.g., construction of a given plant at one site, at two sites, at three sites, etc.

Cask (Radioactive Materials). As defined by the U.S. Environmental Protection Agency, a cask is a thick-walled container (usually lead) that meets all applicable regulatory requirements for transporting radioactive materials.

CERCLA. *See* **Comprehensive Environmental Response, Compensation, and Liability Act.**

Characterization. The determination of waste composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transportation, and disposal requirements.

Class I Area. Under the Clean Air Act, any Federal land that is classified or reclassified "Class I." The designation applies to pristine areas, such as national parks and wilderness areas, where substantial growth is effectively precluded in order to avoid any degradation of the air quality.

Classified Waste. Waste materials, including weapons components and assemblies, designated by the U.S. Government, pursuant to Executive Order, statute, or regulation, that require protection against unauthorized information or material disclosure for reasons of national security. Additional security and safeguards management activities are required in the handling of these materials.

Clean Air Act. Federal Act that mandates the promulgation and enforcement of air pollution control standards for stationary sources and motor vehicles.

Clean Water Act of 1972, 1987. Federal Act regulating the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit, as well as regulating discharges to or dredging of wetlands.

Code of Federal Regulations (CFR). All Federal regulations in force are published in codified form in the Code of Federal Regulations.

Collective Dose. The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem.

Collocated Workers. Workers in a fixed population outside the day-to-day safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located some distance from the reference facility area. Also, an individual assumed to be located 100 meters (328 feet) from where an accidental release occurs.

Combined Impact. Depending on the scope of the program concerned, a Programmatic Environmental Impact Statement may address more than one "Purpose and Need," each with its own set of alternatives. These several actions, however, may have common environments (e.g., two or more nuclear waste types being managed at the same site). The sum of these impacts with respect to the site concerned are combined impacts, as opposed to cumulative impacts (see "Cumulative Impacts"), which incorporate the site-specific impacts of activities not otherwise related to the action(s) and alternatives in question.

Commercialization. In this PEIS, commercialization refers to the use of a waste management facility that is owned and operated by a private entity (or State) that treats, stores, or disposes of waste from a variety of sources for a fee.

Committed Dose Equivalent (CDE). The calculated dose equivalent projected to be received by a tissue or organ over a 50-year period after an intake of radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem.

Committed Effective Dose Equivalent (CEDE). The sum of the committed dose equivalents to various tissues in the body, each multiplied by its weighting factor. It does not include contributions from external dose. Committed effective dose equivalent is expressed in units of rem.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). A Federal law (also known as "Superfund") that provides a comprehensive framework to deal with past or abandoned hazardous materials. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment that could endanger public health, welfare, or the environment, as well as the cleanup of inactive hazardous waste disposal sites. CERCLA has jurisdiction over any release

or threatened release of any "hazardous substance" to the environment. Under CERCLA, the definition of "hazardous" is much broader than under the Resource Conservation and Recovery Act, and the hazardous substance need not be a waste. If a site meets the CERCLA requirements for designation, it is ranked along with other "Superfund" sites and listed on the National Priorities List. This ranking and listing is the U.S. Environmental Protection Agency's way of determining which sites have the highest priority for cleanup.

Contact-Handled Waste. Waste with a surface dose rate that does not exceed 200 millirems/hour.

Contamination. The deposition of unwanted radioactive or hazardous material on the surfaces of structures, areas, objects, or personnel.

Cradle-to-Grave. In the context of waste management, cradle-to-grave means from the time of generation through permanent disposal.

Criteria Air Pollutant. One of six air pollutants for which National Ambient Air Quality Standards are established by the U.S. Environmental Protection Agency under Title I of the Federal Clean Air Act. The six pollutants are sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter (equal to or smaller than 10 microns in diameter), and lead.

Cultural Resources. Archaeological sites, architectural features, traditional-use areas, and Native American sacred sites or special-use areas.

Cumulative Impact. In an Environmental Impact Statement, the impact on the environment that results from incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR Part 1508.7) (see "Combined Impact").

Curie (Ci). The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations/second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations/second.

Daughter Products. Nuclides formed by the radioactive disintegration of a radionuclide (parent).

Deactivation. A technology applied to a hazardous substance to mitigate its hazardous characteristics, such as ignitability, corrosivity, or reactivity.

Decommissioning. The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

Decontamination. The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination from facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

Depleted Uranium. Uranium whose content of the isotope uranium-235 is less than 0.7%, which is the uranium-235 content of naturally occurring uranium.

Derived Concentration Guide (DCG). The concentration of a radionuclide in air or water that, under conditions of continuous exposure by ingestion of water, submersion in air, or irradiation, would result in an effective dose equivalent of 100 millirem for 1 year of exposure. DCG values are listed in DOE Order 5400.5. DOE drinking water standards are 4% of the DCG values for ingestion, and thus meet the criterion of 4 millirem/year.

Disposal. Emplacement of waste in a manner that ensures protection of human health and the environment within prescribed limits for the foreseeable future with no intent of retrieval and that requires deliberate action to regain access to the waste.

Disposal Facility. A facility or part of a facility at which hazardous, radioactive, or solid waste is intentionally placed into or on any land or water, and at which waste is intended to permanently remain after closure.

Disposition, Final. The ultimate solution to disposition of nuclear or hazardous waste: it will never again require handling and/or movement. For a given volume of waste, the final disposition may be represented by recycling, reprocessing, incineration, or burial (see "Storage" and "Storage, Long-Term").

Disproportionate. Neither DOE nor the Federal Working Group on Environmental Justice has yet issued final guidance on interpreting the provisions of the Executive Order on Environmental Justice, nor has there been a judicial interpretation of the term "disproportionate" within the context of environmental justice. In general use, disproportionate refers to a condition of disparity, or a lack of symmetry in the relation of one part of an entity to another part or to the whole with respect to magnitude, quantity, or degree. For purposes of the environmental justice analysis in the WM PEIS, the use of the term refers to any distribution of impacts across minority, low-income, or Native American populations that may be substantially greater in magnitude or quantity than that experienced by the general population. A high or adverse impact (or risk or rate of impact) is disproportionate when it significantly exceeds, for a low-income, minority, or Native American community, the same type of impacts in the larger community (for environmental impacts) or the risk or rate to the general population and, where available, to another appropriate comparison group (for health impacts).

Dose (or Radiation Dose). The amount of energy deposited in body tissue as a result of radiation exposure. Various technical terms, such as absorbed dose, collective dose, dose equivalent, and effective dose equivalent, are used to evaluate the amount of radiation an exposed person receives. Each of these terms is defined in this glossary.

Dose Equivalent. (a) That number (corrected for background) zero (minimal or negligible) and above, that is recorded as representing an individual's dose from external radiation sources or internally deposited radioactive materials determined in accordance with DOE Order 5480.1B, Chapter XI, Requirements. (b) The product of absorbed dose in rads in tissue and a quality factor. Dose equivalent is expressed in units of rem. (c) The product of the absorbed dose, the quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the biological effectiveness of different kinds of radiation (based on the quality of radiation and its spacial distribution in the body) on a common scale. The unit of dose equivalent is the rem. A millirem (mrem) is one thousandth (0.001) of a rem.

Ecological Impact. The effect that a manmade or natural activity has on living organisms and their nonliving (abiotic) environment.

Ecotoxicity. A measure of the ecological effects of chemicals.

Effective Dose Equivalent (EDE). The summation of the products of the dose equivalent received by specified tissues (or organs) of the body and a tissue-specific weighing factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighing factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body. Weighing factors are: 0.25 for gonads, 0.15 for breast, 0.12 for red bone marrow, 0.12 for lungs, 0.03 for thyroid, 0.03 for bone surface, and 0.06 for each of the other five organs receiving the highest dose equivalent. Effective dose equivalent is expressed in units of rem.

Effects (40 CFR Part 1508.8). "Effects" include: (a) direct effects, which are caused by the action and occur at the same time and place; (b) indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. Effects and impacts as used in the Council on Environmental Quality regulations are synonymous. Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (see "Human Environment").

Effluent. A gas or fluid discharged into the environment.

EIS. *See* **Environmental Impact Statement**.

Emission Standard. A permit or regulatory requirement contained in 40 CFR Part 60 or 40 CFR Part 61 (that sets forth the National Emission Standards for Hazardous Air Pollutants), that limits the quantity, rate, or concentration of emissions on a continuous basis, including any requirements that limit opacity, prescribe equipment, set fuel specifications, or prescribe operation or maintenance procedures to ensure continuous emission control.

Endangered Species. Any species or subspecies of animal or plant whose survival is threatened with extinction throughout all or a significant portion of its range.

Endpoints. The types of potential adverse health effects evaluated in the health risk analysis. These effects include cancer incidence, cancer fatality, genetic effects, physical trauma injury and fatality, and noncancer effects (e.g., headaches, dermal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and development toxicity).

Engineered Barriers. Manmade components in a disposal system designed to prevent the release of radionuclides into the geologic medium involved. This term includes the radioactive waste form, radioactive waste containers, and other materials placed over and around such containers. A manmade structure or device that is intended to improve the land disposal facility's ability to meet performance objectives.

Enriched Uranium. Uranium that has greater amounts of the fissionable isotope uranium-235 than occurs naturally. Naturally occurring uranium is 0.72% uranium-235.

Environment. The sum of all external conditions affecting the life, development, and survival of an organism.

Environmental Impact Statement (EIS). A report by Federal agencies, prepared in accordance with the National Environmental Policy Act, that documents the information required to evaluate the environmental impact (both positive and negative effects) of a proposed project ("action"). Such a report informs decision makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the environment. The draft EIS (DEIS) is circulated for public comment before the final EIS (FEIS) is prepared.

Environmental Justice. The fair treatment of people of all races, cultures, and income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (U.S. Environmental Protection Agency Office of Environmental Justice Small Grants Programs, Pre-Application Kit for Assistance, FY 1995).

Environmental Monitoring. The process of sampling and analyzing environmental media in and around a facility being monitored to (a) confirm compliance with performance objectives and (b) detect any contamination entering the environment early enough to facilitate timely remedial action.

Environmental Restoration. Cleanup and restoration of sites, and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substances during past production, accidental releases, or disposal activities.

Environmental Restoration Program. A U.S. Department of Energy (DOE) subprogram concerned with all aspects of assessment and cleanup of both contaminated (radioactive and/or hazardous substances) DOE-owned facilities in use and of DOE sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and groundwater and decontamination and decommissioning are responsibilities of this program.

Epidemiology. Study of the distribution of disease or other health-related states and events in human populations, as related to age, sex, occupation, ethnic, and economic status in order to identify and alleviate health problems and promote better health.

Exceedance. A value that goes over a prescribed limit.

Exposure Index. The sum of all ratios that compare the estimated exposure concentration of a particular noncarcinogenic chemical to an appropriate occupational exposure limit for that chemical.

Exposure Pathways. The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air or water is also included.

External Dose Rate. The radiation dose from a shipping package delivered per unit time (e.g., rem per year).

Facility. (a) Any equipment, structure, system, process, or activity that fulfills a specific purpose. Examples include accelerators, storage areas, research devices, nuclear reactors, production or processing plants, conversion plants, windmills, radioactive waste disposal systems and burial grounds, testing laboratories, research laboratories, transportation activities, and accommodations for analytical examinations of irradiated and nonirradiated components. (b) Buildings and other structures; their functional systems and equipment, including site development features such as landscaping, roads, walks, and parking areas; outside lighting and communications systems; central utility plants; utilities supply and distribution systems; and other physical plant features. (c)(1) Any building, structure, installation, equipment, pipe, or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, or aircraft, or (2) any site or area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located; but does not include any consumer product in consumer use or any vessel (see "Site").

Fault. A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Federal Facility Compliance Act (FFCAct). Federal law signed in October 1992 amending the Resource Conservation and Recovery Act. The objective of the FFCAct is to bring all Federal facilities into compliance with applicable Federal and state hazardous waste laws, to waive Federal sovereign immunity under those laws, and to allow the imposition of fines and penalties. The law also requires the U.S. Department of Energy to submit an inventory of all its mixed waste and to develop a treatment plan for mixed wastes.

Federal Land Management Policy Act of 1976. Act that provides for the periodic and systematic inventory of public lands and their resources and for projecting their present and future use through a land use planning process coordinated with Federal and state planning efforts. Among other things, it encourages management on the basis of multiple uses and protection of the quality of scenic, historical, ecological, environmental, air and atmospheric, water resources, and archaeological values.

Federally Listed Species. *See* **Threatened Species**, **Endangered Species**, and **Candidate Species**.

Fines. Finely crushed or powdered material; i.e., very small particles in a mixture of various sizes.

Fission. The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

Floodplain. The lowlands and relatively flat areas adjoining inland and coastal waters including, at a minimum, that area inundated by a 1% or greater chance flood in any given year. The base floodplain is defined as the 100-year (1.0%) floodplain. The critical action floodplain is defined as the area inundated on average once every 500 years (0.2%).

Fugitive Emissions. Emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

Gamma Ray. High-energy, short-wavelength electromagnetic radiation of nuclear origin (radioactive decay) similar to x-rays. Gamma rays are true rays of energy, in contrast to alpha and beta radiation, and they are the highest penetrating of the three common types of radioactive decay. They are best stopped or shielded against by dense materials, such as lead or depleted uranium.

Gaussian Plume. The distribution of material (a plume) in the atmosphere resulting from the release of pollutants from a stack or other source. The distribution of concentrations about the centerline of the plume, which is assumed to decrease as a function of its distance from the source and centerline (Gaussian distribution), depends on the mean wind speed and atmospheric stability.

General Conformity Rule. U.S. Environmental Protection Agency rule that establishes minimal levels for criteria air pollutant emissions, in tons per year, based on the air quality control region's nonattainment designation.

Genetic Effects. The outcome resulting from exposure to mutagenic chemicals or radiation that results in genetic changes in germ line or somatic cells. Effects on genetic material in germ line (sex cells) cause trait modifications that can be passed from parents to offspring. Effects on genetic material in somatic cells result in tissue or organ modifications (e.g., liver tumors) that do not pass from parents to offspring.

Geologic Repository. A system intended to be used for, or may be used for, the disposal of radioactive waste or spent nuclear fuel in excavated geologic media. A geologic repository includes (a) a geologic repository operating area, and (b) the portion of the geologic setting that provides isolation. A near-surface disposal area is not a geologic repository.

Greater-Than-Class-C Waste (GTCC). Low-level radioactive waste that is generated by the commercial sector and that exceeds U.S. Nuclear Regulatory Commission concentration limits for Class-C low-level waste, as specified in 10 CFR Part 61. DOE is responsible for disposing of Greater-Than-Class-C wastes from U.S. Department of Energy nondefense programs.

Groundwater. In general, all water contained in the ground. Water held below the water table available to freely enter wells.

Habitat. Area where a plant or animal lives.

Half-Life (Radiological). The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; this varies for specific radioisotopes from millionths of a second to billions of years.

Hazard Index. The sum of ratios that compare the estimated concentration of a noncarcinogenic chemical to which an individual may be exposed to a criterion presumed to be protective of human health against noncancer toxicity.

Hazard Quotient. The ratio of the exposure concentration (or dose) of a single substance to the reference concentration (or reference dose) for that substance; hazard quotients are used by the U.S. Environmental Protection Agency to measure the risk of noncancer health effects and are independent of cancer risk, which is calculated only for those chemicals identified as carcinogens.

Hazardous Air Pollutants (HAPs). U.S. Environmental Protection Agency definition: Air pollutants that are not covered by ambient air quality standards but that, as defined in the Clean Air Act, may reasonably be expected to cause or contribute to irreversible illness or death. Such pollutants include asbestos, beryllium, mercury, benzene, coke oven emissions, radionuclides, and vinyl chloride. Office of Environmental Safety and Health definition: Air contaminants to which no ambient air quality standard is applicable and that causes, or contributes to, air pollution that may reasonably be anticipated to result in

an increase in mortality or an increase in serious irreversible or incapacitating reversible, illness. Hazardous air pollutants are regulated by 40 CFR 61 (Regulations on National Emission Standards for Hazardous Air Pollutants).

Hazardous Materials Transportation Act of 1975, as Amended. Act that provides the U.S. Department of Transportation the authority to establish standards on any safety aspect of the transport of hazardous (including radioactive) materials by any mode in interstate and foreign commerce.

Hazardous Substance. Any substance that, when released to the environment in an uncontrolled or unpermitted fashion, becomes subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act.

Hazardous Waste (HW). Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

Heavy Metals. Metallic or semimetallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations.

High-Efficiency Particulate Air (HEPA) Filter. A filter with an efficiency of at least 99.95% used to separate particles from air exhaust streams prior to releasing that air into the atmosphere.

High-Level Waste (HLW). The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

Human Environment (40 CFR Part 1508.14). "Human environment" shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment. This means that economic or social effects are not intended by themselves to require preparation of an Environmental Impact Statement (EIS). When an EIS is prepared and economic or social and natural or physical environmental effects are interrelated, then the EIS will discuss all of these effects on the human environment.

Human Health Risk. A measure of the probability that adverse effects, or impacts, on human health will occur as a result of a given hazard.

Hypothetical Farm Family. An imaginary family assumed to live 300 meters downgradient of the center of a waste disposal unit. The family farms, grows, and consumes its own crops and livestock and uses groundwater for watering crops and animals—an estimated maximum exposure scenario taking place in the future at a time when institutional controls no longer exist. The scenario is analyzed to determine potential upper-bound exposures by ingestion of contaminated groundwater.

Hypothetical Intruder. An imaginary adult who drills a well directly through a disposal unit to the groundwater. As a result of the drilling, contaminated soil from within the unit is brought to the surface where it mixes with the top layers of the surface soil. The individual farms the land and eats the crops. The intruder scenario occurs after the failure of institutional control. This is consistent with the analysis required for disposal facilities under DOE Order 5820.2A.

Impact. In an Environmental Impact Statement, the positive or negative effect of an action (past, present, or future) on the environment. Environmental impacts are usually categorized as (a) natural environment (land use, air quality, water resources, geological resources, ecological resources, and aesthetic and scenic resources), or (b) human environment (infrastructure, economics, social, and cultural). Within an Environmental Impact Statement, cost; health risks; transportation and transportation accidents; and treatment, storage, and disposal facility accidents are treated separately from environmental impacts.

Impact Attribute. Environmental impacts are broadly defined as those affecting the "natural and physical environment and the relationship of people thereto." If natural and physical attributes are involved, economic and social impacts may be brought into play as appropriate. More specifically, these attributes include geology and soils, water resources, air quality, ecological resources, socioeconomic and land uses,

infrastructure, cultural resources, the local transportation network, and the level of radionuclide and radiation exposure.

Incineration. The efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. Incinerators are designed to burn with extremely high efficiency. The greater the burning efficiency, the cleaner the air emission. Incineration of radioactive materials does not destroy the radionuclides but does significantly reduce the volume of the waste matrix. High-efficiency particulate air filters are used to prevent radionuclides and heavy metals from escaping from the stack into the atmosphere.

Increased Cancer Incidence Effects. An air concentration of hazardous waste containing carcinogens above which an exposed person has an increased carcinogenic risk of 1 in 1 million (1E–06) or higher.

Individual Health Risk Impacts. Impacts focusing on the probability that the maximally exposed individual within each receptor population would experience an adverse health impact. These impacts include the probability of a cancer fatality, the probability of cancer incidence, and the probability of genetic effects.

Inventory Waste. The accumulated waste remaining from the development and production of U.S. nuclear weapons, i.e., waste that is currently in warehouse storage, retrievable storage on bermed pads, or disposed of in trenches.

Isotope. A variation of an element that has the same number of protons, but a different weight because the number of neutrons differs from that of its other isotope(s). A given element may have many isotopes. For example, uranium occurs naturally in three forms: uranium-234 (142 neutrons), uranium-235 (143 neutrons), and uranium-238 (146 neutrons); each of these isotopes has 92 protons. Various isotopes of the same element may have different radioactive behaviors—some are highly unstable (i.e., they decay spontaneously and/or emit radiation) (see "Radioisotope" and "Radiation").

Land Disposal Restrictions (LDRs). Restrictions on the disposal of waste that is hazardous under the Resource Conservation and Recovery Act. LDRs include technology-based or performance-based treatment standards that must be met before hazardous waste can be land disposed. The regulations in 40 CFR Part 268 address LDRs.

Land-Use Planning. A decision-making process to determine the future or end use of a parcel of land, considering such factors as current land use, public expectations, cultural considerations, local ecological factors, legal rights and obligations, technical capabilities, and costs.

Life Cycle. The entire time period from generation to permanent disposal or elimination of waste.

Low-Income Population. A census tract within the 80-kilometer (50-mile) zone of impact at each of the 17 U.S. Department of Energy sites that has a low-income population proportion greater than the national average of 13.1%.

Low-Income Status. Based on U.S. Census Bureau data definitions of individuals below the poverty line. The poverty line is defined by a statistical threshold that considers family size and income. For 1990, the poverty threshold for a family unit consisting of four individuals, based on 1989 income, was $12,674. Other poverty thresholds are provided by the U.S. Census Bureau for larger and smaller family sizes.

Low-Level Waste (LLW). Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section 11(e)(2) of the Atomic Energy Act). Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided that the concentration of transuranic is less than 100 nCi/g.

Low-Level Mixed Waste (LLMW). Waste that contains both hazardous waste under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954 (42 USC 2011, *et seq.*).

Maximally Exposed Individual (MEI). A hypothetical individual whose location and habits maximize the highest total radiation dose and/or chemical intake for all exposure routes (e.g., inhalation, ingestion, direct exposure) over the individual's lifetime. Two types of MEIs are considered in this PEIS. One is the offsite MEI, a member of the general population located within 80 kilometers (50 miles) of an onsite facility. The other is the MEI of the noninvolved worker population, that is, the population of onsite employees not directly involved in waste handling activities.

Millirem. One thousandth of a rem (see "Rem").

Minimum Treatment. The least amount of treatment required to meet waste acceptance criteria for disposal and, if shipped to another site, packaging requirements for transportation. Minimum treatment includes solidification of liquids and fines, and packaging.

Minority Population. Includes individuals who report themselves as belonging to any of the following racial groups: Black (reported their race as "Black or Negro," or reported entries such as "African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian"); American Indian, Eskimo, or Aleut; Asian or Pacific Islander, or "Other Race." Individuals identifying themselves as of Hispanic origin are also included in the minority category. Hispanics can be of any race, however. To avoid double-counting minority Hispanic individuals, only white Hispanics were included in the number of racially based minorities in a tabulation, since nonwhite Hispanics had already been counted under their minority racial classification. For this analysis, minority populations consist of any census tract within the 80-kilometer (50-mile) zone of impact at each of the 17 U.S. Department of Energy sites that has a minority population proportion greater than the national average of 24.4%.

Mitigation (40 CFR Part 1508.20). "Mitigation" includes: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or (e) compensating for the impact by replacing or providing substitute resources or environments.

Mixed Waste. Waste that contains both (a) hazardous waste under the Resource Conservation and Recovery Act, and (b) source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954 (see "Low-Level Mixed Waste").

Most Exposed Lifetime (MEL). The 70-year lifetime out of the 143 lifetimes evaluated during which the highest exposures are estimated to occur for the hypothetical farm family.

Multimedia Environmental Pollutant Assessment System (MEPAS). For the groundwater pathway, various computer models, including MEPAS, are used to simulate environmental transport of contaminants

from the source (waste disposal location) to groundwater to potential receptors. Contaminant-specific unit rate of transfer (flux) rates out of the engineered disposal facility are used by MEPAS to simulate the transport of contaminants through the vadose zone (the area above the permanent groundwater level) and into the groundwater. The MEPAS model then predicts the environmental concentration of contaminants at various receptor locations as a function of time.

National Ambient Air Quality Standards (NAAQS). Air quality standards established by the Clean Air Act, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants (NESHAPS). A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the Clean Air Act Amendments of 1977.

National Environmental Policy Act (NEPA) (10 CFR Part 1021.1). This 1969 legislation (42 U.S.C. 4321 *et seq.*) establishes national policies and goals for protecting the environment. Section 102(2) of NEPA contains certain procedural requirements directed toward attaining such goals. In particular, all Federal agencies are required to give appropriate consideration to the environmental effects of their proposed actions in their decision making and to prepare detailed environmental statements on recommendations or reports on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. Executive Order 11991 of May 24, 1977, directed the Council on Environmental Quality to issue regulations to implement the procedural provisions of NEPA.

National Historic Preservation Act of 1966, as Amended. This Act directs Federal agencies to consider the effects of their programs and projects on properties listed or eligible for the National Register of Historic Places. It does not require any permits, but pursuant to Federal code, if a proposed action could impact an archaeological, historic, or architectural resource, it mandates consultation with the proper agencies.

National Pollutant Discharge Elimination System (NPDES). Federal permitting system required for hazardous effluents regulated through the Clean Water Act, as amended.

National Priorities List (NPL). A formal listing of the Nation's most hazardous waste sites, as established under the Comprehensive Environmental Response, Compensation, and Liability Act, that have been identified for remediation.

National Register of Historic Places (NRHP). The official list of historic properties (districts, sites, buildings, structures, and objects) maintained by the Secretary of the Interior deserving preservation because of their local, state, or national significance in American history, architecture, archaeology, engineering, and culture. Properties listed or eligible for the National Register are protected by the National Historic Preservation Act of 1966, as amended.

Native American Grave Protection and Repatriation Act of 1990. Act requiring Federal agencies and Federally funded museums to repatriate human remains, sacred objects, and objects of cultural patrimony to the culturally affiliated Native American groups. This includes repatriation of cultural items in collections, proof of consultation with appropriate Native American groups for excavation on Federal or tribal lands, and notification of the Federal Land Manager and appropriate Native American group when an inadvertent discovery is made on Federal or tribal land. Any cultural items excavated after November 16, 1990, pertaining to this Act, are owned by lineal descendants.

NEPA. *See* **National Environmental Policy Act**.

Neutron. An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and proton.

Nitrogen Oxides (NO_x). Gases formed in great part from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and high pressure; considered a major air pollutant. Two major nitrogen oxides, nitric oxide (NO), and nitrogen dioxide (NO_2), are important airborne contaminants. In the presence of sunlight, nitric oxide combines with atmospheric oxygen to produce nitrogen dioxide, which in high enough concentrations can cause lung damage.

Nonattainment Area. An air quality control region (or portion thereof) in which the U.S. Environmental Protection Agency has determined that ambient air concentrations exceed National Ambient Air Quality Standards for one or more criteria pollutants.

NPDES. *See* **National Pollutant Discharge Elimination System.**

Nuclear Waste Policy Act of 1982, as Amended. This Act authorizes Federal agencies to develop a geologic repository for the permanent disposal of spent nuclear fuel and high-level radioactive waste. The Act specifies the process for selecting a repository site and constructing, operating, closing, and decommissioning the repository. The Act also establishes programmatic guidance for these activities.

Nuclide. A general term referring to all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements (see "Isotope" and "Radioisotope").

Offsite Population. For facility accident analyses, the collective sum of individuals located within an 80-kilometer (50-mile) radius of a facility and within the path of the plume with the wind blowing in the most populous direction.

Onsite. The same or geographically contiguous property that may be divided by public or private right-of-way, provided the entrance and exit between the properties is at a crossroads intersection, and access is by crossing as opposed to going along the right-of-way. Noncontiguous properties owned by the same person but connected by a right-of-way that he/she controls and to which the public does not have access is also considered onsite property.

Ozone (O_3). The triatomic form of oxygen; in the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere ozone is considered an air pollutant.

Paleontology. The study of fossils.

Paleozoic Era. Geologic time dating from 570 million to 245 million years ago when seed-bearing plants and vertebrates first appeared.

Particulate Matter. Any material, except uncombined water, that exists in a finely divided form as a liquid or solid.

Particulates. Particles in an aerosol stream, the larger of which usually can be removed by filtration.

PEIS. *See* **Programmatic Environmental Impact Statement**.

Playa. A dry lake bed in a desert basin or a closed depression that contains water on a seasonal basis.

Pleistocene Epoch. Geologic time that occurred approximately 1.8 to 10,000 years ago. Generally equated with the "Ice Age."

Plume. The three-dimensional area (usually in air or groundwater) containing measurable concentrations of a compound or element that has migrated from its source point.

Plutonium (Pu). A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombardment of uranium with neutrons and is used in the production of nuclear weapons.

PM_{10}. All particulate matter in the ambient air with an aerodynamic diameter less than or equal to a nominal 10 micrometers (10 microns). Particles less than this diameter are small enough to be breathable and could be deposited in lungs.

Pollution Prevention. The use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and wastes into land, water, and air. Pollution prevention includes practices that reduce the use of hazardous materials, energy, water, and other resources along with practices that protect natural resources through conservation or more efficient use.

Polychlorinated Biphenyls (PCBs). A class of chemical substances formerly manufactured as an insulating fluid in electrical equipment that is highly toxic to aquatic life. In the environment, PCBs exhibit many of the characteristics of dichloro diphenyl trichloroethane (DDT); they persist in the environment for a long time and accumulate in animals.

Population Dose. The overall dose to the offsite population.

Population Health Risk Impacts. Impacts focusing on the total number of persons in each population who may experience adverse health impacts if a particular alternative were implemented. These impacts include fatalities from physical hazards, cancer fatalities, cancer incidences, and genetic effects.

Potential Life-Threatening Concentration (PLC). An air concentration of hazardous waste above which exposed persons are at risk of potentially life-threatening health effects when exposed for the associated exposure period.

Potentially Adverse Effects Concentration (PAEC). An air concentration of hazardous waste above which exposed persons are at risk of any adverse effect, which may include mild transient effects such as headaches.

Precursor Pollutants. Pollutants that must be present in the atmosphere before chemical reactions take place and form the pollutant of interest. For example, nitrogen oxides, volatile organic compounds, and carbon monoxide are precursor pollutants to the formation of ozone.

Prevention of Significant Deterioration (PSD). Regulations established by the 1977 Clean Air Act Amendments to limit increases in criteria air pollutant concentrations above baseline.

Privatization. In this PEIS, privatization refers to the use of a DOE facility on a DOE site that is operated, maintained, and eventually decontaminated and decommissioned by a private entity who operates that waste management facility for the exclusive use of DOE and is reimbursed by DOE on a competitive, fixed-price basis. Privatization also includes the construction and subsequent operation of a new waste management facility by a private entity on a DOE site.

Programmatic Environmental Impact Statement (PEIS). A broad-scope Environmental Impact Statement that identifies and assesses the environmental impacts of a U.S. Department of Energy program. A PEIS may have several purposes (see "Purpose and Need") with distinct proposed actions and alternatives for each (see "Combined Impacts").

Proposed Action. The activity proposed to accomplish an agency's purpose and need (see "Purpose and Need"). An Environmental Impact Statement analyzes the environmental impacts of the proposed action and of reasonable alternatives to that action (see the various entries under "Alternatives"). A proposed action is described as a project and its related support operations to include preconstruction, construction, and operational activities, and postoperational requirements.

PSD. *See* **Prevention of Significant Deterioration.**

Public. Anyone outside the U.S. Department of Energy site boundary at the time of an accident or during normal operation. With respect to accidents analyzed in this Environmental Impact Statement, anyone outside the site boundary at the time of an accident.

Purpose and Need. In the context of an Environmental Impact Statement, the broad requirement to be met or goal to be achieved (with respect to a specific statutory authority) by the Federal agency concerned. The proposed action and its alternatives are means of accomplishing the purpose and need (see "Action" and "Alternative").

Quality Assurance. All those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or components will perform satisfactorily and safely in service. Quality assurance includes quality control, which is all those actions necessary to control and verify the features and characteristics of material, process, product, or service to specified requirements.

Quaternary. The period of geologic time since the end of the Pliocene, consisting of the Pleistocene and Holocene, from about 1.8 million years ago to the present.

Radiation. The release of energy in the form of particles and/or electromagnetic radiation resulting from the spontaneous nuclear decay of an unstable atomic nucleus.

Radioactive Waste. Waste managed for its radioactive content.

Radioactivity. The property or characteristic of material to spontaneously "disintegrate" with the corresponding release of energy in the form of particles and/or electromagnetic radiation (see "Radiation"). The unit of radioactivity is the curie.

Radioisotope. An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. Approximately 5,000 natural and artificial radioisotopes have been identified (see"Isotope").

Radionuclide. *See* **Radioisotope**.

Radon. Gaseous, radioactive element with the atomic number 86 resulting from the radioactive decay of radium. Radon occurs naturally in the environment, and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

RCRA. *See* **Resource Conservation and Recovery Act**.

Record of Decision (ROD). A public document that records the final decision(s) on a proposed action. The Record of Decision is based in whole or in part on information and technical analysis generated either during the Comprehensive Environmental Response, Compensation, and Liability Act process or the National Environmental Policy Act process, both of which take into consideration public comments and community concerns. 40 CFR Part 1505.2 states, in part: "At the time of its decision or, if appropriate, its recommendation to Congress, each agency shall prepare a concise public record of decision. The record shall:

- State what the decision was.
- Identify all alternatives considered by the agency in reaching its decision, specifying the alternative or alternatives that were considered to be environmentally preferable. An agency may discuss preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions. An agency shall identify and discuss all such factors including any essential considerations of national policy which were balanced by the agency in making its decision and state how those considerations entered into its decision.
- State whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not."

Recycling. Recycling techniques are characterized as use, reuse, and reclamation techniques (resource recovery). Use or reuse involves the return of a potential waste material either to the originating process as a substitute for an input material or to another process as an input material. Reclamation is the recovery of a useful or valuable material from a waste stream. Recycling allows potential waste materials to be put to a beneficial use rather than going to treatment, storage, or disposal.

Region of Influence (ROI). The physical area that bounds the environmental, sociological, economic, or cultural feature of interest for the purpose of analysis.

Regional Input-Output Modeling System (RIMS). The economic multipliers (for disposable income, output, and job years) used by the Programmatic Environmental Impact Statement team to assess the economic impact of waste management activities were derived from an 80-sector (80 industries) model based on the RIMS approach developed by the U.S. Department of Commerce.

Rem (Roentgen Equivalent Man). A unit of individual dose of absorbed ionizing radiation used to measure the effect on human tissue. The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of x-ray or gamma-ray exposure.

Remediation. Process of remedying a site where a hazardous substance release has occurred.

Remote-Handled Waste. Wastes whose external dose rate exceeds 200 millirem per hour.

Repository. A permanent deep geologic disposal facility for high-level or transuranic wastes and spent nuclear fuel.

Reprocessing. A recycling procedure in which the useful material is removed from spent nuclear fuel and reused, and the remaining material is disposed of as waste.

Resource Conservation and Recovery Act (RCRA). A Federal law addressing the management of waste. Subtitle C of the law addresses hazardous waste under which a waste must either be "listed" on one of the U.S. Environmental Protection Agency's (EPA's) hazardous waste lists or meet one of EPA's four hazardous characteristics of ignitability, corrosivity, reactivity, or toxicity, as measured using the toxicity characterization leaching procedure. Cradle-to-grave management of wastes classified as Resource Conservation and Recovery Act (RCRA) hazardous wastes must meet stringent guidelines for environmental protection as required by law. These guidelines include regulation of transportation, treatment, storage, and disposal of RCRA-defined hazardous waste. Subtitle D of the law addresses the management of nonhazardous, nonradioactive solid waste, such as municipal wastes.

Risk. Usually quantitative, sometimes qualitative expression of possible loss that considers both the probability that a hazard/event causes harm and the consequences (damage to life, health, property) of the event/hazard. It is usually described in terms of loss or injury over a given period of time.

Saltcake. Concentrated waste in the form of crystallized salts resulting from the evaporation of liquid high-level waste.

Scrubber. An air pollution control device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Seismicity. The tendency for the occurrence of earthquakes.

Shielding. A material interposed between a source of radiation and persons, equipment, or other objects in order to absorb radiation and thereby reduce radiation exposure. Depending on the type of radiation being shielded, typical materials include lead, steel, depleted uranium, concrete, and water.

Site. (1) A U.S. Government-owned property, including land, facilities, structures, and equipment, that usually is operated for DOE by a prime contractor that administratively reports to a U.S. Department of Energy (DOE) Operations Office; e.g., the Oak Ridge National Laboratory is operated by Martin Marietta and reports administratively to DOE's Oak Ridge Operations Office; the Los Alamos National Laboratory is operated by the University of California and reports administratively to DOE's Albuquerque Operations Office. (2) When qualified (for example, *release site*), an area of contaminated ground (see "Facility").

Socially Sensitive Action. One that includes a question(s) of environmental justice (see "Action" and "Environmental Justice").

Socioeconomics. The measure of an economy's (community's) ability to support its infrastructure (e.g., schools, roads, police) and standard of living (e.g., parks, cultural facilities). Usually used with respect to changes in this measure effected by significant changes in the local economy, such as shutdown of an established industry; opening of a new industry.

Sole Source Aquifer. An aquifer that supplies 50% or more of the drinking water of an area. As defined by the Safe Drinking Water Act, an aquifer that is the only source or potential source of drinking water in an area.

Solid Waste. Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained

gaseous material resulting from industrial, commercial, mining, or agricultural operations or from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges that are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended, or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended (Public Law 94-580, 1004[27] [Resource Conservation and Recovery Act]).

Solidification. Treatment process that produces a monolithic block of waste with high structural integrity from excavated solid particulates, liquids, or sludge wastes.

Source Term. The type and quantity of pollutants released to the environment (e.g., air, water) from a specific source or group of sources.

Special-Case Waste. Waste generated by the U.S. Department of Energy that does not fit into any typical low-level waste management and is usually not suitable for near-surface disposal.

Spent Nuclear Fuel. Fuel that has been withdrawn from a nuclear reactor after irradiation, the constituent elements of which have not been separated.

Special Nuclear Material. As defined in Section 11 of the Atomic Energy Act of 1954, special nuclear material means (a) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the U.S. Nuclear Regulatory Commission determines to be special nuclear material or (b) any material artificially enriched by any of the foregoing.

Stakeholder. Any person or organization with an interest in or affected by U.S. Department of Energy activities. Stakeholders may include representatives from Federal agencies, state agencies, Congress, Native American Tribes, unions, educational groups, industry, environmental groups, other groups, and members of the general public.

State-Listed Species. Any species listed by a state government as threatened or endangered (see "Threatened Species," "Endangered Species," and "Candidate Species").

Storage. The collection and containment of waste or spent nuclear fuel (in such a manner as not to constitute disposal of the waste or spent nuclear fuel) for the purposes of awaiting treatment or disposal capacity (i.e., not short-term accumulation) (see "Storage, Long-Term," and "Disposition, Final").

Storage, Long-Term. The containment of waste (usually after undergoing treatment) for a period of years, possibly decades, until ultimate permanent disposal.

Targets. Refers to a variety of nonfuel components that are placed within a nuclear reactor or particle accelerator in order to produce a desired material.

Terrestrial. Pertaining to plants or animals living on land rather than in the water.

Tertiary Period. The first geologic period of the Cenozoic Era, dating from 66 million to about 5.5 million years ago. During this time, mammals became the dominant life form.

Thermal Treatment. Thermal destruction is the efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. The greater the destruction efficiency, the cleaner the air emissions. The thermal destruction technology assumed in the WM PEIS is incineration.

Threatened Species. Any species or subspecies of plant or animal that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Total Effective Dose Equivalent (TEDE). The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Toxic Air Pollutants (TAPs). Other toxic compounds regulated by the U.S. Environmental Protection Agency and state or local governments.

Toxic Substances Control Act (TSCA). Act authorizing the U.S. Environmental Protection Agency (EPA) to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by EPA before they are manufactured for commercial purposes.

Transuranic Waste (TRUW). Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, per gram of waste, with half-lives greater than 20 years, except for (a) high-level radioactive waste, (b) waste that the Secretary has determined, with concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or (c) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

Treatment. Any method, technique, or process designed to change the physical or chemical character of the waste to render it less hazardous; safer to transport, store, or dispose of; or reduced in volume.

Treatment Facility. Land area, structures, and/or equipment used for treating waste or spent nuclear fuel.

Treatment Group. Refers to the grouping together of waste streams that receive treatment through the same sequence of treatment steps.

Type B Package. A Type B packaging together with its radioactive contents. An NRC-certified container that must be used for the transport of highly radioactive materials. Type B packaging must be able to withstand both normal and accident transport conditions without releasing its radioactive contents. These containers are tested under severe, hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water.

Type B Shipping Cask. An NRC-certified cask with a protective covering that contains and shields radioactive materials, dissipates heat, prevents damage to the contents, and prevents criticality during normal shipment and accident conditions. It is used for transport of highly radioactive materials, and is tested under severe, hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water.

Vadose Zone. The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

Vitrification. (a) A waste treatment process in which calcined or another decomposed form of waste is mixed with glass and fused into a solid mass. The resultant mass is expected to remain a stable and insoluble form for long time periods, and thus will be a leading candidate for the most benign waste form for disposal. (Vitrification with borosilicate glass is the Best Demonstrated Available Technology for high-level

waste and certain mixed waste streams.) (b) The conversion of high-level waste materials into a glassy or noncrystalline solid for subsequent disposal. (c) The process of immobilizing waste that produces a glasslike solid that permanently captures the radioactive materials.

Volatile Organic Compounds (VOCs). A broad range of organic compounds such as benzene, chloroform, and methyl alcohol, often halogenated, that vaporize at ambient or relatively low temperatures.

Volume Reduction. Reduces the overall disposal volume of low-level waste by using a variety of treatment techniques. Volume reduction uses several different available technologies, including thermal destruction, compaction/supercompaction, size reduction, and evaporation/concentration. For low-level waste disposal, DOE evaluated the impacts associated with both shallow land burial and engineered disposal facilities.

Waste Acceptance Criteria (WAC). The requirements specifying the characteristics of waste and waste packaging acceptable to a waste receiving facility and the documents and processes the generator needs to certify that waste meets applicable requirements.

Waste Characterization. *See* **Characterization.**

Waste Generation. Any waste produced during a particular calendar year. This does not include waste produced in previous years that is being repacked, treated, or disposed of in the current calendar year. It does include any secondary waste (e.g., clothing, gloves, waste from maintenance operations) generated by treatment, storage, or disposal activities of previously generated wastes.

Waste Isolation Pilot Plant (WIPP). A facility in southeastern New Mexico being developed as the disposal site for transuranic and transuranic mixed waste, not yet in operation.

Waste Isolation Pilot Plant Land Withdrawal Act. A Federal statute (Public Law 102-579) that addresses issues associated with the Waste Isolation Pilot Plant (WIPP) as a disposal site for transuranic waste. Among other things, it withdraws the land comprising WIPP from usual public land laws and reserves it to the U.S. Department of Energy for uses associated with its being a disposal site for transuranic waste.

Waste Load. Inventory defined by waste type, current or to-be-generated, and/or physical or radiological characteristics, as the case may be. Expressed in a variety of units of weight, mass, volume, and/or activity, and sometimes specifying a treatment group.

Waste Management. The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated pollution prevention and surveillance and maintenance activities.

Waste Management Program. A U.S. Department of Energy (DOE) subprogram concerned with all aspects of waste management associated with radioactive and/or hazardous substances generated by DOE-owned facilities.

Waste Minimization. An action that economically avoids or reduces the generation of waste by source reduction, by reducing the toxicity of hazardous waste, by improving energy usage, or by recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

Waste Package. The waste, waste container, and any absorbent that are intended for disposal as a unit.

Waste Stream. A flow of waste materials with specific definable characteristics that remain the same throughout the life of the process generating the waste stream. A waste stream is produced by a single process or subprocess; however, that process or subprocess may be one that combines two or more input waste streams together to produce a single output waste stream.

Waste Type. The waste types being considered in this Programmatic Environmental Impact Statement are high-level waste, transuranic waste, low-level mixed waste, low-level waste, and hazardous waste (see specific waste type definitions).

Wastewater. Water that typically contains less than a 1% concentration of organic hazardous waste materials.

Wetland. Lands or areas exhibiting hydric soils, saturated, or inundated soil during some portion of the plant growing season, and plant species tolerant of such conditions (includes swamps, marshes, and bogs).

Worker, Facility. Any worker whose day-to-day activities are controlled by process safety management programs and a common emergency response plan associated with a facility or facility area. This definition includes any individual within a facility/facility area or its 0.6-kilometer (0.4-mile) exclusion zone. This definition can also include those transient individuals or small populations outside the exclusion zone but inside the radius defined by the maximally exposed collocated worker, if reasonable efforts to account for such people have been made in the facility or facility area emergency plan. For facility accident analyses, the facility worker is defined as an individual located 100 meters (328 feet) downwind of the facility location where an accidental release occurs.

Worker, Noninvolved. Workers on DOE sites who are not involved directly in waste management. In accident studies, these workers are assumed to be located some prescribed distance from the point of release.

Worker, Waste Management. Onsite employees working in a site's waste management facilities (e.g., treatment, storage, and disposal), including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste.

X-rays. Penetrating electromagnetic radiation with wavelengths shorter than those of visible light, usually produced by irradiating a metallic target with large numbers of high-energy electrons. In nuclear reactions, it is customary to refer to photons originating outside the nucleus as x-rays and those originating in the nucleus as gamma rays, even though they are the same.

CHAPTER 15
List of Appendices and Technical Reports

15.1 Appendices

The Waste Management Programmatic Environmental Impact Statement (WM PEIS) includes nine appendices. The following paragraphs include the letter designation and title of each of these appendices and provide a brief abstract of each.

Appendix A Public Comments to DOE's Proposed Revisions to the Scope of the WM PEIS

This appendix reproduces the Department's *Federal Register* notice of January 24, 1995 (in which the Department announced proposed modifications to the title and scope of the "Environmental Restoration and Waste Management PEIS"), and addresses the public's response to the notice. In summary, the Department proposed to eliminate the analysis of environmental restoration alternatives, focus primarily on the evaluation and analysis of waste management issues confronting the Department, and rename the analysis the "Waste Management PEIS."

Appendix B Environmental Restoration Wastes

This appendix provides an estimate of waste to be generated by environmental restoration activities throughout the DOE complex and discusses whether managing those potential waste loads would cause DOE management to make a different decision than would be made by the analysis of waste management wastes alone. The discussion focuses on the subset of environmental restoration wastes that will be transferred to the waste management program. The environmental restoration program generates low-level mixed, low-level, and transuranic wastes, all of which may affect the respective components of the waste management program. The environmental restoration program is not responsible for the management of high-level waste.

Appendix C Environmental Impacts Analysis Methods

This appendix describes the methods used to estimate costs and environmental impacts. It presents the methods in the context of the three-phase approach to the PEIS analysis. The appendix describes Phase-I of the analysis in which waste volumes and treatability groups are identified; treatment, storage, and disposal technologies and the engineering modules used to model those technologies are selected; and alternative-specific waste transportation requirements and waste loads are identified at each site, for each waste type. The appendix summarizes the outputs of the module-based engineering analysis produced in Phase II, which include discharges to the environment from treatment, storage, and disposal facilities; resource use and labor requirements; and facility and transportation costs. The appendix then describes in detail the impacts analysis methods that use the Phase II outputs to evaluate air quality, water resources, and ecological resources impacts, economic and social impacts, environmental justice concerns, and land use, infrastructure, and cultural resources impacts.

In accordance with the requirements of Executive Order 12898, DOE evaluated the potential for the WM PEIS program alternatives to cause disproportionately high and adverse human health or environmental effects to minority and low-income populations at the 17 major waste management sites and then reviewed the human health effects and environmental impacts associated with alternatives for the five waste types at those sites. This appendix provides the full details of the methods used to evaluate environmental justice impacts and presents maps showing the distribution of minority and low-income populations at the 17 sites. The maps are based on an analysis of 1990 U.S. Bureau of the Census files, which contain political boundaries, geographical features, and demographic information. Two sets of maps are provided, one for minority population distribution, and the other for low-income population distribution. Data were resolved to the census tract group level. Native American tribal lands located within 50 miles of each site also were identified and mapped. They are included where applicable with the minority population distribution maps.

Appendix D Waste Management Facility Human Health Risk Estimates

This appendix summarizes the human health impacts posed by stationary sources of waste at DOE waste management facilities. The purpose of this human health risk evaluation is to provide projections of the health risks posed by the waste consolidation options being considered for DOE waste management facilities in this WM PEIS. This information, in conjunction with other WM PEIS impacts (e.g., transportation risks,

ecological risks, air, water, and socioeconomic impacts) and costs, is intended to aid in determining the advantages and disadvantages of the various waste consolidation options.

Appendix E Radioactive and Hazardous Waste Transportation Risk Assessment

This appendix presents a summary of the transportation-related human-health risk assessment conducted for the WM PEIS and provides supplementary references to more detailed sources of information for all types of waste. The assessment of the risks associated with the transportation of radioactive waste is described in Part I. The risk assessment for the transportation of hazardous waste (HW) is described in Part II.

Transportation is an integral component of the alternatives being considered for each type of radioactive waste in the WM PEIS. For some alternatives, radioactive waste would be shipped among the DOE sites at various stages of the treatment, storage, and disposal process. The magnitude of the transportation-related activities varies with each alternative, ranging from minimal transportation for Decentralized approaches to significant transportation for some Centralized approaches. The human health risks associated with transporting various waste materials were assessed to ensure a complete appraisal of the impacts of each WM PEIS alternative being considered.

The transportation of radioactive waste and HW involves a risk to both crew members and members of the public. Part of this risk results from the nature of transportation itself, independent of the radioactive or hazardous characteristics of the cargo. These risks can be viewed as "vehicle-related" risks. On the other hand, the transportation of radioactive waste and HW may pose an additional risk because of the characteristics and potential hazards of the material itself. These risks are considered to be "cargo-related" risks. In this appendix, the risks to human health from both vehicle- and cargo-related causes are assessed.

Appendix F Treatment and Storage Facility Accidents

This appendix documents the methodology and computational framework for facility accident analyses performed for the WM PEIS. The output of the facility accident analyses is a specification for each waste type of the accidents potentially important to human health risk, an assessment of the frequencies of these accidents, and an evaluation of the radiological and chemical source terms resulting from these accidents.

A radiological source term is defined by specifying the amount (in curies) of each radionuclide released during an accident, where release is conservatively assumed to be instantaneous. A chemical source term is defined by specifying the rate and duration of release for each toxic chemical released during an accident. The frequencies of the accidents and the results of the source term evaluation are provided as input to the WM PEIS for calculations of the human health and risk impacts.

The methodology considers the spectrum of accident sequences that could occur in activities covered by the WM PEIS and uses a graded approach emphasizing the risk-dominant scenarios to facilitate discrimination among the various WM PEIS alternatives. Although it allows reasonable estimates of the risk impacts associated with each alternative, the main goal of the accident analysis methodology is to allow reliable estimates of the relative risks among the alternatives. Rather than developing all accident sequences in detail, the accident models are systematically applied to approximate the key source term parameters as a function of (1) the phenomenology and severity of the accident, (2) the process parameters, (3) the characteristics of the facility, and (4) the properties of the waste types. This allows many of the uncertainties in the data that are reflected in estimates of absolute risk to be canceled in estimates of relative risk providing a sufficient and scrutable basis for discriminating among alternatives.

Appendix G Pollution Prevention

DOE has a waste reduction policy that requires DOE sites to engage in waste minimization and pollution prevention and to have an established program for implementing this policy. The DOE Office of Waste Management (WM) is responsible for coordinating and consolidating this waste reduction policy. The purpose of this appendix is to discuss how DOE's associated programs and practices may affect the waste loads that WM facilities receive and, consequently, the need for the facilities. It contains estimates of reductions in waste loads, risks associated with WM activities, and WM costs resulting from these waste minimization practices.

Within DOE, the activities concerned are those that involve source reduction and recycling of all waste and pollutants, and include those practices that reduce or eliminate pollutants through increased efficiency in the use of raw materials, energy, water, or other resources, or the protection of natural resources by conservation. Source reduction means any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment before

recycling, treatment, or disposal; and any practice that reduces the hazards to public health and the environment associated with the release of such substance, pollutants or contaminants.

Appendix H Technology Development

This appendix addresses the potential impact of technology development on the alternatives being considered in the WM PEIS. The availability, and the projected availability, of appropriate technologies govern what can be cleaned up, how, and how soon. DOE's objective is to manage its waste with the greatest effectiveness, efficiency, and lowest tolerable risks to people (health, safety, jobs), as well as to the environment. In many cases, the development of new technologies presents the best hope for ensuring a substantial reduction in risk to the environment and improved safety for workers and the public within realistic financial constraints. This appendix outlines the developmental approach taken by DOE's Office of Environmental Management through its Office of Technology Development and discusses selected examples of emerging technologies that may influence the WM PEIS alternatives and/or mitigate the impact of associated activities.

The Office of Technology Development is responsible for managing an aggressive national program of applied research, development, demonstration, testing, and evaluation for environmental cleanup, waste management, and related technologies. This Technology Development (TD) Program undertakes a focused problem-oriented approach to have technologies available for use to support DOE's environmental management needs. The TD Program is designed to resolve major technical issues, to rapidly advance beyond current technologies for environmental restoration and waste management operations, and to expedite compliance with applicable environmental laws and regulations.

Appendix I Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW

DOE is characterizing the many types of waste at its facilities. Because information about the waste streams is continually being updated, DOE documents prepared at different times may contain different information on waste inventories and waste disposition. Since the initial preparation of the WM PEIS, DOE has issued updated information on several types of waste. This appendix addresses newly available data on LLW,

LLMW, and TRUW; potential impacts on the analyses of alternatives in the WM PEIS; and recommendations for reanalysis where critical to programmatic decision making.

15.2 Technical Reports

Technical reports provide detailed data and other background information developed in support of the WM PEIS and its appendices. These documents were produced as noted below by DOE's National Laboratories or by the contractor (META/Berger) that supported DOE in the development of the WM PEIS. The available documents are listed here, organized into major categories pertinent to the WM PEIS.

Waste Types, Technologies, and Source Terms

Argonne National Laboratory. 1996. *High-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by S.M. Folga, G. Conzelmann, J.L. Gillette, P.H. Kier, and L.A. Poch. ANL/EAD/TM-17. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Low-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by M.L. Goyette and D.A. Dolak. ANL/EAD/TM-20. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Transuranic Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by K.J. Hong, T.J. Kotek, S.M. Folga, B.L. Koebnick, Y. Wang, and C.M. Kaicher. ANL/EAD/TM-22. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Hazardous Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by M.A. Lazaro, A.A. Antonopoulos, M.P. Esposito, and A.J. Policastro. ANL/EAD/TM-25. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *WASTE_MGMT: A Computer Model for Calculation of Waste Loads, Profiles, and Emissions* by T.J. Kotek, H.I. Avci, and B.L. Koebnick. ANL/EAD/TM-30. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Information Related to Low-Level Mixed Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by B.D. Wilkins, D.A. Dolak, Y.Y. Wang, and N.K. Meshkov. ANL/EAD/TM-32. Aug. Argonne, IL.

Los Alamos National Laboratory. 1996. *Mixed-Waste Treatment Model: Basis and Analysis* by Bryon Palmer. LA-13041-M5. Sept. Los Alamos, NM.

Musgrave, B.C. 1995. *Analysis of Waste Treatment Requirements for DOE Mixed Waste - Technical Basis.* Feb. Livermore, CA: BC Musgrave, Inc.

Pacific Northwest Laboratory. 1995. *Description of Source Term Data on Contaminated Sites and Buildings Compiled for the Waste Management Programmatic Environmental Impact Statement (WM PEIS)* by S.M. Short, D.E. Smith, J.G. Hill, and M.E. Lerchen. PNL-10450, AD-940. Sept. Richland, WA.

Treatment, Storage, and Disposal Facility Accidents

Argonne National Laboratory. 1996. *Analysis of Accident Sequences and Source Terms at Waste Treatment and Storage Facilities for Waste Generated by U.S. Department of Energy Waste Management Operations* by C. Mueller, B. Nabelssi, J. Roglans-Ribas, S.M. Folga, and A. Policastro (ANL); W. Freeman, University of Illinois at Chicago; and R. Jackson, S. Turner, and J. Mishima (Science Applications International Corporation). ANL/EAD/TM-29. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Waste_ACC: A Computer Model for Analysis of Waste Management Accidents* by B.K. Nabelssi, S. Folga, E.J. Kohout, C.J. Mueller, and J. Roglans-Ribas. ANL/EAD/TM-52. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Analysis of Accident Sequences and Source Terms for Waste Treatment and Storage Operations and Related Facilities for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by S. Folga, C. Mueller, B. Nabelssi, E. Kohout, and J. Mishima. ANL/EAD/TM-53. Aug. Argonne, IL.

Transportation Risk

Argonne National Laboratory. 1996. *Risk Assessment for the On-Site Transportation of Radioactive Wastes for the Department of Energy Waste Management Programmatic Environmental Impact Statement* by B.M. Biwer, F.A. Monette, and S.Y. Chen. ANL/EAD/TM-18. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Risk Assessment for the Off-Site Transportation of High-Level Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, and S.Y. Chen. ANL/EAD/TM-21. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Information Related to Risk Assessment for the Off-Site Transportation of Low-Level Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, D.J. LePoire, and S.Y. Chen. ANL/EAD/TM-23. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Information Related to Risk Assessment for the Off-Site Transportation of Transuranic Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, D. LePoire, and S.Y. Chen. ANL/EAD/TM-27. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Risk Assessment for Transportation of Hazardous Waste and Hazardous Waste Components of Low-Level Mixed Waste and Transuranic Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by M.A. Lazaro, A.J. Policastro, H.M. Hartmann, A.A. Antonopoulos, D.F. Brown, W.E. Dunn, M.A. Cowen, Y.S. Chang, and B.L. Koebnick. ANL/EAD/TM-28. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Information Related to Risk Assessment for the Off-Site Transportation of Low-Level Mixed Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, D.J. LePoire, M.A. Lazaro, A.A. Antonopoulos, H.M. Hartmann, A.J. Policastro, and S.Y. Chen. ANL/EAD/TM-35. Aug. Argonne, IL.

Facility Human Health Risk

Oak Ridge National Laboratory. 1995. *DOE Public and Onsite Population Health Risk Evaluation Methodology for Assessing Risks Associated with Environmental Restoration and Waste Management.* ORNL-6832. April. Oak Ridge, TN: Center for Risk Management.

Oak Ridge National Laboratory. 1995. *DOE Worker Health Risk Evaluation Methodology for Assessing Risks Associated with Environmental Restoration and Waste Management*. ORNL-6833. May. Oak Ridge, TN: Center for Risk Management.

Oak Ridge National Laboratory. 1995. *Waste Management Programmatic Environmental Impact Statement Methodology for Estimating Human Health Risks Associated with Waste Management*. ORNL-6864. May. Oak Ridge, TN: Center for Risk Management.

Oak Ridge National Laboratory. 1996. *Supplemental Results of the Human Health Risk Analysis for the U.S. Department of Energy Draft Waste Management Programmatic Environmental Impact Statement*. ORNL-6867. July. Oak Ridge, TN: Center for Risk Management.

Oak Ridge National Laboratory. 1995. *Ecological Risks of the Department of Energy's Programmatic Waste Management Alternatives* prepared by Oak Ridge National Laboratory, Environmental Sciences Division and Advanced Sciences, Incorporated. Aug. Oak Ridge, TN.

Environmental and Socioeconomic Impacts

U.S. Department of Energy. 1996. *Waste Management Environmental and Socioeconomic Impacts Methods and Results* prepared by META/Berger. M/B SR-02. Washington, DC: Office of Environmental Management.

Treatment Alternatives for LLMW

U.S. Department of Energy. 1996. *Impacts from Use of an Alternative Organic Treatment Technology in the Waste Management Programmatic Environmental Impact Statement* prepared by META/Berger. M/B SR-03. Washington, DC: Office of Environmental Management.

Costs

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Mixed Low-Level Waste* by D.E. Shropshire, Michael Sherick, and Chuck Biagi. INEL-95/0014, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Transuranic Waste* by D.E. Shropshire, Michael Sherick, and Chuck Biagi. INEL-95/0015, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Hazardous Waste* by D.E. Shropshire, Michael Sherick, and Chuck Biagi. INEL-95/0016, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Low-Level Waste* by D.E. Shropshire, Michael Sherick, and Chuck Biagi. INEL-95/0013, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Transportation of Radioactive and Hazardous Materials* by F.H. Feizollahi, D.E. Shropshire, and D. Burton. INEL-95/0300, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1996. *Life-Cycle Costs and FTE for the Department of Energy's Waste Management Programmatic Environmental Impact Statement* by M. J. Sherick and D.E. Shropshire. INEL-95-0127. Idaho Falls, ID.

Affected Environment

Oak Ridge National Laboratory. 1995. *Programmatic Environmental Impact Statement Installation Descriptions*. ORNL-6841. Oak Ridge, TN: Center for Risk Management.

U.S. Department of Energy. 1996. *Technical Report on Affected Environment for the DOE Sites Considered in the DOE Waste Management Programmatic Environmental Impact Statement (WM PEIS)* prepared by META/Berger. M/B SR-01. Washington, DC: Office of Environmental Management.

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Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

Volume II of V

DOE/EIS-0200-F

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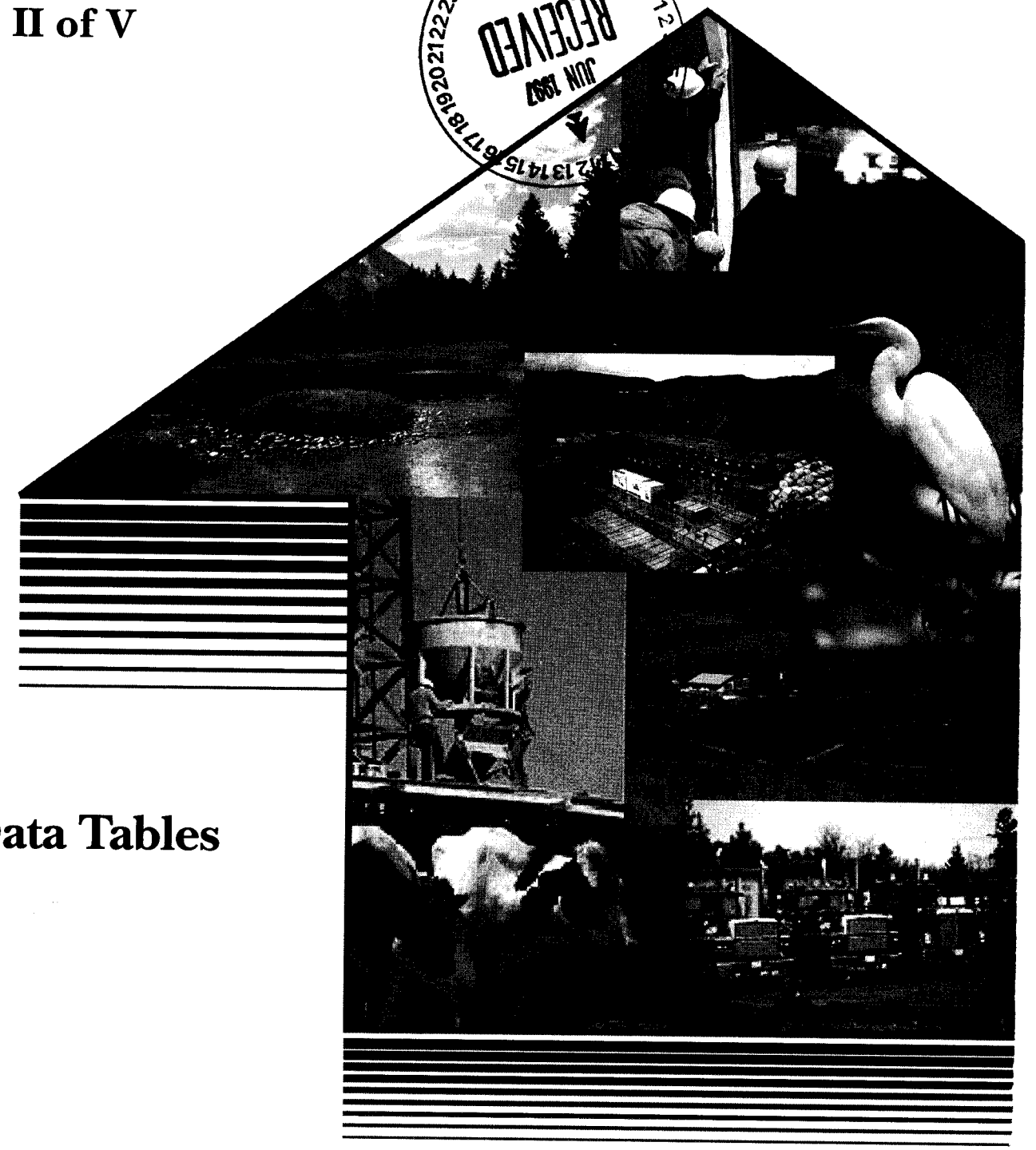

Site Data Tables

DOE/EIS-0200-F

FINAL
WASTE MANAGEMENT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
for
Managing Treatment, Storage, and Disposal of
Radioactive and Hazardous Waste

Volume II of V

Site Data Tables

U.S. Department of Energy
Office of Environmental Management
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Washington, DC 20585

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SITE DATA TABLES

II.1.0 Introduction

Volume II is an integral part of the Office of Environmental Management's (EM's) Waste Management Programmatic Environmental Impact Statement (WM PEIS), which portrays the impacts of EM's waste management activities at each of the 17 major DOE sites evaluated in the WM PEIS.

II.1.1 Scope

Impacts are displayed for each of the 17 major sites in tabular form as a complement to the impact discussions in waste-type Chapters 6 through 10 (see Table II.1.1). The chapters present background information on each waste type, volume data, existing capacities for managing the wastes, and assumptions used in the waste-type analysis. Readers should refer to these chapters and to Chapter 5, "Impact Analysis Methodologies," for a more thorough discussion of the methodologies, assumptions and definitions associated with these impacts. A synopsis of key definitions and assumptions is also presented at the rear of this introductory section.

Table II.1-1. Waste-Type Chapters

Chapter 6	Impacts of the Management of Low-Level Mixed Waste
Chapter 7	Impacts of the Management of Low-Level Waste
Chapter 8	Impacts of the Management of Transuranic Waste
Chapter 9	Impacts of the Management of High-Level Waste
Chapter 10	Impacts of the Management of Hazardous Waste

Sites were evaluated only when the sites were considered as potential treatment, storage, and/or disposal locations for a given waste type. Not all sites were involved in the alternatives for all waste types. Table II.1-2 presents waste types considered for treatment, storage and/or disposal at the 17 major sites.

Table II.1-2. Waste Types Considered for Treatment, Storage and/or Disposal at Major DOE Sites

SITES	LLMW	LLW	TRUW	HW	HLW
1. ANL-E	x	x	x		
2. BNL	x	x			
3. FEMP	x	x			
4. HS	x	x	x	x	x
5. INEL	x	x	x	x	x
6. LANL	x	x	x	x	
7. LLNL	x	x	x		
8. NTS	x	x	x		
9. ORR	x	x	x	x	
10. PGDP	x	x	x		
11. Pantex	x	x			
12. PORTS	x	x			
13. RFETS	x	x	x		
14. SNL-NM	x	x	x		
15. SRS	x	x	x	x	x
16. WIPP			x		
17. WVDP	x	x			x

1. Argonne National Laboratory-East (Illinois)
2. Brookhaven National Laboratory (New York)
3. Fernald Environmental Management Project (Ohio)
4. Hanford Site (Washington)
5. Idaho National Engineering Laboratory (Idaho)
6. Los Alamos National Laboratory (New Mexico)
7. Lawrence Livermore National Laboratory (California)
8. Nevada Test Site (Nevada)
9. Oak Ridge Reservation (Tennessee)
10. Paducah Gaseous Diffusion Plant (Kentucky)
11. Pantex Plant (Texas)
12. Portsmouth Gaseous Diffusion Plant (Ohio)
13. Rocky Flats Plant (Colorado)
14. Sandia National Laboratory- Albuquerque (New Mexico)
15. Savannah River Site (South Carolina)
16. Waste Isolation Pilot Plant (New Mexico)
17. West Valley Demonstration Plant (New York)

Fifteen impact categories were analyzed; however, they do not apply to all wastes types, as shown in Table II.1-3 below.

Table II.1-3. Impact Categories Associated With the Waste Types

Impact Category		LLMW	LLW	TRUW	HW	HLW
1.	Treatment and Disposal (LLMW & LLW), Treatment (TRUW, HW), or Storage (HLW): Estimated Number of Fatalities	x	x	x	x	x
2.	Treatment (LLMW, LLW, TRUW, HW) or Storage (HLW): Estimated Number of Cancer Incidences and Genetic Effects	x	x	x	x*	x
3.	Disposal: Estimated Number of Cancer Incidences and Genetic Effects	x	x			
4.	Treatment and Disposal (LLMW & LLW) or Treatment (TRUW): MEI Probability of Cancer Fatality	x	x	x		
5.	Treatment and Disposal (LLMW & LLW) or Treatment (TRUW): MEI Probability of Cancer Incidences and Genetic Effects	x	x	x		
6.	Treatment and Disposal (LLMW) or Treatment (TRUW, HW): Noncancer Health Risk from Chemical Exposure	x		x	x	
7.	Emissions in tons per year of criteria pollutants	x	x	x	x	x
8.	Percent standard/guide of criteria pollutants	x	x	x	x	x
9.	Percent standard/guideline for hazardous air pollutants and toxic air pollutants	x	x	x	x	x
10.	Impacts on Water Resources Due to Increased Water Use	x	x	x	x	x
11.	Radionuclide Concentration in Ground Water (Percent of Comparison Criteria) for Disposal (Contact and Remote Handled)	x	x			
12.	Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact and Remote Handled)	x				
13.	Socioeconomics Impacts	x	x	x	x	x
14.	Infrastructure Impacts	x	x	x	x	x
15.	Cost	x	x	x	x	x

* Cancer incidences only.

II.1.2 General Description of Table Formats

Sections II.2 through II.18 present the impacts of managing radioactive and hazardous wastes at each of the 17 major sites. Typical sections are subdivided by waste type, then by impact category. Impacts are presented in the form of tables for applicable impact categories and sites. Each of these tables provides a comparative analysis: displaying the magnitude of a given impact for each of the alternatives analyzed by this PEIS. [These alternatives are described in detail in Chapter 3 as well as in the specific waste-type chapters (see Table II.1-1)].

When reviewing the impacts and costs identified for the No Action Alternative for LLMW and TRUW, it is important to realize that the results for indefinite storage of those waste types are based on the initial 20 years of that indefinite period. This is consistent with the period of analysis for the other alternatives; however, not shown are the impacts from storage expected beyond this 20-year time frame. The longer term storage impacts and costs are likely to exceed those for the first 20 years, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of LLMW and TRUW, where risks to workers and the offsite population, and other impacts and costs, are reduced following disposal. The No Action Alternative does not reduce or avoid impacts and costs; rather it causes impacts and costs to be experienced every year for an indefinite period of time. A discussion of the longer term impacts expected for indefinite storage of LLMW can be found in Section 6.16 of Chapter 6, Volume I. A brief discussion of the longer term effects of storage of TRUW can be found in Section 8.3.1 of Chapter 8, Volume I, with a more detailed assessment in the *Waste Isolation Pilot Plant Disposal Phase Draft Supplemental II Environmental Impact Statement* (DOE/EIS-0026-S-2).

It should also be noted that the No Action Alternative for HLW does not provide enough canister storage capacity for all of the canisters that would be produced after treatment of HLW. Provision of adequate storage would lead to costs and impacts as great as shown for the other HLW alternatives. A discussion of the assumptions made to address this shortage of storage capacity in the HLW analyses is contained in Section 9.3.1 of Chapter 9, Volume I.

Impact tables are often further subdivided to present impacts associated with the treatment of waste versus those associated with the disposal of waste. A glossary is provided in Volume I for acronyms and selected terms appearing under these two major headings in the tables. Also in Volume I, Chapter 5 provides a detailed explanation of each of the 14 impact categories.

The site tables that present information for LLMW and LLW include two columns, one labeled with a T for Treatment and the other labeled with a D for Disposal. The information in these two columns represents, for the alternative concerned, the number of sites that are treating LLMW or LLW, and the number of sites disposing LLMW or LLW.

The site tables that present information for TRUW include three columns, one labeled CH Treat, the next labeled RH Treat, and the third labeled Treat STD (treatment standard). The information in these three columns represents, for the alternative concerned, the number of sites treating contact-handled TRUW, the number of sites treating remote-handled TRUW, and the treatment standard that the sites are using (i.e., to meet current waste acceptance criteria at WIPP (WIPP WAC), or to reduce the potential for gas generation after disposal, or to meet land disposal restrictions (LDRs) under the Resource Conservation and Recovery Act).

The site tables that present information for HLW include a column that is labeled with an S for Storage. The information in this column represents, for the alternative concerned, the number of sites storing HLW.

The site tables that present information for HW include a column that is labeled with a T for Treatment. The information in this column represents, for the alternative concerned, the number of sites treating HW.

II.1.3 Description of Health Risk Data Tables

Background

Health risk impacts can result from exposure to radiation and chemicals and from physical trauma associated with constructing and operating treatment, storage and/or disposal facilities or transporting waste. Health effects resulting from radiation exposure, whether from sources external or internal to the body, can affect either the exposed individual (known as "somatic" effects, such as cancer) or descendants of the exposed individual (known as "genetic" effects). Chapter 5 of Volume I provides additional information about the methodologies and assumptions used in the health risk analysis.

The WM PEIS evaluated potential health risks to a number of receptor populations and individuals including:

- The offsite population—those individuals living within an 80 km (50-mile) radius of the site, as well as along transportation routes
- Noninvolved workers population—the workers on DOE sites who are not involved directly in waste management activities
- Waste management workers population (or "waste management workers")—onsite employees working in an installation's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste
- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose
- Hypothetical farm family most exposed lifetime MEI—hypothetical individual in the most exposed lifetime of the farm family who would receive the highest dose from groundwater contamination following disposal of LLW and LLMW

- A hypothetical intruder—an individual who would experience maximum potential risks from direct contact with disposed LLW and LLMW upon the loss of institutional control. The hypothetical intruder risks are not reported in Volume II Site Data Tables; see Chapters 6 and 7 of Volume I for this information.

- A waste management worker—an individual who would experience potential noncancer effects, as estimated using the Exposure Index, following exposure to the hazardous chemical constituents of LLMW, TRUW, and HW.

Population impacts focus on the *total number* of people in each population who would experience adverse health impacts if a particular alternative is implemented. Individual impacts focus on the *probability* (e.g., one-in-one million) that the individual would experience an adverse health impact over his or her lifetime.

The types of potential health impacts evaluated include:

- Fatalities from physical hazards

- Latent cancer fatalities from radiation exposure

- Cancer incidences from radiation or chemical exposure

- Genetic effects from radiation exposure

- Noncancer effects from chemical exposure (e.g., headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

The WM PEIS did not estimate the incidence of nonfatal cancers from exposure to radionuclides. However, the number of nonfatal cancers can be derived from the total cancer incidence estimates by subtracting the estimated number of fatal cancer cases. Note that both the total cancer incidence and the nonfatal cancer incidence values are overestimated by factor of about two because the estimates contain a relatively large component of skin cancers. The International Commission on Radiological Protection (ICRP) dose conversion factor (see "Interpreting the Health Risk Tables") used in the WM PEIS to estimate total cancer incidence includes incidences of skin cancer. However, the internal exposure pathways evaluated in the WM PEIS (i.e., inhalation or ingestion of radionuclides) are not likely to induce large numbers of skin cancer cases.

Data in the risk tables are presented in scientific notation; see Table II.1-4 for an explanation of this format.

Table II.1-4. Scientific Notation and "E" Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10	*Negative Powers of 10*
$10^1 = 10 \times 1 = 10$	$10^1 = 1/10 = 0.1$
$10^2 = 10 \times 10 = 100$	$10^2 = 1/100 = 0.01$
and so on, therefore,	*and so on, therefore,*
$10^6 = 1{,}000{,}000$ *(or 1 million)*	$10^6 = 0.000001$ *(or 1 in 1 million)*

A power of 10 is also commonly expressed as "E," where "E" means "x 10." For example, 3×10^5 *can also be written as 3E+05, and* 3×10^{-5} *is equivalent to 3E-05. Therefore, 3E+05=300,000 and 3E-05=0.00003.*

The health risk data in this volume use "E" notation with negative exponents. An important value for relative comparison of health risk probability estimates is the number "1 in 1 million." This value appears in the data tables as "1E-06." It can also be expressed as 1×10^{-6}*, and is equivalent to 0.000001, or 1/1,000,000.*

Tables II.1-5 and II.1-6 provide indices for the health risk information contained in the Volume II Site Data Tables. Interpreting the results of the health risk analyses involves consideration of both uncertainties and appropriate standards. See Chapter 5 of Volume I for a further discussion of these issues.

The Volume II Site Data Tables are organized by waste type. Table II.1-5 indicates the health risk endpoint/population receptor combinations that were evaluated for each waste type. Table II.1-6 presents similar information for individual receptors.

Table II.1-5. Crosswalk of Health Risk Information for Receptor Populations Contained in Volume II Site Data Tables

Receptors	Health Risk Endpoints				
	Number of Radiation Cancer Fatalities	**Number of Physical Trauma Fatalities**	**Number of Radiation Cancer Incidences**	**Number of Chemical Cancer Incidences**	**Number of Radiation Genetic Effects**
Offsite Population	LLMW, LLW, TRUW	NA	LLMW, LLW, TRUW	LLMW, TRUW, HW	LLMW, LLW, TRUW
Noninvolved Workers	LLMW, LLW, TRUW	NA	LLMW, LLW, TRUW	LLMW, TRUW, HW	LLMW, LLW, TRUW
WM Workers	LLMW, LLW, TRUW, HLW	LLMW, LLW, TRUW, HLW, HW	LLMW, LLW, TRUW, HLW	LLMW, TRUW, HW	LLMW, LLW, TRUW, HLW

NA = not applicable.

Table II.1-6. Crosswalk of Health Risk Information for Receptor Individuals Contained in Volume II Site Data Tables

Receptors*	Health Risk Endpoints				
	Radiation Cancer Fatality Probability	**Radiation Cancer Incidence Probability**	**Chemical Cancer Incidence Probability**	**Radiation Genetic Effects Probability**	**Noncancer Effects (Hazard Index/ Exposure Index)**
Offsite MEI	LLMW, LLW, TRUW	LLMW, LLW, TRUW	LLMW, TRUW, HW	LLMW, LLW, TRUW	LLMW, TRUW, HW
Noninvolved Worker MEI	LLMW, LLW, TRUW	LLMW, LLW, TRUW	LLMW, TRUW, HW	LLMW, LLW, TRUW	LLMW, TRUW, HW
WM Worker	NA	NA	NA	NA	LLMW, TRUW, HW
Hypothetical Farm Family MEI (most exposed lifetime)	LLMW, LLW	LLMW, LLW	LLMW	LLMW, LLW	LLMW

*Volume II risk tables do not contain results for the Hypothetical Intruder. See Chapters 6 and 7 of Volume I and Appendix D in Volume II for results for this receptor (LLMW and LLW only).
NA = not applicable.

Table II.1-7 provides a summary of the exposure pathways evaluated for treatment, storage and disposal activities.

Table II.1-7. Exposure Pathways for Treatment, Storage, Transportation, and Disposal Activities

Waste Processing Phase	Pathway	Potentially Exposed Populations and Individuals
Treatment • Routine emissions	Atmospheric • Inhalation • Ingestion of crops and animals Direct Radiation	• Public within 50-mile radius • Onsite employees, evenly distributed within site borders (atmospheric only) • Onsite MEI (atmospheric only) • Offsite MEI (atmospheric only) • Waste management worker (inhalation and direct radiation only)
Storage • Routine emissions	Atmospheric • Inhalation • Ingestion of crops and animals Direct Radiation	• Public within 50-mile radius • Onsite employees, evenly distributed within site borders (atmospheric only) • Onsite MEI (atmospheric only) • Offsite MEI (atmospheric only) • Waste management worker (inhalation and direct radiation only)
Disposal • Routine emissions	Atmospheric • Inhalation Groundwater • Ingestion of drinking water • Irrigation of crops • Watering of livestock • Bathing Direct Radiation	• Waste management worker (atmospheric and direct radiation during disposal operations only) • Hypothetical farm family (ingestion of groundwater and food) • Hypothetical intruder (ingestion of crops and soil, inhalation of soil particulates, direct radiation)

Interpreting the Health Risk Tables

This section provides some examples of the types of health risk tables found in this volume and describes how the data should be interpreted using the following series of tables for management of LLMW. Table II.1-8 presents information on the estimated number of fatalities resulting from treatment and disposal of LLMW for several receptor groups (i.e., Waste Management Workers, Offsite Population, Noninvolved Workers). Since each of these receptor groups contains multiple individuals, the estimated health risks are presented as the number of potential adverse health effects in each population. For example, under the "Treatment" heading, "Waste Management Workers" are the first receptor group listed. Under the "Waste Management Workers" heading, the column entitled "Radiation Exposure" contains the estimated number of latent cancer fatalities resulting from radiation exposure of waste management workers.

Table II.1-8. LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure	WM Worker	
	T	D	Radiation Exposure	Physical Hazards			Radiation Exposure	Physical Hazards
No Action	3	--	4.4E-02	9.1E-02	2.6E-02	1.2E-04	NA	NA
Decentralized	37	16	1.9E-02	2.1E-01	1.3E-03	6.1E-06	1.24E-02	3.91E-02
Regionalized-1	11	12	1.0E-02	4.7E-02	6.0E-06	2.8E-08	NA	NA
Regionalized-2	7	6	1.0E-02	4.7E-02	6.0E-06	2.8E-08	NA	NA
Regionalized-3	7	1	1.0E-02	4.7E-02	6.0E-06	2.8E-08	NA	NA
Regionalized-4	4	6	1.0E-02	4.7E-02	6.0E-06	2.8E-08	NA	NA
Centralized	1	1	1.0E-02	4.7E-02	6.0E-06	2.8E-08	NA	NA

Notes: T = treatment; D = disposal; -- = disposal of LLMW is not considered for this alternative; NA = not applicable.

Waste management workers are assumed to be exposed to direct radiation during the 10-year operational lifetime of the treatment facility. However, radiation-induced latent cancer fatalities are estimated over the entire 70-year lifetime of the workers since a fatal cancer could occur throughout the lifetime of exposed workers. The numbers in this column are all less than one, ranging from 0.01 to 0.044. These values mean that less than one worker cancer fatality is estimated to result from direct radiation exposure received during treatment of LLMW under each of the waste management alternatives at this site. The data listed under the column headings "Offsite Population Radiation Exposure" and "Noninvolved Workers Radiation Exposure", as well as the column labeled "Waste Management Workers Radiation Exposure" under the "Disposal" heading can be interpreted in a similar manner.

The columns labeled "Physical Hazards" for waste management workers list the estimated numbers of worker fatalities resulting from physical trauma encountered during construction and operation of the treatment and disposal facilities. These values were estimated using an assumed 10-year period for facility construction followed by a 10-year period of operation.

Similar types of population level impact tables present estimates of the number of cancer and genetic effects in various receptor groups, as shown in Table II.1-9 below.

Table II.1-9. LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	--	5.2E+01	8.8E-02	3.8E-04	5.2E-03	2.5E-01	4.2E-04	7.9E-06	2.5E-05	1.1E+02	1.6E-01	2.2E-06	6.7E-03
Decentralized	37	16	2.6E+00	4.5E-03	1.8E-05	2.6E-04	1.2E-02	2.1E-05	3.7E-07	1.2E-06	4.8E+01	6.7E-02	2.2E-04	2.9E-03
Regionalized-1	11	12	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03
Regionalized-2	7	6	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03
Regionalized-3	7	1	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03
Regionalized-4	4	6	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03
Centralized	1	1	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03

Notes: T = treatment; D = disposal; -- = disposal of LLMW is not considered for this alternative.

This table represents estimates of the radiation doses received by the receptor groups as well as the number of cancer incidences and genetic effects. Note that radiation dose estimates for populations are presented in the tables in units of "person-rem," which is the sum of the radiation dose, measured in units of rems, received by each individual in the receptor group. Numbers of adverse health effects are estimated based on the application of risk factors to the dose estimates produced by the models used in the analysis. The risk factors used, listed below, are from the International Commission on Radiological Protection (ICRP) published in 1990:

Endpoint	Risk Factors for Public Receptors	Risk Factors for Workers
Cancer incidence	0.0017/rem-lifetime	0.0014/rem-lifetime
Cancer fatality	0.0005/rem-lifetime	0.0004/rem-lifetime
Genetic effects	0.0001/rem-lifetime	0.00006/rem-lifetime

For example, for the "Offsite Population," under the No Action Alternative, the estimated dose is 52 person-rem. Multiplying this value by the cancer incidence risk factor for public receptors of 0.0017 cancer/rem-lifetime listed above produces the estimate of 0.088 cancers listed in the table. For "Waste Management Workers," under the Decentralized Alternative, the estimated dose is 48 person-rem. Multiplying this dose by the genetic effects risks factor for workers of 0.00006 genetic effects/rem-lifetime listed above produces the estimate of 2.9E-03 listed in the table. Similar calculations can be made using the dose estimates and the appropriate cancer fatality risk factor to obtain the radiation fatality values listed in Table II.1-8. Note that slight differences in values are due to rounding and that the risk factors for public receptors were used to calculate risks for the "Noninvolved Workers". Also note that the risk factors presented above are used only in converting radiation doses to estimates of adverse health effects; the chemical cancer incidence values listed in the table are calculated in a different manner (see Chapter 5 of Volume I and Appendix D for additional information).

The WM PEIS also evaluated health risk impacts to hypothetical individuals estimated to experience the maximum exposure (i.e., the maximally exposed individual, or MEI) within the offsite population and noninvolved worker receptor groups (for treatment) and the most exposed lifetime of the farm family (for disposal). Table II.1-10 is an example of an MEI table that presents data on cancer fatality probabilities resulting from treatment and disposal. Since the MEI receptors are by definition single individuals, the risk estimates are *probabilities* that the MEI within each receptor population would experience an adverse health impact. Chapter 5 of Volume II contains a discussion of risk benchmarks that may be helpful in interpreting the risk probability estimates. Note that the MEI radiation exposure estimates are presented in units of "rem." Similar tables present information on probabilities of cancer incidence and genetic effects.

Table II.1-10 is an example of an MEI table that presents data on cancer fatality probabilities resulting from treatment an disposal.

Table II.1-10. LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	--	1.4E-07	1.2E-07	NA
Decentralized	37	16	7.2E-09	6.1E-09	8.5E-05
Regionalized-1	11	12	3.3E-11	2.8E-11	NA
Regionalized-2	7	6	3.3E-11	2.8E-11	NA
Regionalized-3	7	1	3.3E-11	2.8E-11	NA
Regionalized-4	4	6	3.3E-11	2.8E-11	NA
Centralized	1	1	3.3E-11	2.8E-11	NA

Notes: T = treatment; D = disposal; MEI = maximally exposed individual; -- = disposal of LLMW is not considered for this Alternative; NA = not applicable.

Table II.1-11 is an example of a table that presents noncancer health risk data. Noncancer health risk estimates are for single individuals and result from exposure to chemicals that are not believed to cause cancer. The data presented in the table are index values rather than probabilities. Both the Hazard Index (for the Offsite population MEI, Noninvolved Worker MEI, and the Hypothetical Farm Family Most Exposed Lifetime MEI) and the Exposure Index (for the WM Worker) are ratios of concentrations. They compare the estimated exposure concentrations of chemicals to concentrations thought to be protective of health (i.e., concentrations that should not produce adverse health effects upon prolonged exposure). If the index or ratio values exceed 1, there is a potential for adverse noncancer health effects. Values below 1 indicate that adverse noncancer health effects are not of concern. Since the values in Table II.1-11 are less than 1, these receptors are not at risk for adverse noncancer health effects under the waste management alternatives evaluated at this site.

Table II.1-11. LLMW—Noncancer Health Risk for Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	--	2.7E-06	8.1E-06	4.7E-06	NA
Decentralized	37	16	1.8E-07	5.4E-07	6.0E-04	5.5E-01
Regionalized-1	11	12	1.2E-09	3.5E-09	4.7E-06	NA
Regionalized-2	7	6	1.2E-09	3.5E-09	4.7E-06	NA
Regionalized-3	7	1	1.2E-09	3.5E-09	4.7E-06	NA
Regionalized-4	4	6	1.2E-09	3.5E-09	4.7E-06	NA
Centralized	1	1	1.2E-09	3.5E-09	4.7E-06	NA

Notes: T = treatment; D = disposal; MEI = maximally exposed individual; -- = Disposal of LLMW is not considered for this alternative; NA = not applicable.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

II.1.4 Description of Air Quality Data Tables

DOE evaluated air quality impacts at each proposed waste management site on the basis of estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (which include radionuclides), and toxic air pollutants. Pollutant emission estimates were made for the construction, and operations and maintenance (O&M) activities of waste management facilities.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where criteria air pollution standards are not met (known as "nonattainment areas"), activities that introduce new sources of emissions from both "stationary" (e.g., treatment, storage, and/or disposal facilities) and mobile (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria pollutant for nonattainment areas. A Federal entity that seeks to engage in an activity that will result in emissions equal to or greater than those limits in a nonattainment area, in addition to obtaining a New Source Review permit, must also conduct a formal conformity determination.

In "attainment areas" (where criteria air pollution standards are met), new and existing sources of emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A PSD permit is required for a new stationary source that equals or exceeds the allowable increase. A PSD permit is not required for criteria pollutant emissions from mobile sources.

Major Types of Air Pollutants

Criteria Air Pollutants: *carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 microns in diameter (PM_{10})*

Hazardous Air Pollutants: *189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

Toxic Air Pollutants: *Other toxic compounds regulated by EPA and state or local governments*

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site. Both are considered to be "mobile sources." Criteria air pollutants are also emitted during the O&M of waste management facilities (stationary sources) and by vehicles that are driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas). Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared with the National Ambient Air Quality Standards (NAAQS) (40 CFR 50).

Thermal treatment of waste will also result in emission of small quantities of hazardous and toxic air pollutants. Hazardous air pollutants, other than radionuclides, and toxic air pollutants were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits. Radionuclides from air emissions were evaluated by comparing the annual radiation dose to a maximally exposed individual (MEI) with the National Emissions Standards for Hazardous Air Pollutants—10 millirems per year (mrem/yr) (40 CFR 61).

Volume II contains three air quality tables for each site, for each waste type. The first is similar to example Table II.1–12 provided below, and shows the emissions of criteria air pollutants in tons per year for construction and operations. For construction, the table includes total emissions, and in parenthesis, emissions from construction equipment exhaust and worker vehicles. For operations, the table includes total emissions, and in parenthesis, emissions from stationary-sources (waste management facilities), and mobile-sources (worker and waste shipment vehicles).

Table II.1–12. Emissions in Tons per Year of Criteria Air Pollutants

Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO_2	Pb	PM_{10}	SO_2	VOC	CO	NO_2	Pb	PM_{10}	SO_2	VOC
No Action	3	--	12(1/11)	5(3/2)	0	0	0	2(1/1)	9(1/8)	4(2/2)	0	0	0	1((0/1)
Decentralized	37	16	58(5/53)	24(13/11)	0	1(1/0)	1(1/0)	7(1/6)	50(0/50)	15(5/10)	0	3(3/0)	0	6(0/6)
Regionalized	11	12	70(5/65)	25(12/13)	0	1(1/0)	1(1/0)	9(1/8)	52(1/51)	15(5/10)	0	4(4/0)	0	6(0/6)
Centralized	1	1	93(25/68)	99(44/54)	0	6(5/1)	6(6/0)	38(6/32)	93(3/90)	75(33/42)	0	23(22/1)	2(2/0)	25(0/25)

Notes: T = treatment; D = disposal; -- = disposal is not considered for this alternative. VOC = volatile organic compounds; CO = carbon monoxide; NO_2 = nitrogen dioxide; Pb = lead; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide. Emissions <1 ton per year are shown as zeros.
(1) Values = total emissions (equipments emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emissions).

The second table is similar to example Table II.1-13 provided below, and shows the percentage of applicable tons per year standards for emissions listed in the first table. The second table also shows the percentage of applicable National Ambient Air Quality Standards (NAAQSs) for criteria air pollutant concentrations due to releases from incineration. Double dashes are used to show where information is not applicable or not available.

Table II.1-13. Percent of Standard/Guidelines for Criteria Air Pollutants

Alternatives	Number of Sites		Construction: Percent of Tons/Year General Conformity Rule (1)						Operations & Maintenance: Percent of Tons/Year Standard or Guideline (2)						Operations & Maintenance: Percent of NAAQS Concentration (3)					
	T	D	CO	NO_2	Pb	PM_{10}	SO_2	VOC	CO(4)	NO_2(4)	Pb(4)	PM_{10}(5)	SO_2(4)	VOC(4)	CO	NO_2	Pb	PM_{10}	SO_2	VOC
No Action	3	--	NA	NA	NA	0	NA	NA	1	4	0	5(1/4)	0	0	NA	NA	NA	NA	NA	NA
Decentralized	37	16	NA	NA	NA	3(2/1)	NA	NA	1	12	0	4(1/3)	1	0	0	0	0	0	0	0
Regionalized	11	12	NA	NA	NA	3(2/1)	NA	NA	1	13	0	10(2/8)	1	0	0	0	0	0	0	0
Centralized	1	1	NA	NA	NA	12(11/7)	NA	NA	3	82	1	25(5/20)	5	1	0	0	0	0	2	0

Notes: T = treatment; D = disposal; -- = disposal is not considered for this alternative; NA = not applicable; PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule. CO = carbon monoxide. NO_2 = nitrogen dioxide. Pb = lead. PM_{10} = particulate matter less than 10 microns in diameter. SO_2 = sulfur dioxide. VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard. Percentages <1% are shown as zeros.
(1) GCR de minimis levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the No Action and minimum treatment (no incineration) alternatives are assumed to be negligible.
(4) Attainment area for this pollutant; therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant; therefore GCR de minimis levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).

The final table is similar to example Table II.1-14 provided below, and shows the percentages of the applicable concentration standards for hazardous and toxic air pollutants. The percentages of the 10 mrem per year total dose standard for the air pathway under the National Emissions Standards for Hazardous Air Pollutants (NESHAP) are also included in this table.

Table II.1-14. Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

Alternatives	Number of Sites		Operations & Maintenance						
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form
No Action	3	--	0	0	0	NA	NA	0	NA
Decentralized	37	16	0	0	0	NA	NA	0	NA
Regionalized	11	12	0	0	0	NA	NA	0	NA
Centralized	1	1	1	0	0	NA	NA	0	NA

Notes: T = treatment; D = disposal;
-- = disposal is not considered for this alternative; NA = not applicable.
Percentages <1% are shown as zeros.

II.1.5 Description of Water Resources Data Tables

DOE evaluated the effects on water availability from building and operating treatment, storage and disposal facilities. Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of waste management facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite water body at a given site. Volume II tables identify projected water usage under any alternative.

In addition, DOE evaluated the impacts to groundwater quality caused by the migration of radionuclides and chemicals that leach from LLMW and LLW disposal facilities over time. DOE calculated concentrations of radionuclides and hazardous components at a hypothetical well located 300 meters from the center of the disposal facility, and compared these to DOE or EPA drinking water standards. For radionuclides, most of the allowable drinking water concentrations equate to a 4 mrem per year effective dose equivalent.

The drinking water standards are used as comparison criteria for groundwater quality. Although they are not enforceable standards, they are often used as goals for contaminated site cleanup actions under the Comprehensive Environmental Response, Compensation and Liability Act. DOE and EPA established these criteria to protect human health, therefore groundwater concentrations of radionuclides and chemicals at or below these levels present a low risk.

The concentrations of hazardous constituents in the groundwater from disposal of LLMW are largely due to assumptions on the routing of wastes through the treatment system. As shown in the LLMW flow diagram in Chapter 6 (Figure 6.2-1), some wastes containing solvents were assumed to bypass the thermal treatment processes. The solvents in these wastes were not destroyed, but instead, ended up in the disposal facility. Some of these wastes contain solvents in large enough concentrations to cause drinking water standards to be exceeded when the wastes are disposed. In practice, LLMW to be disposed would meet EPA standards for treatment and disposal, and therefore should not produce major impacts to groundwater quality. Therefore, although the absolute values of the results for hazardous constituent contamination in groundwater are higher than would result from wastes treated to EPA standards, the results are still useful in showing the relative suitability of the sites. Even with the conservative assumptions used in the WM PEIS, drinking water standards were not exceeded at some sites. This may indicate that these sites are better for LLMW disposal than other sites.

The performance of disposal facilities at a specific site would be evaluated in greater detail in DOE's Performance Assessment process under DOE Order 5820.2A. This process would help to ensure that all regulatory requirements are met and significant contamination of groundwater would not occur.

Volume II contains two types of water resources tables for each site. The first type of table (Table II.1-15) presents the water use in gallons per day for construction and operations, along with the percent of current use and percent of streamflow for the water use. This table also provides the percent of streamflow for wastewater discharges, assuming all water used by the facility during operations is discharged. The first type of table is provided for all five waste types. The second type of table (Table II.1-16) provides results of the analysis of impacts to groundwater quality from the disposal of LLMW and LLW. Concentrations of radionuclides are shown as a percentage of drinking water standards. In addition, tables that show the percent of drinking water standards for hazardous constituents are provided for LLMW.

Table II.1-15. Impacts on Water Resources due to Increased Water Use

Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	--	9,920	0.1	0.00	11,491	0.1	0.00	0.00
Decentralized	37	16	24,085	0.1	0.00	14,992	0.1	0.00	0.00
Regionalized	11	12	24,085	0.1	0.00	14,992	0.1	0.00	0.00
Centralized	1	1	7,888	0.0	0.00	4,686	0.0	0.00	0.00

Notes: T = treatment; D = disposal; -- = disposal is not considered for this alternative.
Water is supplied by surface water from the river. Current water use = 18,300,000 gallons/day. Wastewater is discharged to the River. Average flow rate of the River = 3,003,000,000 gallons/day.

Table II.1-16. Radionuclide Concentrations in Groundwater (Percent of Drinking Water Standard) for Disposal

Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D*																					
No Action	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1,000	600	0
Regionalized	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1,000	600	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1,000	600	0

Notes: T = treatment; D = disposal; -- = no disposal for this alternative.

II.1.6 Description of Socioeconomic Impacts Data Tables

DOE estimated the effects of expenditures for waste management on the regional economies at the 17 major sites and on the national economy. Regional economic effects were based on direct expenditures at each site for construction, operations and maintenance, and decontamination of treatment and disposal facilities. The region-of-influence (ROI), where these effects were evaluated, consists essentially of the counties of residence of site employees. The economy at each site was represented by employment, personal income, and industry output (revenue) data for the ROI counties. Transportation expenditures were not considered in the regional level analysis.

Regional economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined to estimate total project effects at each site. For all alternatives, the construction phase at any site was assumed to take 4 years; the operations phase was assumed to follow the construction phase immediately and to take 15 years (a 10-year operations and maintenance period and a 5-year decontamination period). Five years was added to the operations phase to account for the continued effects on employment and income after this last phase ends. Job and personal income increases only are shown for each site in the Volume II site tables. Industry effects are listed in the impacts technical report.

In addition to the economic effects, proposed waste management activities could affect the social environment by increasing population. Potential population changes in the ROI were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that population changes would cause social effects, such as changes in community size and diversity, and effects on the provision of necessary social services.

Volume II contains one socioeconomic impacts table for each site, for each waste type. The table is similar to example Table II.1-17 below which presents information used to assess the impacts of the waste management alternatives on the regional economies and population. The cost required for the waste management alternatives is listed since this is the factor that drives the socioeconomic impacts. To be consistent with the socioeconomic baseline data (1990 census) on the regional economies, the costs listed here have been corrected to 1990 dollars from the costs in 1994 dollars appearing in the cost tables. The annual number of jobs and the percent annual change in the number of jobs in the ROI are supplied as an indicator of impacts to employment in the region. The annual income attributable to the waste management action, and the percent change in the annual income in the ROI are presented as a measure of economic effects. The percent change in the local population is provided as a measure of the potential for changes in community size and diversity that may produce adverse social effects.

Table II.1-17. Socioeconomic Impacts for Treatment and Disposal Alternatives

Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	--	230	187	0.09	2.0	0.03	0.05
Decentralized	37	16	759	772	0.36	8.2	0.13	0.17
Regionalized	11	12	828	842	0.39	9.0	0.14	0.19
Centralized	1	1	3507	3567	1.66	38.1	0.58	0.76

Notes: T = treatment; D = disposal; ROI = region of influence; -- = disposal is not considered for this alternative.
(1) In 1990 dollars.
(2) Compared with 1990 baseline.

Land Use and Infrastructure Impacts

DOE examined the impacts of the waste management alternatives on land use by comparing the acreage required for construction of new treatment and disposal facilities to the acreage either designated for waste operations or suitable for development. Suitable land is the total site acreage, minus the acreage of existing structures, known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, surface waters, and any other features that would preclude development.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to new WM requirements for water, wastewater treatment, and power. Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of increased demand on the community infrastructure.

Volume II contains one land use and infrastructure table for each site, for each waste type. Table II.1-18 provides an example of this table. The table provides information on land use, water supply systems, wastewater treatment systems, electrical power supply systems, and site employment. The table shows the acres required for the waste management action and the percent of designated or suitable land areas proposed to be used; the water, wastewater and power demands, and the corresponding percent of current capacity that would be required; and peak construction employment and the percent of current site employment that this construction employment represents.

Table II.1-18. Land Use and Infrastructure Impacts for Treatment and Disposal

Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	--	11.2	0.94	29,232	1.62	2,066	0.08	4.32	18.76	111	2
Decentralized	37	16	7.5	0.63	11,457	0.64	5,603	0.22	0.97	4.24	430	10
Regionalized	11	12	0.3	0.02	757	0.04	757	0.03	0.11	0.49	39	1
Centralized	1	1	0.3	0.02	757	0.04	757	0.03	0.11	0.49	39	1

Notes: T = treatment; D = Disposal; GPD = gallons per day; MW = megawatts; FTE = full-time employee; -- = disposal is not considered for this alternative.
(1) Based on 1991 Site Employment

II.1.7 Description of Cost Data Tables

DOE estimated costs for building and operating treatment storage and disposal facilities, and for transportation, from both a life-cycle and process perspective, using 1994 dollars.

Life-Cycle Costs: DOE evaluated facility costs for four phases representing the life-cycle of the facilities and their operations: pre-operations, construction, operations and maintenance, and decontamination and decommissioning.

- Costs for pre-operation activities consist of technology and site adaptation, including bench scale tests and demonstration; permitting; plant startup and cold run costs; and related conceptual design, safety analysis, project management, and contingencies.

- Facility construction costs consist of building construction, equipment purchase and installation, contractor overhead, and related design; construction management; project management; and contingencies.

- Operations and maintenance costs consist of annual operations labor and material, maintenance labor and equipment, utilities, contractor supervision and overhead, and related project management and contingencies.

- Decontamination and decommissioning costs consist of facility decontamination and demolition, environmental closure, post-closure, and monitoring activities.

Process Costs: DOE also analyzed costs based on treatment, storage, disposal, and transportation activities.

- Treatment costs include costs to build and operate treatment facilities (such as wastewater treatment or incineration) and support facilities (such as maintenance and certification/shipping facilities).

- Storage capacity, for the purpose of the WM PEIS analysis, was assumed to be sufficient for a number of alternatives as discussed in Chapters 6-10. When necessary, DOE estimated the costs to build and operate sufficient storage capacity.

- Disposal costs include costs to build and operate administration and receiving facilities for disposal as well as the actual disposal units.

- Transportation costs include the costs associated with the physical movement of the waste from one site to another, for either treatment or disposal. Transportation costs are evaluated for both truck transportation and rail shipments, and are displayed as total transportation costs for each alternative. They are not presented in the site data tables.

Volume II contains one table as shown in Table II.1-19 that displays costs for each of the above components. The table first displays total costs as the sum of facility costs (site cost tables exclude transportation). The next columns display total "facility" costs by life-cycle component, followed by columns that display total "facility" costs by process (e.g., treatment, storage, disposal—as applicable).

Table II.1-19. Cost

Alternatives	Number of Sites		Total Cost (Millions)	Life-Cycle Costs				Functional Area Costs		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	--	207	16	53	125	14	88	118	0
Decentralized	37	16	739	72	207	431	29	431	0	308
Regionalized	11	12	96	8	18	61	10	96	0	0
Centralized	1	1	96	8	18	61	10	96	0	0

Notes: T = treatment; D = disposal; -- = disposal is not considered for this alternative.
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not add to the total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.2.0 Argonne National Laboratory-East (ANL-E)

ANL-E currently is custodian of significant volumes of LLMW, LLW, and TRUW. Each of the waste types is treated independently in the following sections.

II.2.1 ANL-E LLMW

Fifteen tables immediately following portray the impacts of LLMW at ANL-E.

Impact Category

No.	Description	Table No.	Page No.
1.	ANL-E—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-2.1-1	2-2
2.	ANL-E—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-2.1-2	2-3
3.	ANL-E—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-2.1-3	2-4
4.	ANL-E—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-2.1-4	2-5
5.	ANL-E—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-2.1-5	2-6
6.	ANL-E—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure	II-2.1-6	2-7
7.	ANL-E—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-2.1-7	2-8
8.	ANL-E—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-2.1-8	2-9
9.	ANL-E—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-2.1-9	2-10
10.	ANL-E—LLMW—Impacts on Water Resources Due to Increased Water Use	II-2.1-10	2-11
11.	ANL-E—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-2.1-11	2-12
12.	ANL-E—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-2.1-12	2-13
13.	ANL-E—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-2.1-13	2-14
14.	ANL-E—LLMW—Infrastructure Impacts for Treatment and Disposal	II-2.1-14	2-15
15.	ANL-E—LLMW—Cost	II-2.1-15	2-16

Table II-2.1-1. ANL-E—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	6.5E-05	1.8E-03	2.6E-04	1.2E-06	- -	- -
Decentralized	37	16	6.7E-05	6.4E-03	1.7E-05	7.3E-08	2.6E-05	3.2E-04
Regionalized-1	11	12	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -
Regionalized-2	7	6	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -
Regionalized-3	7	1	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -
Regionalized-4	4	6	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -
Centralized	1	1	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-2.1-2. ANL-E—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	5.2E-01	8.8E-04	6.2E-06	5.2E-05	2.5E-03	4.2E-06	1.3E-07	2.5E-07	1.6E-01	2.3E-04	6.1E-09	9.8E-06
Decentralized	37	16	3.3E-02	5.6E-05	2.6E-07	3.3E-06	1.5E-04	2.5E-07	5.5E-09	1.5E-08	1.7E-01	2.3E-04	1.6E-07	1.0E-05
Regionalized-1	11	12	1.2E-03	2.0E-06	1.2E-07	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06
Regionalized-2	7	6	1.2E-03	2.0E-06	6.2E-09	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06
Regionalized-3	7	1	1.2E-03	2.0E-06	6.2E-09	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06
Regionalized-4	4	6	1.2E-03	2.0E-06	6.2E-09	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06
Centralized	1	1	1.2E-03	2.0E-06	6.2E-09	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06

Notes:
T = Treatment
D = Disposal

Table II-2.1-3. ANL-E—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	6.6E-02	9.2E-05	3.9E-06
Regionalized-1	11	12	- -	- -	- -
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-2.1-4. ANL-E—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.4E-09	1.2E-09	- -
Decentralized	37	16	9.1E-11	7.4E-11	8.5E-07
Regionalized-1	11	12	3.3E-12	8.7E-13	- -
Regionalized-2	7	6	3.3E-12	8.7E-13	- -
Regionalized-3	7	1	3.3E-12	8.7E-13	- -
Regionalized-4	4	6	3.3E-12	8.7E-13	- -
Centralized	1	1	3.3E-12	8.7E-13	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-2.1-5. ANL-E—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Most Exposed Farm Family Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	2.8E-06	4.8E-09	3.9E-11	2.8E-10	2.5E-06	4.2E-09	1.2E-10	2.5E-10	--	--	--	--
Decentralized	37	16	1.8E-07	3.1E-10	1.7E-12	1.8E-11	1.5E-07	2.5E-10	4.9E-12	1.5E-11	1.7E-03	2.9E-06	1.4E-06	1.7E-07
Regionalized-1	11	12	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--
Regionalized-2	7	6	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--
Regionalized-3	7	1	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--
Regionalized-4	4	6	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--
Centralized	1	1	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered for this alternative.

Table II-2.1-6. ANL-E—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	1.0E-08	3.0E-08	1.7E-07	- -
Decentralized	37	16	8.0E-10	2.4E-09	8.3E-06	1.7E-02
Regionalized-1	11	12	4.8E-12	1.4E-11	1.6E-07	- -
Regionalized-2	7	6	4.8E-12	1.4E-11	1.6E-07	- -
Regionalized-3	7	1	4.8E-12	1.4E-11	1.6E-07	- -
Regionalized-4	4	6	4.8E-12	1.4E-11	1.6E-07	- -
Centralized	1	1	4.8E-12	1.4E-11	1.6E-07	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of Exposure concentration to chemical-specific occupational threshold limits.

Table II-2.1-7. ANL-E—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	2 (1/1)	2 (2/0)	0	0	0	0	0	0	0	0	0	0
Decentralized	37	16	10 (4/6)	11 (10/1)	0	1 (1/0)	1 (1/0)	2 (1/1)	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-1	11	12	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Regionalized-2	7	6	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Regionalized-3	7	1	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Regionalized-4	4	6	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Centralized	1	1	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-2.1-8. ANL-E—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	10 (9/1)	--	0	--	1 (1/0)
Decentralized	37	16	--	44 (39/5)	--	1 (1/0)	--	7 (4/3)
Regionalized-1	11	12	--	27 (20/7)	--	0	--	6 (2/4)
Regionalized-2	7	6	--	27 (20/7)	--	0	--	6 (2/4)
Regionalized-3	7	1	--	27 (20/7)	--	0	--	6 (2/4)
Regionalized-4	4	6	--	27 (20/7)	--	0	--	6 (2/4)
Centralized	1	1	--	27 (20/7)	--	0	--	6 (2/4)

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	0	5 (1/4)	0	0	0	2 (0/2)	0	0	0	0	0	0
Regionalized-1	11	12	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-2	7	6	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-3	7	1	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-4	4	6	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--
Centralized	1	1	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions)
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions)

Table II-2.1-9. ANL-E—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-2.1-10. ANL-E—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	1337	0.2	--	37	0.0	--	0.00
Decentralized	37	16	2826	0.5	--	919	0.1	--	0.00
Regionalized-1	11	12	1500	0.2	--	287	0.0	--	0.00
Regionalized-2	7	6	1500	0.2	--	287	0.0	--	0.00
Regionalized-3	7	1	1500	0.2	--	287	0.0	--	0.00
Regionalized-4	4	6	1500	0.2	--	287	0.0	--	0.00
Centralized	1	1	1500	0.2	--	287	0.0	--	0.00

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Niagara Aquifer. Current water use = 626,000 gallons/day.
Wastewater discharged to the Des Plains River.
Average flow rate of the Des Plains River = 582,000,000 gallons/day.
-- = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-2.1-11. ANL-E—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-2.1-12. ANL-E—LLMW— Percent of Drinking Water Standards for Hazardous Constitutents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	30	0	2	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	6	0	0	20	1	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-2.1-13. ANL-E—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	19	19	<0.01	0.2	<0.01	<0.01
Decentralized	37	16	53	52	<0.01	0.6	<0.01	<0.01
Regionalized-1	11	12	28	28	<0.01	0.3	<0.01	<0.01
Regionalized-2	7	6	28	28	<0.01	0.3	<0.01	<0.01
Regionalized-3	7	1	28	28	<0.01	0.3	<0.01	<0.01
Regionalized-4	4	6	28	28	<0.01	0.3	<0.01	<0.01
Centralized	1	1	28	28	<0.01	0.3	<0.01	<0.01

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars
(2) Compared to 1990 baseline

Table II-2.1-14. ANL-E—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	0.6	0.05	1336	0.07	37	0.001	0.08	0.34	25	1
Decentralized	37	16	2.3	0.2	2825	0.16	919	0.04	0.31	1.33	25	1
Regionalized-1	11	12	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2
Regionalized-2	7	6	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2
Regionalized-3	7	1	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2
Regionalized-4	4	6	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2
Centralized	1	1	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-2.1-15. ANL-E—LLMW—Cost

(1) In 1994 dollars; LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	22	2	7	13	0.4	9	13	0
Decentralized	37	16	59	4	14	38	3	56	--	3
Regionalized-1	11	12	32	2	4	25	1	32	--	0
Regionalized-2	7	6	32	2	4	25	1	32	--	0
Regionalized-3	7	1	32	2	4	25	1	32	--	0
Regionalized-4	4	6	32	2	4	25	1	32	--	0
Centralized	1	1	32	2	4	25	1	32	--	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.2.2 ANL-E LLW

Thirteen tables immediately following, portray the impacts of LLW at ANL-E. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	ANL-E—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-2.2–1	2–18
2.	ANL-E—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-2.2–2	2–19
3.	ANL-E—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-2.2–3	2–20
4.	ANL-E—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-2.2–4	2–21
5.	ANL-E—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-2.2–5	2–22
7.	ANL-E—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-2.2–6	2–23
8.	ANL-E—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-2.2–7	2–24
9.	ANL-E—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-2.2–8	2–25
10.	ANL-E—LLW—Impacts on Water Resources Due to Increased Water Use	II-2.2–9	2–26
11.	ANL-E—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-2.2–10	2–27
13.	ANL-E—LLW—Socioeconomic Impacts for Treatment and Disposal	II-2.2–11	2–28
14.	ANL-E—LLW—Infrastructure Impacts for Treatment and Disposal	II-2.2–12	2–29
15.	ANL-E—LLW—Cost	II-2.2–13	2–30

Table II-2.2–1. ANL-E—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	4.2E-02	7.1E-02	2.3E-06	9.3E-09	--	--
Decentralized		16	3.2E-02	5.1E-02	2.5E-06	9.8E-09	4.3E-02	6.3E-02
Regionalized-1		12	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Regionalized-2	11	12	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Regionalized-3		6	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Regionalized-4	7	6	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Regionalized-5	4	6	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Regionalized-6		2	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Regionalized-7		2	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Centralized-1		1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Centralized-2		1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Centralized-3	7	1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Centralized-4	7	1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--
Centralized-5	1	1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	--	--

Note:
T = Treatment
D = Disposal
-- = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-2.2–2. ANL-E—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Worker			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	4.7E-03	8.0E-06	4.7E-07	1.9E-05	3.2E-08	1.9E-09	1.1E+02	1.5E-01	6.3E-03
Decentralized		16	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-1		12	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-2	11	12	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-3		6	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-4	7	6	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-5	4	6	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-6		2	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-7		2	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-1		1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-2		1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-3	7	1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-4	7	1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-5	1	1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–3. ANL-E—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	1.1E+02	1.5E-01	6.5E-03
Regionalized-1		12	- -	- -	- -
Regionalized-2	11	12	- -	- -	- -
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–4. ANL-E—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	1.3E-11	9.4E-12	- -
Decentralized		16	1.4E-11	1.0E-11	2.9E-05
Regionalized-1		12	1.4E-11	1.0E-11	- -
Regionalized-2	11	12	1.4E-11	1.0E-11	- -
Regionalized-3		6	1.4E-11	1.0E-11	- -
Regionalized-4	7	6	1.4E-11	1.0E-11	- -
Regionalized-5	4	6	1.4E-11	1.0E-11	- -
Regionalized-6		2	1.4E-11	1.0E-11	- -
Regionalized-7		2	1.4E-11	1.0E-11	- -
Centralized-1		1	1.4E-11	1.0E-11	- -
Centralized-2		1	1.4E-11	1.0E-11	- -
Centralized-3	7	1	1.4E-11	1.0E-11	- -
Centralized-4	7	1	1.4E-11	1.0E-11	- -
Centralized-5	1	1	1.4E-11	1.0E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–5. ANL-E—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite MEI			Noninvolved Worker MEI			Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	2.6E-08	4.4E-11	2.6E-12	1.9E-08	3.2E-11	1.9E-12	--	--	--
Decentralized		16	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	5.7E-02	9.7E-05	5.7E-06
Regionalized-1		12	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Regionalized-2	11	12	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Regionalized-3		6	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Regionalized-4	7	6	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Regionalized-5	4	6	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Regionalized-6		2	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Regionalized-7		2	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Centralized-1		1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Centralized-2		1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Centralized-3	7	1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Centralized-4	7	1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--
Centralized-5	1	1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–6. ANL-E—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	10 (3/7)	9 (8/1)	0	1 (1/0)	1 (1/0)	2 (1/1)	4 (0/4)	1 (0/1)	0	0	0	0
Decentralized		16	13 (5/8)	14 (13/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	19 (0/19)	4 (0/4)	0	0	0	2 (0/2)
Regionalized-1		12	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	11	12	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-3		6	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-4	7	6	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-5	4	6	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-6		2	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalzied-7		2	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-1		1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-2		1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-3	7	1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-4	7	1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-5	1	1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–7. ANL-E—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	36 (31/5)	--	0	--	6 (3/3)
Decentralized		16	--	58 (52/6)	--	1 (1/0)	--	9 (5/4)
Regionalized-1		12	--	12 (6/6)	--	0	--	4 (1/4)
Regionalized-2	11	12	--	12 (6/6)	--	0	--	4 (1/4)
Regionalized-3		6	--	12 (6/6)	--	0	--	4 (1/4)
Regionalized-4	7	6	--	12 (6/6)	--	0	--	4 (1/4)
Regionalized-5	4	6	--	12 (6/6)	--	0	--	4 (1/4)
Regionalized-6		2	--	12 (6/6)	--	0	--	4 (1/4)
Regionalzied-7		2	--	12 (6/6)	--	0	--	4 (1/4)
Centralized-1		1	--	12 (6/6)	--	0	--	4 (1/4)
Centralized-2		1	--	12 (6/6)	--	0	--	4 (1/4)
Centralized-3	7	1	--	12 (6/6)	--	0	--	4 (1/4)
Centralized-4	7	1	--	12 (6/6)	--	0	--	4 (1/4)
Centralized-5	1	1	--	12 (6/6)	--	0	--	4 (1/4)

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Decentralized		16	0	17 (2/15)	0	0	0	9 (0/9)	--	--	--	--	--	--
Regionalized-1		12	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-2	11	12	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-3		6	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-4	7	6	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-5	4	6	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-6		2	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalzied-7		2	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Centralized-1		1	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Centralized-2		1	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Centralized-3	7	1	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Centralized-4	7	1	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--
Centralized-5	1	1	0	4 (0/4)	0	0	0	2 (0/2)	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–8. ANL-E—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–9. ANL-E—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	1875	0.3	--	640	0.1	--	<0.1
Decentralized		16	12053	1.9	--	1014	0.2	--	<0.1
Regionalized-1		12	2099	0.3	--	646	0.1	--	<0.1
Regionalized-2	11	12	2099	0.3	--	646	0.1	--	<0.1
Regionalized-3		6	2099	0.3	--	646	0.1	--	<0.1
Regionalized-4	7	6	2099	0.3	--	646	0.1	--	<0.1
Regionalized-5	4	6	2099	0.3	--	646	0.1	--	<0.1
Regionalized-6		2	2099	0.3	--	646	0.1	--	<0.1
Regionalized-7		2	2099	0.3	--	646	0.1	--	<0.1
Centralized-1		1	2099	0.3	--	646	0.1	--	<0.1
Centralized-2		1	2099	0.3	--	646	0.1	--	<0.1
Centralized-3	7	1	2099	0.3	--	646	0.1	--	<0.1
Centralized-4	7	1	2099	0.3	--	646	0.1	--	<0.1
Centralized-5	1	1	2099	0.3	--	646	0.1	--	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Niagara Aquifer. Current water use = 626,000 gallons/day.
Wastewater discharged to the Des Plains River. Average flow rate of the Des Plains River = 582,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-2.2–10. ANL-E—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-2.2–11. ANL-E—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	125	100	0.00	1.2	0.00	0.00
Decentralized		16	344	344	0.01	4.0	0.00	0.00
Regionalized-1		12	94	94	0.00	1.1	0.00	0.00
Regionalized-2	11	12	94	94	0.00	1.1	0.00	0.00
Regionalized-3		6	94	94	0.00	1.1	0.00	0.00
Regionalized-4	7	6	94	94	0.00	1.1	0.00	0.00
Regionalized-5		6	94	94	0.00	1.1	0.00	0.00
Regionalized-6		2	94	94	0.00	1.1	0.00	0.00
Regionalized-7		2	94	94	0.00	1.1	0.00	0.00
Centralized-1		1	94	94	0.00	1.1	0.00	0.00
Centralized-2		1	94	94	0.00	1.1	0.00	0.00
Centralized-3	7	1	94	94	0.00	1.1	0.00	0.00
Centralized-4	7	1	94	94	0.00	1.1	0.00	0.00
Centralized-5	1	1	94	94	0.00	1.1	0.00	0.00

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–12. ANL-E—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	0.8	0.06	1875	0.10	640	0.02	0.11	0.49	53	1
Decentralized		16	4.1	0.33	12053	0.67	1014	0.04	1.70	7.40	195	4
Regionalized-1		12	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-2	11	12	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-3		6	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-4	7	6	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-5	4	6	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-6		2	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-7		2	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-1		1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-2		1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-3	7	1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-4	7	1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-5	1	1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–13. ANL-E—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	142	8	28	101	5	142	0	0
Decentralized		16	389	30	93	177	89	106	0	283
Regionalized-1		12	106	9	30	61	6	106	0	0
Regionalized-2	11	12	106	9	30	61	6	106	0	0
Regionalized-3		6	106	9	30	61	6	106	0	0
Regionalized-4	7	6	106	9	30	61	6	106	0	0
Regionalized-5	4	6	106	9	30	61	6	106	0	0
Regionalized-6		2	106	9	30	61	6	106	0	0
Regionalized-7		2	106	9	30	61	6	106	0	0
Centralized-1		1	106	9	30	61	6	106	0	0
Centralized-2		1	106	9	30	61	6	106	0	0
Centralized-3	7	1	106	9	30	61	6	106	0	0
Centralized-4	7	1	106	9	30	61	6	106	0	0
Centralized-5	1	1	106	9	30	61	6	106	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.2.3 ANL-E TRUW

Twelve tables immediately following portray the impacts of TRUW at ANL-E. These impacts are presented in the following tables.

Impact Category

No.	Description	Table No.	Page No.
1.	ANL-E—TRUW—Treatment: Estimated Number of Fatalities	II-2.3-1	2-32
2.	ANL-E—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-2.3-2	2-33
4.	ANL-E—TRUW—Treatment: MEI Probability of Cancer Fatality	II-2.3-3	2-34
5.	ANL-E—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-2.3-4	2-35
6.	ANL-E—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-2.3-5	2-36
7.	ANL-E—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-2.3-6	2-37
8.	ANL-E—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-2.3-7	2-38
9.	ANL-E—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-2.3-8	2-39
10.	ANL-E—TRUW—Impacts on Water Resources Due to Increased Water Use	II-2.3-9	2-40
13.	ANL-E—TRUW—Socioeconomic Impacts for Treatment	II-2.3-10	2-41
14.	ANL-E—TRUW—Infrastructure Impacts for Treatment	II-2.3-11	2-42
15.	ANL-E—TRUW—Cost	II-2.3-12	2-43

Table II-2.3-1. ANL-E—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure
	CH Treat	RH Treat		Radiation Exposure	Physical Hazards		
No Action **	16	5	WIPP WAC	9.8E-07	2.8E-02	6.2E-07	3.2E-09
Decentralized ***	16	5	WIPP WAC	8.8E-03	1.2E-01	2.0E-06	1.0E-08
Regionalized-1	5	2	Reduce Gas	8.8E-03	4.5E-02	1.7E-06	9.0E-09
Regionalized-2	5	2	LDR	8.8E-03	4.5E-02	1.7E-06	9.0E-09
Regionalized-3	3	2	LDR	8.8E-03	4.5E-02	1.7E-06	9.0E-09
Centralized	WIPP	2	LDR	8.8E-03	4.5E-02	1.7E-06	9.0E-09

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-2.3-2. ANL-E—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

Number of Sites			Offsite Population				Noninvolved Workers				WM Workers			
CH Treat	RH Treat	Treat STD	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
16	5	WIPP WAC	1.2E-03	2.1E-06	3.8E-10	1.2E-07	6.5E-06	1.1E-08	8.0E-12	6.5E-10	2.5E-03	3.4E-06	4.8E-10	1.5E-07
16	5	WIPP WAC	4.0E-03	6.7E-06	1.5E-09	4.0E-07	2.1E-05	3.5E-08	3.1E-11	2.1E-09	2.2E+01	3.1E-02	1.9E-09	1.3E-03
5	2	Reduce Gas	3.5E-03	5.9E-06	2.9E-09	3.5E-07	1.8E-05	3.1E-08	6.0E-11	1.8E-09	2.2E+01	3.1E-02	2.8E-09	1.3E-03
5	2	LDR	3.5E-03	5.9E-06	2.9E-09	3.5E-07	1.8E-05	3.1E-08	6.0E-11	1.8E-09	2.2E+01	3.1E-02	2.8E-09	1.3E-03
3	2	LDR	3.5E-03	5.9E-06	2.9E-09	3.5E-07	1.8E-05	3.1E-08	6.0E-11	1.8E-09	2.2E+01	3.1E-02	2.8E-09	1.3E-03
WIPP	2	LDR	3.5E-03	5.9E-06	2.9E-09	3.5E-07	1.8E-05	3.1E-08	6.0E-11	1.8E-09	2.2E+01	3.1E-02	2.8E-09	1.3E-03

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-2.3-3. ANL-E—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	3.5E-12	3.2E-12
Decentralized***	16	5	WIPP WAC	1.1E-11	1.0E-11
Regionalized-1	5	2	Reduce Gas	9.7E-12	9.0E-12
Regionalized-2	5	2	LDR	9.7E-12	9.0E-12
Regionalized-3	3	2	LDR	9.7E-12	9.0E-12
Centralized	WIPP	2	LDR	9.7E-12	9.0E-12

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-4. ANL-E—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	6.9E-09	1.2E-11	0.0E+00	6.9E-13	6.5E-09	1.1E-11	0.0E+00	6.5E-13
Decentralized ***	16	5	WIPP WAC	2.2E-08	3.7E-11	0.0E+00	2.2E-12	2.1E-08	3.5E-11	2.8E-14	2.1E-12
Regionalized-1	5	2	Reduce Gas	1.9E-08	3.3E-11	1.3E-14	1.9E-12	1.8E-08	3.1E-11	5.4E-14	1.8E-12
Regionalized-2	5	2	LDR	1.9E-08	3.3E-11	1.3E-14	1.9E-12	1.8E-08	3.1E-11	5.4E-14	1.8E-12
Regionalized-3	3	2	LDR	1.9E-08	3.3E-11	1.3E-14	1.9E-12	1.8E-08	3.1E-11	5.4E-14	1.8E-12
Centralized	WIPP	2	LDR	1.9E-08	3.3E-11	1.3E-14	1.9E-12	1.8E-08	3.1E-11	5.4E-14	1.8E-12

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites then to WIPP.
MEI = Maximally Exposed Individual

Table II-2.3-5. ANL-E—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment		
	CH Treat	RH Treat		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	7.7E-13	2.3E-12	1.9E-08
Decentralized***	16	5	WIPP WAC	5.9E-12	1.7E-11	3.8E-08
Regionalized-1	5	2	Reduce Gas	1.0E-11	3.0E-11	1.4E-07
Regionalized-2	5	2	LDR	1.0E-11	3.0E-11	1.4E-07
Regionalized-3	3	2	LDR	1.0E-11	3.0E-11	1.4E-07
Centralized	WIPP	2	LDR	1.0E-11	3.0E-11	1.4E-07

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-2.3-6. ANL-E—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treat STD	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -	6 (0/6)	1 (0/1)	0	0	0	1 (0/1)
Decentralized***	16	5	WIPP WAC	34 (2/32)	12 (6/6)	0	0	1 (1/0)	5 (1/4)	10 (0/10)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-1	5	2	Reduce Gas	32 (2/30)	10 (4/6)	0	0	0	4 (0/4)	7 (0/7)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	5	2	LDR	22 (2/20)	10 (6/4)	0	1 (1/0)	1 (1/0)	3 (1/2)	9 (0/9)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-3	3	2	LDR	22 (2/20)	10 (6/4)	0	1 (1/0)	1 (1/0)	3 (1/2)	9 (0/9)	2 (0/2)	0	0	0	1 (0/1)
Centralized	WIPP	2	LDR	22 (2/20)	10 (6/4)	0	1 (1/0)	1 (1/0)	3 (1/2)	9 (0/9)	2 (0/2)	0	0	0	1 (0/1)

Notes:

Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.

CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.

(1) Values = total emissions (equipment emissions / worker vehicles emission).

(2) Values = total emissions (stationary-source emissions / mobile-source emissions).

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-7. ANL-E—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	--	49 (23/26)	--	1 (0/0)	--	17 (2/15)
Regionalized-1	5	2	Reduce Gas	--	40 (16/24)	--	0	--	16 (2/14)
Regionalized-2	5	2	LDR	--	34 (25/9)	--	1 (1/0)	--	8 (2/6)
Regionalized-3	3	2	LDR	--	34 (25/9)	--	1 (1/0)	--	8 (2/6)
Centralized	WIPP	2	LDR	--	34 (25/9)	--	1 (1/0)	--	8 (2/6)

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	0	5 (0/5)	0	0	0	3 (0/3)	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	0	9 (1/8)	0	0	0	5 (0/5)	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	5 (0/5)	0	0	0	3 (0/3)	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	8 (0/8)	0	0	0	5 (0/5)	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	8 (0/8)	0	0	0	5 (0/5)	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	8 (0/8)	0	0	0	5 (0/5)	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR only applies to pollutants in nonattainment.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-8. ANL-E—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled

Table II-2.3-9. ANL-E—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	921	0.1	- -	<0.1
Decentralized***	16	5	WIPP WAC	4769	0.8	- -	1509	0.2	- -	<0.1
Regionalized-1	5	2	Reduce Gas	3207	0.5	- -	941	0.2	- -	<0.1
Regionalized-2	5	2	LDR	3726	0.6	- -	941	0.2	- -	<0.1
Regionalized-3	3	2	LDR	3726	0.6	- -	941	0.2	- -	<0.1
Centralized	WIPP	2	LDR	3726	0.6	- -	941	0.2	- -	<0.1

Notes:
Water supplied by groundwater in the Niagara Aquifer. Current water use = 626,000 gallons/day.
Wastewater discharged to the Des Plains River.
Average flow rate of the Des Plains River = 582,000,000 gallons/day.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-2.3-10. ANL-E—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	91	73	0.00	0.9	0.00	0.0
Decentralized***	16	5	WIPP WAC	292	292	0.01	3.4	0.00	0.0
Regionalized-1	5	2	Reduce Gas	198	199	0.01	2.3	0.00	0.0
Regionalized-2	5	2	LDR	295	295	0.01	3.4	0.00	0.0
Regionalized-3	3	2	LDR	295	295	0.01	3.4	0.00	0.0
Centralized	WIPP	2	LDR	295	295	0.01	3.4	0.00	0.0

Notes:
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-11. ANL-E—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	921	0.05	921	0.05	0.09	0.41	0	0.00
Decentralized***	16	5	WIPP WAC	2.7	0.23	4769	0.26	1509	0.06	0.44	1.93	172	3.90
Regionalized-1	5	2	Reduce Gas	1.4	0.12	3207	0.18	941	0.04	0.27	1.17	114	2.60
Regionalized-2	5	2	LDR	1.8	0.15	3726	0.21	941	0.04	0.31	1.34	207	4.60
Regionalized-3	3	2	LDR	1.8	0.15	3726	0.21	941	0.04	0.31	1.34	207	4.60
Centralized	WIPP	2	LDR	1.8	0.15	3726	0.21	941	0.04	0.31	1.34	207	4.60

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-12. ANL-E—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	104	0	0	86	18	0	92	12
Decentralized***	16	5	WIPP - WAC	330	25	89	183	33	0	308	22
Regionalized-1	5	2	Reduce Gas	224	18	56	140	10	0	224	0
Regionalized-2	5	2	LDR	334	24	118	178	14	0	334	0
Regionalized-3	3	2	LDR	334	24	118	178	14	0	334	0
Centralized	WIPP	2	LDR	334	24	118	178	14	0	334	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.3.0 BNL

BNL currently is custodian of significant volumes of LLMW. The waste type is treated independently in the following sections.

II.3.1 BNL LLMW

Fifteen tables immediately following portray the impacts of LLMW at BNL.

Impact Category

No.	Description	Table No.	Page No.
1.	BNL—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-3.1-1	3-2
2.	BNL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-3.1-2	3-3
3.	BNL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-3.1-3	3-4
4.	BNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-3.1-4	3-5
5.	BNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-3.1-5	3-6
6.	BNL—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure	II-3.1-6	3-7
7.	BNL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-3.1-7	3-8
8.	BNL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-3.1-8	3-9
9.	BNL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-3.1-9	3-10
10.	BNL—LLMW—Impacts on Water Resources Due to Increased Water Use	II-3.1-10	3-11
11.	BNL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-3.1-11	3-12
12.	BNL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-3.1-12	3-13
13.	BNL—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-3.1-13	3-14
14.	BNL—LLMW—Infrastructure Impacts for Treatment and Disposal	II-3.1-14	3-15
15.	BNL—LLMW—Cost	II-3.1-15	3-16

Table II-3.1-1. BNL—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	7.3E-05	2.0E-03	1.1E-04	7.0E-07	- -	- -
Decentralized	37	16	1.2E-04	1.6E-02	1.2E-05	7.1E-08	6.1E-05	1.5E-03
Regionalized-1	11	12	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -
Regionalized-2	7	6	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -
Regionalized-3	7	1	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -
Regionalized-4	4	6	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -
Centralized	1	1	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-3.1-2. BNL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	2.3E-01	3.9E-04	8.0E-06	2.3E-05	1.4E-03	2.4E-06	2.8E-07	1.4E-07	1.8E-01	2.6E-04	1.9E-08	1.1E-05
Decentralized	37	16	2.4E-02	4.1E-05	7.3E-07	2.4E-06	1.4E-04	2.4E-07	2.5E-08	1.4E-08	3.1E-01	4.3E-04	1.9E-06	1.8E-05
Regionalized-1	11	12	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06
Regionalized-2	7	6	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06
Regionalized-3	7	1	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06
Regionalized-4	4	6	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06
Centralized	1	1	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06

Notes:
T = Treatment
D = Disposal

Table II-3.1-3. BNL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	1.5E-01	2.1E-04	9.2E-06
Regionalized-1	11	12	- -	- -	- -
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-3.1-4. BNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.5E-09	7.8E-10	- -
Decentralized	37	16	1.6E-10	7.9E-11	1.1E-05
Regionalized-1	11	12	7.0E-13	3.6E-13	- -
Regionalized-2	7	6	7.0E-13	3.6E-13	- -
Regionalized-3	7	1	7.0E-13	3.6E-13	- -
Regionalized-4	4	6	7.0E-13	3.6E-13	- -
Centralized	1	1	7.0E-13	3.6E-13	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-3.1-5. BNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Most Exposed Farm Family Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	3.0E-06	5.2E-09	1.3E-10	3.0E-10	1.6E-06	2.6E-09	1.3E-10	1.6E-10	--	--	--	--
Decentralized	37	16	3.2E-07	5.4E-10	1.2E-11	3.23-11	1.6E-07	2.7E-10	1.2E-11	1.6E-11	2.1E-02	3.6E-05	8.1E-06	2.1E-06
Regionalized-1	11	12	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--
Regionalized-2	7	6	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--
Regionalized-3	7	1	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--
Regionalized-4	4	6	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--
Centralized	1	1	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered for this alternative.

Table II-3.1-6. BNL—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	1.3E-07	1.3E-07	4.4E-07	- -
Decentralized	37	16	1.8E-08	1.8E-08	5.0E-05	1.6E-01
Regionalized-1	11	12	1.1E-10	1.1E-10	4.4E-07	- -
Regionalized-2	7	6	1.1E-10	1.1E-10	4.4E-07	- -
Regionalized-3	7	1	1.1E-10	1.1E-10	4.4E-07	- -
Regionalized-4	4	6	1.1E-10	1.1E-10	4.4E-07	- -
Centralized	1	1	1.1E-10	1.1E-10	4.4E-07	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of Exposure concentration to chemical-specific occupational threshold limits.

Table II-3.1-7. BNL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	2 (1/1)	2 (2/0)	0	0	0	0	1 (0/1)	0	0	0	0	0
Decentralized	37	16	11 (0/11)	3 (1/2)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-3.1-8. BNL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	8 (7/1)	--	--	--	2 (1/1)
Decentralized	37	16	--	14 (5/9)	--	--	--	6 (1/5)
Regionalized-1	11	12	--	0	--	--	--	0
Regionalized-2	7	6	--	0	--	--	--	0
Regionalized-3	7	1	--	0	--	--	--	0
Regionalized-4	4	6	--	0	--	--	--	0
Centralized	1	1	--	0	--	--	--	0

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (4)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	0	2 (0/2)	0	0	0	1 (0/1)	0	0	0	0	0	0
Regionalized-1	11	12	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Regionalized-2	7	6	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Regionalized-3	7	1	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Regionalized-4	4	6	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).

Table II-3.1-9. BNL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-3.1-10. BNL—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	1736	<0.1	- -	117	<0.1	- -	<0.1
Decentralized	37	16	2083	<0.1	- -	370	<0.1	- -	<0.1
Regionalized-1	11	12	0	<0.1	- -	42	<0.1	- -	<0.1
Regionalized-2	7	6	0	<0.1	- -	42	<0.1	- -	<0.1
Regionalized-3	7	1	0	<0.1	- -	42	<0.1	- -	<0.1
Regionalized-4	4	6	0	<0.1	- -	42	<0.1	- -	<0.1
Centralized	1	1	0	<0.1	- -	42	<0.1	- -	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Upper Glacial Aquifer and Magothy Aquifer. Current water use = 4,500,000 gallons/day.
Wastewater discharged to the Peconic River.
Average flow rate of the Peconic River = 1,000,000 gallons/day.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-3.1-11. BNL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
-- = No disposal at this site for this alternative.

Table II-3.1-12. BNL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	20	0	1	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	7	0	0	7	3	1	0
Regionalized-1	11	12	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-3.1-13. BNL—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	22	18	0.00	0.2	0.00	0.00
Decentralized	37	16	88	92	0.01	1.0	0.00	0.00
Regionalized-1	11	12	7	8	0.00	0.1	0.00	0.00
Regionalized-2	7	6	7	8	0.00	0.1	0.00	0.00
Regionalized-3	7	1	7	8	0.00	0.1	0.00	0.00
Regionalized-4	4	6	7	8	0.00	0.1	0.00	0.00
Centralized	1	1	7	8	0.00	0.1	0.00	0.00

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.

Table II-3.1-14. BNL—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW) (2)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	1.0	0.03	1736	0.03	117	0.01	0.23	0.49	10	0.3
Decentralized	37	16	1.6	0.06	2083	0.03	370	0.02	0.2	0.42	86	2
Regionalized-1	11	12	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0
Regionalized-2	7	6	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0
Regionalized-3	7	1	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0
Regionalized-4	4	6	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0
Centralized	1	1	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment. (2) Electrical requirement for the Decentralized Alternative is less than that for the No Action Alternative because of the decreased waste volume after treatment.

Table II-3.1-15. BNL—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	25	2	4	9	10	10	15	0
Decentralized	37	16	84	14	44	21	6	84	0	0
Regionalized-1	11	12	8	0	0	4	5	8	0	0
Regionalized-2	7	6	8	0	0	4	5	8	0	0
Regionalized-3	7	1	8	0	0	4	5	8	0	0
Regionalized-4	4	6	8	0	0	4	5	8	0	0
Centralized	1	1	8	0	0	4	5	8	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.3.2 BNL LLW

Thirteen tables immediately following portray impacts of LLW at BNL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	BNL — LLW — Treatment and Disposal: Estimated Number of Fatalities	II-3.2–1	3-18
2.	BNL — LLW — Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-3.2–2	3-19
3.	BNL — LLW — Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-3.2–3	3-20
4.	BNL — LLW — Treatment and Disposal: MEI Probability of Cancer Fatality	II-3.2–4	3-21
5.	BNL — LLW — Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-3.2–5	3-22
7.	BNL — LLW —Emissions in Tons per Year of Criteria Air Pollutants	II-3.2–6	3-23
8.	BNL — LLW —Percent of Standard/Guideline for Criteria Air Pollutants	II-3.2–7	3-24
9.	BNL — LLW — Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-3.2–8	3-25
10.	BNL — LLW — Impacts on Water Resources Due to Increased Water Use	II-3.2–9	3-26
11.	BNL — LLW — Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-3.2–10	3-27
13.	BNL — LLW — Socioeconomic Impacts for Treatment and Disposal	II-3.2–11	3-28
14.	BNL — LLW — Infrastructure Impacts for Treatment and Disposal	II-3.2–12	3-29
15.	BNL — LLW — Cost	II-3.2–13	3-30

Table II-3.2-1. BNL—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	6.0E-02	5.1E-02	2.2E-06	1.1E-08	- -	- -
Decentralized	- -	16	3.6E-02	2.2E-02	9.7E-09	2.4E-11	3.8E-02	2.3E-02
Regionalized-1	- -	12	3.9E-02	4.3E-02	2.3E-06	3.1E-11	- -	- -
Regionalized-2	11	12	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-3	- -	6	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-4	7	6	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-5	4	6	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-6	- -	2	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-7	- -	2	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Centralized-1	- -	1	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Centralized-2	- -	1	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Centralized-3	7	1	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Centralized-4	7	1	3.4E-09	2.0E-02	2.3E-06	1.2E-08	- -	- -
Centralized-5	1	1	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.
** = Ten sites use existing facilities for volume reduction.

Table II-3.2-2. BNL—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Worker		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	4.4E-03	7.4E-06	4.4E-07	2.3E-05	3.9E-08	2.3E-09	1.5E+02	2.1E-01	9.0E-03
Decentralized	- -	16	1.9E-05	3.3E-08	1.9E-09	4.8E-08	8.1E-11	4.8E-12	9.1E+01	1.3E-01	5.5E-03
Regionalized-1	- -	12	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-2	11	12	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-3	- -	6	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-4	7	6	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-5	4	6	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-6	- -	2	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-7	- -	2	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-1	- -	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-2	- -	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-3	7	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-4	7	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-5	1	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03

Notes:
T = Treatment
D = Disposal
** = Ten sites use existing facilities for volume reduction.

Table II-3.2-3. BNL—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized	- -	16	9.4E+01	1.3E-01	5.6E-03
Regionalized-1	- -	12	- -	- -	- -
Regionalized-2	11	12	- -	- -	- -
Regionalized-3	- -	6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6	- -	2	- -	- -	- -
Regionalized-7	- -	2	- -	- -	- -
Centralized-1	- -	1	- -	- -	- -
Centralized-2	- -	1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.
** = Ten sites use existing facilities for volume reduction.

Table II-3.2-4. BNL—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	2.9E-11	1.3E-11	- -
Decentralized	- -	16	1.3E-13	2.7E-14	4.6E-04
Regionalized-1	- -	12	3.1E-11	1.3E-11	- -
Regionalized-2	11	12	3.1E-11	1.3E-11	- -
Regionalized-3	- -	6	3.1E-11	1.3E-11	- -
Regionalized-4	7	6	3.1E-11	1.3E-11	- -
Regionalized-5	4	6	3.1E-11	1.3E-11	- -
Regionalized-6	- -	2	3.1E-11	1.3E-11	- -
Regionalized-7	- -	2	3.1E-11	1.3E-11	- -
Centralized-1	- -	1	3.1E-11	1.3E-11	- -
Centralized-2	- -	1	3.1E-11	1.3E-11	- -
Centralized-3	7	1	3.1E-11	1.3E-11	- -
Centralized-4	7	1	3.1E-11	1.3E-11	- -
Centralized-5	1	1	3.1E-11	1.3E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative
** = Ten sites use existing facilities for volume reduction

Table II-3.2-5. BNL—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	5.8E-08	9.9E-11	5.8E-12	2.5E-08	4.3E-11	2.5E-12	--	--	--
Decentralized	--	16	2.6E-10	4.4E-13	2.6E-14	5.3E-11	9.0E-14	5.3E-15	9.2E-01	1.6E-03	9.2E-05
Regionalized-1	--	12	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-2	11	12	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-3	--	6	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-4	7	6	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-5	4	6	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-6	--	2	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-7	--	2	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-1	--	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-2	--	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-3	7	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-4	7	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-5	1	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for this alternative.
** = Ten sites use existing facilities for volume reduction

Table II-3.2-6. BNL—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Decentralized	- -	16	23 (8/14)	25 (22/3)	0	2 (2/0)	2 (2/0)	4 (2/2)	12 (0/12)	3 (1/2)	0	0	0	1 (0/1)
Regionalized-1	- -	12	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	11	12	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-3	- -	6	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-4	7	6	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-5	4	6	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-6	- -	2	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-7	- -	2	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-1	- -	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-2	- -	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-3	7	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-4	7	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-5	1	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
** = Ten sites use existing facilities for volume reduction
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-3.2-7. BNL—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	T	D	Construction — Percent of Tons/Year — General Conformity Rule (1)					
			CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	26 (20/6)	--	--	--	6 (2/4)
Decentralized	--	16	--	100 (88/12)	--	--	--	15 (8/7)
Regionalized-1	--	12	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-2	11	12	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-3	--	6	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-4	7	6	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-5	4	6	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-6	--	2	--	26 (20/6)	--	--	--	6 (2/4)
Regionalzied-7	--	2	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-1	--	1	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-2	--	1	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-3	7	1	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-4	7	1	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-5	1	1	--	26 (20/6)	--	--	--	6 (2/4)

LLW Alternatives	T	D	Percent of Tons/Year — Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
			CO (4)	NO2 (5)	Pb (4)	PM10 (4)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	14 (4/10)	0	1	0	6 (0/6)	--	--	--	--	--	--
Regionalized-1	--	12	--	4 (0/4)	--	--	--	3 (0/3)	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Regionalzied-7	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--

T = Treatment
D = Disposal
** = Ten sites use existing facilities for volume reduction.
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions)

Table II-3.2-8. BNL—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance										
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide
No Action	10**	6	0	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	--	--	--	--	--	--	--	--	--
Regionalized-1	--	12	0	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	0	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	0	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	0	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	0	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	0	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	--	--	--	--	--	--	--	--	--	--
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for volume reduction.

Table II-3.2-9. BNL—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	1,259	<0.1	- -	442	<0.1	- -	<0.1
Decentralized	- -	16	8,000	0.2	- -	886	<0.1	- -	<0.1
Regionalized-1	- -	12	1,259	<0.1	- -	442	<0.1	- -	<0.1
Regionalized-2	11	12	1,259	<0.1	- -	442	<0.1	- -	<0.1
Regionalized-3	- -	6	1,259	<0.1	- -	442	<0.1	- -	<0.1
Regionalized-4	7	6	1,259	<0.1	- -	442	<0.1	- -	<0.1
Regionalized-5	4	6	1,259	<0.1	- -	442	<0.1	- -	<0.1
Regionalized-6	- -	2	1,259	<0.1	- -	442	<0.1	- -	<0.1
Regionalized-7	- -	2	1,259	<0.1	- -	442	<0.1	- -	<0.1
Centralized-1	- -	1	1,259	<0.1	- -	442	<0.1	- -	<0.1
Centralized-2	- -	1	1,259	<0.1	- -	442	<0.1	- -	<0.1
Centralized-3	7	1	1,259	<0.1	- -	442	<0.1	- -	<0.1
Centralized-4	7	1	1,259	<0.1	- -	442	<0.1	- -	<0.1
Centralized-5	1	1	1,259	<0.1	- -	442	<0.1	- -	<0.1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
Water supplied by groundwater in the Upper Glacial and Magothy aquifers. Current water use = 4,500,000 gallons/day.
Wastewater discharged to the Peconic River. Average flow rate of the Peconic River = 1,000,000 gallons/day.
** Ten sites use existing facilities for volume reduction.
<0.1 indicates that the percentage is less than 0.1%.

Table II-3.2-10. BNL—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for volume reduction
-- = Disposal is not considered for this Alternative.

Table II-3.2-11. BNL—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	98	102	<0.01	1.2	<0.01	<0.01
Decentralized	- -	16	203	212	0.02	2.4	<0.01	0.01
Regionalized-1	- -	12	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-2	11	12	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-3	- -	6	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-4	7	6	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-5	4	6	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-6	- -	2	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-7	- -	2	98	102	<0.01	1.2	<0.01	<0.01
Centralized-1	- -	1	98	102	<0.01	1.2	<0.01	<0.01
Centralized-2	- -	1	98	102	<0.01	1.2	<0.01	<0.01
Centralized-3	7	1	98	102	<0.01	1.2	<0.01	<0.01
Centralized-4	7	1	98	102	<0.01	1.2	<0.01	<0.01
Centralized-5	1	1	98	102	<0.01	1.2	<0.01	<0.01

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for volume reduction.

Table II-3.2-12. BNL—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Land Use		Water		Waste Water		Power		Employment	
	T	D	Acres Required	% Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Peak Construction Employment	% of Current Employment
No Action	10**	6	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Decentralized	--	16	2.8	0.10	8000	0.13	865	0.04	1.10	3.14	113	3
Regionalized-1	--	12	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-2	11	12	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-3	--	6	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-4	7	6	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-5	4	6	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-6	--	2	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-7	--	2	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-1	--	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-2	--	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-3	7	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-4	7	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-5	1	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
-- = Disposal is not considered for this Alternative.
** = Ten sites use existing facilities for volume reduction.

Table II-3.2-13. BNL—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	111	9	41	55	6	111	0	0
Decentralized	--	16	230	17	72	129	12	110	0	120
Regionalized-1	--	12	111	9	41	55	6	111	0	0
Regionalized-2	11	12	111	9	41	55	6	111	0	0
Regionalized-3	--	6	111	9	41	55	6	111	0	0
Regionalized-4	7	6	111	9	41	55	6	111	0	0
Regionalized-5	4	6	111	9	41	55	6	111	0	0
Regionalized-6	--	2	111	9	41	55	6	111	0	0
Regionalized-7	--	2	111	9	41	55	6	111	0	0
Centralized-1	--	1	111	9	41	55	6	111	0	0
Centralized-2	--	1	111	9	41	55	6	111	0	0
Centralized-3	7	1	111	9	41	55	6	111	0	0
Centralized-4	7	1	111	9	41	55	6	111	0	0
Centralized-5	1	1	111	9	41	55	6	111	0	0

Notes:
** Ten sites use existing facilities for volume reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.4.0 FEMP

FEMP currently is custodian of significant volumes of LLMW and LLW. Each of the waste types is treated independently in the following sections.

II.4.1 FEMP LLMW

Fifteen tables immediately following portray the impacts of LLMW at FEMP. These tables are presented as follows:

Impact Category No.	Description	Table No.	Page No.
1.	FEMP—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-4.1-1	4-2
2.	FEMP—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-4.1-2	4-3
3.	FEMP—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-4.1-3	4-4
4.	FEMP—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-4.1-4	4-5
5.	FEMP—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-4.1-5	4-6
6.	FEMP—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure	II-4.1-6	4-7
7.	FEMP—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-4.1-7	4-8
8.	FEMP—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-4.1-8	4-9
9.	FEMP—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-4.1-9	4-10
10.	FEMP—LLMW—Impacts on Water Resources Due to Increased Water Use	II-4.1-10	4-11
11.	FEMP—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-4.1-11	4-12
12.	FEMP—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-4.1-12	4-13
13.	FEMP—LLMW—Socioeconomics Impacts for Treatment and Disposal	II-4.1-13	4-14
14.	FEMP—LLMW—Infrastructure Impacts for Treatment and Disposal	II-4.1-14	4-15
15.	FEMP—LLMW—Cost	II-4.1-15	4-16

Table II-4.1-1. FEMP—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	3.8E-04	1.4E-02	3.2E-04	2.4E-06	- -	- -
Decentralized	37	16	2.9E-04	1.6E-01	2.6E-05	1.9E-07	2.9E-04	9.0E-03
Regionalized-1	11	12	2.7E-02	3.2E-01	7.0E-04	4.7E-06	2.9E-05	9.0E-03
Regionalized-2	7	6	2.5E-04	8.8E-02	1.4E-07	1.1E-09	- -	- -
Regionalized-3	7	1	2.5E-04	8.8E-02	1.4E-07	1.1E-09	- -	- -
Regionalized-4	4	6	2.5E-04	8.8E-02	1.4E-07	1.1E-09	- -	- -
Centralized	1	1	2.5E-04	8.8E-02	1.4E-07	1.1E-09	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-4.1-2. FEMP—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	6.3E-01	1.1E-03	3.3E-05	6.3E-05	4.7E-03	8.0E-06	2.3E-06	4.7E-07	9.4E-01	1.3E-03	2.4E-06	5.6E-05
Decentralized	37	16	5.2E-02	8.8E-05	2.8E-06	5.2E-06	3.9E-04	6.5E-07	2.0E-07	3.9E-08	7.3E-01	1.0E-03	7.3E-05	4.4E-05
Regionalized-1	11	12	1.4E+00	2.4E-03	7.9E-06	1.4E-04	9.4E-03	1.6E-05	5.5E-07	9.4E-07	6.8E+01	9.5E-02	3.5E-04	4.1E-03
Regionalized-2	7	6	2.9E-04	4.9E-07	9.2E-08	2.9E-08	2.1E-06	3.6E-09	6.4E-09	2.1E-10	6.3E-01	8.8E-04	1.5E-06	3.8E-05
Regionalized-3	7	1	2.9E-04	4.9E-07	9.2E-08	2.9E-08	2.1E-06	3.6E-09	6.4E-09	2.1E-10	6.3E-01	8.8E-04	1.5E-06	3.8E-05
Regionalized-4	4	6	2.9E-04	4.9E-07	9.2E-08	2.9E-08	2.1E-06	3.6E-09	6.4E-09	2.1E-10	6.3E-01	8.8E-04	1.5E-06	3.8E-05
Centralized	1	1	2.9E-04	4.9E-07	9.2E-08	2.9E-08	2.1E-06	3.6E-09	6.4E-09	2.1E-10	6.3E-01	8.8E-04	1.5E-06	3.8E-05

Notes:
T = Treatment
D = Disposal

Table II-4.1-3. FEMP—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	7.2E-01	1.0E-03	4.3E-05
Regionalized-1	11	12	7.2E-01	1.0E-03	4.3E-05
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-4.1-4. FEMP—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	6.0E-09	2.1E-09	- -
Decentralized	37	16	4.9E-10	1.7E-10	3.8E-05
Regionalized-1	11	12	1.3E-08	4.1E-09	3.8E-05
Regionalized-2	7	6	2.7E-12	9.4E-13	- -
Regionalized-3	7	1	2.7E-12	9.4E-13	- -
Regionalized-4	4	6	2.7E-12	9.4E-13	- -
Centralized	1	1	2.7E-12	9.4E-13	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-4.1-5. FEMP—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	1.2E-05	2.0E-08	1.1E-09	1.2E-09	4.2E-06	7.1E-09	1.1E-09	4.2E-10	--	--	--	--
Decentralized	37	16	9.7E-07	1.7E-09	8.9E-11	9.7E-11	3.4E-07	5.8E-10	8.9E-11	3.4E-11	7.6E-02	1.3E-04	1.4E-05	7.6E-06
Regionalized-1	11	12	2.6E-05	4.5E-08	2.5E-10	2.6E-09	8.3E-06	1.4E-08	2.5E-10	8.3E-10	7.6E-02	1.3E-04	1.4E-05	7.6E-06
Regionalized-2	7	6	5.4E-09	9.2E-12	2.9E-12	5.4E-13	1.9E-09	3.2E-12	2.9E-12	1.9E-13	--	--	--	--
Regionalized-3	7	1	5.4E-09	9.2E-12	2.9E-12	5.4E-13	1.9E-09	3.2E-12	2.9E-12	1.9E-13	--	--	--	--
Regionalized-4	4	6	5.4E-09	9.2E-12	2.9E-12	5.4E-13	1.9E-09	3.2E-12	2.9E-12	1.9E-13	--	--	--	--
Centralized	1	1	5.4E-09	9.2E-12	2.9E-12	5.4E-13	1.9E-09	3.2E-12	2.9E-12	1.9E-13	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for this alternative.

Table II-4.1-6. FEMP—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	7.3E-07	7.3E-07	7.1E-06	- -
Decentralized	37	16	1.2E-07	1.2E-07	5.6E-04	2.4E-01
Regionalized-1	11	12	3.8E-07	3.8E-07	1.2E-03	2.4E-01
Regionalized-2	7	6	6.3E-10	6.3E-10	6.7E-06	- -
Regionalized-3	7	1	6.3E-10	6.3E-10	6.7E-06	- -
Regionalized-4	4	6	6.3E-10	6.3E-10	6.7E-06	- -
Centralized	1	1	6.3E-10	6.3E-10	6.7E-06	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-4.1-7. FEMP—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	16 (8/8)	22 (20/2)	0	2 (2/0)	2 (2/0)	2 (1/1)	3 (0/3)	2 (1/1)	0	0	0	0
Decentralized	37	16	38 (6/32)	23 (16/7)	0	1 (1/0)	2 (2/0)	6 (2/4)	18 (0/18)	5 (1/4)	0	0	0	2 (0/2)
Regionalized-1	11	12	57 (8/49)	30 (20/10)	0	2 (2/0)	2 (2/0)	8 (2/6)	29 (0/29)	9 (3/6)	0	2 (2/0)	0	4 (0/4)
Regionalized-2	7	6	9 (0/9)	3 (1/2)	0	0	0	1 (0/1)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-3	7	1	9 (0/9)	3 (1/2)	0	0	0	1 (0/1)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-4	4	6	9 (0/9)	3 (1/2)	0	0	0	1 (0/1)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Centralized	1	1	9 (0/9)	3 (1/2)	0	0	0	1 (0/1)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-4.1-8. FEMP—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	22 (20/2)	--	--	--	6 (4/2)
Decentralized	37	16	--	22 (16/6)	--	--	--	11 (3/8)
Regionalized-1	11	12	--	30 (20/10)	--	--	--	16 (4/12)
Regionalized-2	7	6	--	3 (1/2)	--	--	--	2 (0/2)
Regionalized-3	7	1	--	3 (1/2)	--	--	--	2 (0/2)
Regionalized-4	4	6	--	3 (1/2)	--	--	--	2 (0/2)
Centralized	1	1	--	3 (1/2)	--	--	--	2 (0/2)

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (4)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	0	2 (1/1)	0	1	0	1 (0/1)	--	--	--	--	--	--
Decentralized	37	16	0	5 (1/4)	0	2	0	4 (0/4)	0	0	0	0	0	0
Regionalized-1	11	12	0	9 (3/6)	0	12	0	7 (0/7)	0	0	0	0	3	0
Regionalized-2	7	6	0	2 (0/2)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-3	7	1	0	2 (0/2)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-4	4	6	0	2 (0/2)	0	0	0	2 (0/2)	--	--	--	--	--	--
Centralized	1	1	0	2 (0/2)	0	0	0	2 (0/2)	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).

Table II-4.1-9. FEMP—LLMW—Percent of Standards/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-4.1-10. FEMP—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	17682	4.4	- -	1013	0.3	- -	<0.1
Decentralized	37	16	17543	4.4	- -	2799	0.7	- -	0.2
Regionalized-1	11	12	23556	5.9	- -	4630	1.2	- -	0.3
Regionalized-2	7	6	2104	0.5	- -	1296	0.3	- -	<0.1
Regionalized-3	7	1	2104	0.5	- -	1296	0.3	- -	<0.1
Regionalized-4	4	6	2104	0.5	- -	1296	0.3	- -	<0.1
Centralized	1	1	2104	0.5	- -	1296	0.3	- -	<0.1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
Water supplied by groundwater in the Miami Valley Aquifer. Current water use = 400,000 gallons/day.
Wastewater discharged to the Great Miami River.
Average flow rate of the Great Miami River = 1,832,000 gallons/day.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-4.1-11. FEMP—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	400	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	400	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-4.1-12. FEMP—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	20	0	9	9	0
Regionalized-1	11	12	0	0	0	20	0	9	9	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	7	0	0	8	4	3	0
Regionalized-1	11	12	7	0	0	8	4	3	0
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-4.1-13. FEMP—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	95	83	0.01	0.9	0.00	0.01
Decentralized	37	16	339	371	0.05	4.2	0.02	0.02
Regionalized-1	11	12	516	564	0.07	6.4	0.03	0.04
Regionalized-2	7	6	138	151	0.02	1.7	0.01	0.01
Regionalized-3	7	1	138	151	0.02	1.7	0.01	0.01
Regionalized-4	4	6	138	151	0.02	1.7	0.01	0.01
Centralized	1	1	138	151	0.02	1.7	0.01	0.01

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.

Table II-4.1-14. FEMP—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	6.2	2.25	17682	1.11	1013	0.04	2.65	8.04	59	3
Decentralized	37	16	8.5	3.11	17543	1.10	2799	0.12	2.16	6.54	244	13
Regionalized-1	11	12	12.3	4.46	23556	1.47	4630	0.20	2.64	7.99	379	20
Regionalized-2	7	6	1.4	0.49	2104	0.13	1296	0.06	0.76	2.30	71	4
Regionalized-3	7	1	1.4	0.49	2104	0.13	1296	0.06	0.76	2.30	71	4
Regionalized-4	4	6	1.4	0.49	2104	0.13	1296	0.06	0.76	2.30	71	4
Centralized	1	1	1.4	0.49	2104	0.13	1296	0.06	0.76	2.30	71	4

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-4.1-15. FEMP—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	107	9	30	60	8	48	59	0
Decentralized	37	16	384	42	118	198	24	343	0	41
Regionalized-1	11	12	584	67	185	302	30	543	0	41
Regionalized-2	7	6	156	11	36	98	10	156	0	0
Regionalized-3	7	1	156	11	36	98	10	156	0	0
Regionalized-4	4	6	156	11	36	98	10	156	0	0
Centralized	1	1	156	11	36	98	10	156	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.4.2 FEMP LLW

Thirteen tables immediately following portray the impacts of LLW at FEMP. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	FEMP—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-4.2-1	4-18
2.	FEMP—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-4.2-2	4-19
3.	FEMP—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-4.2-3	4-20
4.	FEMP—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-4.2-4	4-21
5.	FEMP—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-4.2-5	4-22
7.	FEMP—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-4.2-6	4-23
8.	FEMP—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-4.2-7	4-24
9.	FEMP—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-4.2-8	4-25
10.	FEMP—LLW—Impacts on Water Resources Due to Increased Water Use	II-4.2-9	4-26
11.	FEMP—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-4.2-10	4-27
13.	FEMP—LLW—Socioeconomic Impacts for Treatment and Disposal	II-4.2-11	4-28
14.	FEMP—LLW—Infrastructure Impacts for Treatment and Disposal	II-4.2-12	4-29
15.	FEMP—LLW—Cost	II-4.2-13	4-30

Table II-4.2-1. FEMP—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	- -	- -	- -	- -	- -	- -
Decentralized		16	- -	- -	- -	- -	- -	- -
Regionalized-1		12	- -	- -	- -	- -	- -	- -
Regionalized-2	11	12	6.5E-03	1.1E-01	2.3E-01	5.2E-04	- -	- -
Regionalized-3		6	- -	- -	- -	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -	- -	- -	- -
Regionalized-6		2	- -	- -	- -	- -	- -	- -
Regionalized-7		2	- -	- -	- -	- -	- -	- -
Centralized-1		1	- -	- -	- -	- -	- -	- -
Centralized-2		1	- -	- -	- -	- -	- -	- -
Centralized-3	7	1	- -	- -	- -	- -	- -	- -
Centralized-4	7	1	- -	- -	- -	- -	- -	- -
Centralized-5	1	1	- -	- -	- -	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Treatment and/or Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-4.2-2. FEMP—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Worker			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -	- -	- -	- -	- -	- -	- -
Decentralized		16	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-1		12	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-2	11	12	4.6E+02	7.9E-01	4.6E-02	1.0E+00	1.8E-03	1.0E-04	1.6E+01	2.3E-02	9.7E-04
Regionalized-3		6	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-6		2	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-7		2	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-1		1	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-2		1	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-3	7	1	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-4	7	1	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-5	1	1	- -	- -	- -	- -	- -	- -	- -	- -	- -

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-4.2-3. FEMP—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	- -	- -	- -
Regionalized-1		12	- -	- -	- -
Regionalized-2	11	12	- -	- -	- -
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-4.2-4. FEMP—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	- -	- -	- -
Decentralized		16	- -	- -	- -
Regionalized-1		12	- -	- -	- -
Regionalized-2	11	12	4.4E-06	4.5E-07	- -
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Treatment and/or disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-4.2-5. FEMP—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	- -	- -	- -	- -	- -	- -	- -	- -	- -
Decentralized		16	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-1		12	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-2	11	12	8.8E-03	1.5E-05	8.8E-07	9.0E-04	1.5E-06	9.0E-08	- -	- -	- -
Regionalized-3		6	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-6		2	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-7		2	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-1		1	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-2		1	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-3	7	1	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-4	7	1	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized-5	1	1	- -	- -	- -	- -	- -	- -	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Treatment and Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-4.2-6. FEMP—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 1		12	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 2	11	12	28 (1/27)	9 (4/5)	0	0	0	3 (0/3)	16 (0/16)	3 (0/3)	0	0	0	2 (0/2)
Regionalized - 3		6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 4	7	6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 5	4	6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 6		2	--	--	--	--	--	--	--	--	--	--	--	--
Regionalzied - 7		2	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission).
(2) Values = total emissions (stationary-source emissions/mobile-source emission).
** Ten sites use existing facilities for Volume Reduction.

Table II-4.2-7. FEMP—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	0	--	--	--	0
Decentralized		16	--	0	--	--	--	0
Regionalized-1		12	--	0	--	--	--	0
Regionalized-2	11	12	--	9 (4/5)	--	--	--	7 (1/6)
Regionalized-3		6	--	0	--	--	--	0
Regionalized-4	7	6	--	0	--	--	--	0
Regionalized-5	4	6	--	0	--	--	--	0
Regionalized-6		2	--	0	--	--	--	0
Regionalzied-7		2	--	0	--	--	--	0
Centralized-1		1	--	0	--	--	--	0
Centralized-2		1	--	0	--	--	--	0
Centralized-3	7	1	--	0	--	--	--	0
Centralized-4	7	1	--	0	--	--	--	0
Centralized-5	1	1	--	0	--	--	--	0

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1		12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	11	12	0	3 (0/3)	0	2 (2/0)	1	4 (0/4)	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	7	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-5	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-6		2	0	0	0	0	0	0	--	--	--	--	--	--
Regionalzied-7		2	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-1		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-2		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-4	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-5	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** Ten sites use existing facilities for Volume Reduction.

Table II-4.2-8. FEMP—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	9	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-4.2-9. FEMP—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--
Regionalized-2	11	12	5254	1.3	--	2403	0.6	--	<0.1
Regionalized-3		6	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
Water supplied by groundwater in the Miami Valley Aquifer. Current water use = 400,000 gallons/day.
Wastewater discharged to the Great Miami River. Average flow rate of the Great Miami River = 1,823,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
- - = FEMP is only considered under the Regionalized 2 Alternative; Under the Regionalized 2 Alternative Stream Flow is not considered.
<0.1 indicates that the percentage is less than 0.1%.

Table II-4.2-10. FEMP—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized*		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1*		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2*	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized*		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1*		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2*	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
* FEMP is shown as a candidate site for disposal in the Decentralized, Regionalized 1, and Regionalized 2 alternatives; however, this disposal would be for onsite waste only if FEMP is determined to have WM LLW. At present, FEMP does not report WM LLW.
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-4.2-11. FEMP—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	276	301	0.04	3.4	0.01	0.02
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5		6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
ROI = Region of Influence
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
- - = Treatment and Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-4.2-12. FEMP—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	3.9	1.40	5254	0.33	2403	0.11	0.50	1.52	207	11
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

-- = Treatment and Disposal is not considered under the alternative.

Table II-4.2-13. FEMP—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--
Regionalized-2	11	12	312	50	81	163	18	312	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.5.0 Hanford Site

Hanford currently is custodian of significant volumes of LLMW, LLW, TRUW, HLW, and HW. Each of the waste types is treated independently in the following sections.

II.5.1 Hanford LLMW

Seventeen tables immediately following portray impacts of LLMW at INEL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	Hanford—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-5.1-1	5-3
2.	Hanford—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-5.1-2	5-4
3.	Hanford—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-5.1-3	5-5
4.	Hanford—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-5.1-4	5-6
5.	Hanford—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-5.1-5	5-7
6.	Hanford—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure	II-5.1-6	5-8
7.	Hanford—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-5.1-7	5-9
8.	Hanford—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-5.1-8	5-10
9.	Hanford—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-5.1-9	5-11
10.	Hanford—LLMW—Impacts on Water Resources Due to Increased Water Use	II-5.1-10	5-12
11.	Hanford—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-5.1-11	5-13
11.	Hanford—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Remote-Handled)	II-5.1-12	5-14
12.	Hanford—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-5.1-13	5-15
13.	Hanford—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Remote-Handled)	II-5.1-14	5-16

13.	Hanford—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-5.1-15	5-17
14.	Hanford—LLMW—Infrastructure Impacts for Treatment and Disposal	II-5.1-16	5-18
15.	Hanford—LLMW—Cost	II-5.1-17	5-19

Table II-5.1-1. Hanford—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	1.1E-01	3.8E-02	7.6E-03	3.1E-04	- -	- -
Decentralized	37	16	1.0E-01	5.2E-01	1.5E-03	5.6E-05	2.0E-01	7.3E-02
Regionalized-1	11	12	1.2E-01	4.8E-01	1.4E-03	5.2E-05	2.0E-01	7.3E-02
Regionalized-2	7	6	1.4E-01	5.0E-01	1.3E-02	1.8E-04	2.1E-01	7.6E-02
Regionalized-3	7	1	1.4E-01	5.0E-01	1.3E-02	1.8E-04	9.3E-12	2.6E-05
Regionalized-4	4	6	1.4E-01	5.0E-01	1.3E-02	1.8E-04	2.1E-01	7.6E-02
Centralized	1	1	4.9E-01	1.7E+00	2.5E-02	3.3E-04	3.6E-01	1.5E-01

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-5.1-2. Hanford—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	1.5E+01	2.6E-02	1.2E-05	1.5E-03	6.2E-01	1.1E-03	7.3E-06	6.2E-05	2.6E+02	3.7E-01	5.8E-05	1.6E-02
Decentralized	37	16	2.9E+00	5.0E-03	1.1E-06	2.9E-04	1.0E-01	1.7E-04	6.7E-07	1.0E-05	2.5E+02	3.5E-01	1.4E-03	1.5E-02
Regionalized -1	11	12	2.7E+00	4.7E-03	1.1E-06	2.7E-04	1.0E-01	1.8E-04	6.5E-07	1.0E-05	3.0E+02	4.1E-01	1.3E-03	1.8E-02
Regionalized-2	7	6	2.6E+01	4.5E-02	1.2E-06	2.6E-03	3.5E-01	6.0E-04	7.1E-07	3.5E-05	3.5E+02	4.9E-01	1.5E-03	2.1E-02
Regionalized-3	7	1	2.6E+01	4.5E-02	1.2E-06	2.6E-03	3.5E-01	6.0E-04	7.1E-07	3.5E-05	3.5E+02	4.9E-01	1.5E-03	2.1E-02
Regionalized-4	4	6	2.7E+01	4.5E-02	1.2E-06	2.7E-03	3.6E-01	6.1E-04	7.4E-07	3.6E-05	3.7E+02	5.1E-01	1.6E-03	2.2E-02
Centralized	1	1	5.0E+01	8.5E-02	1.2E-05	5.0E-03	6.6E-01	1.1E-03	7.3E-06	6.6E-05	1.2E+03	1.7E+00	1.8E-02	7.4E-02

Notes:
T = Treatment
D = Disposal

Table II-5.1-3. Hanford—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	5.1E+02	7.0E-01	3.0E-02
Regionalized-1	11	12	5.0E+02	7.0E-01	3.0E-02
Regionalized-2	7	6	5.3E+02	7.4E-01	3.2E-02
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	5.3E+02	7.4E-01	3.2E-02
Centralized	1	1	9.1E+02	1.3E+00	5.4E-02

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for No Action Alternative for LLMW.

Table II-5.1-4. Hanford—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.6E-07	5.3E-07	- -
Decentralized	37	16	3.0E-08	9.7E-08	2.4E-04
Regionalized-1	11	12	2.8E-08	8.9E-08	2.2E-04
Regionalized-2	7	6	2.7E-07	3.1E-07	3.3E-04
Regionalized-3	7	1	2.7E-07	3.1E-07	- -
Regionalized-4	4	6	2.7E-07	3.1E-07	3.5E-04
Centralized	1	1	5.2E-07	5.7E-07	4.9E-03

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-5.1-5. Hanford—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	3.1E-04	5.3E-07	4.1E-10	3.1E-08	1.1E-03	1.8E-06	1.4E-08	1.1E-07	- -	- -	- -	- -
Decentralized	37	16	6.0E-05	1.0E-07	3.8E-11	6.0E-09	1.9E-04	3.3E-07	1.3E-09	1.9E-08	4.7E-01	8.0E-04	1.2E-04	4.7E-05
Regionalized-1	11	12	5.6E-05	9.6E-08	3.6E-11	5.6E-09	1.8E-04	3.0E-07	1.3E-09	1.8E-08	4.3E-01	7.3E-04	1.1E-04	4.3E-05
Regionalized-2	7	6	5.4E-04	9.2E-07	4.0E-11	5.4E-08	6.1E-04	1.0E-06	1.4E-09	6.1E-08	6.6E-01	1.1E-03	1.1E-04	6.6E-05
Regionalized-3	7	1	5.4E-04	9.2E-07	4.0E-11	5.4E-08	6.1E-04	1.0E-06	1.4E-09	6.1E-08	- -	- -	- -	- -
Regionalized-4	4	6	5.5E-04	9.3E-07	4.1E-11	5.5E-08	6.3E-04	1.1E-06	1.5E-09	6.3E-08	7.0E-01	1.2E-03	1.2E-04	7.0E-05
Centralized	1	1	1.0E-03	1.8E-06	4.1E-10	1.0E-07	1.1E-03	2.0E-06	1.4E-08	1.1E-07	9.7E+00	1.6E-02	2.4E-04	9.7E-04

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for the No Action Alternative for LLMW

Table II-5.1-6. Hanford—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure

quotient values for a LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	4.5E-07	1.6E-05	9.0E-05	- -
Decentralized	37	16	5.1E-08	1.8E-06	3.6E-03	1.4E+00
Regionalized-1	11	12	5.0E-08	1.7E-06	3.6E-03	1.4E+00
Regionalized-2	7	6	5.5E-08	1.9E-06	4.0E-03	1.6E+00
Regionalized-3	7	1	5.5E-08	1.9E-06	4.0E-03	- -
Regionalized-4	4	6	5.6E-08	2.0E-06	4.0E-03	1.6E+00
Centralized	1	1	4.5E-07	1.6E-05	2.6E-02	2.4E+00

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for No Action Alternative for LLMW.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-5.1-7. Hanford—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	12 (1/11)	5 (3/2)	0	0	0	2 (1/1)	9 (1/8)	4 (2/2)	0	0	0	1 (0/1)
Decentralized	37	16	58 (5/53)	24 (13/11)	0	1 (1/0)	1 (1/0)	7 (1/6)	50 (0/50)	15 (5/10)	0	3 (3/0)	0	6 (0/6)
Regionalized-1	11	12	70 (5/65)	25 (12/13)	0	1 (1/0)	1 (1/0)	9 (1/8)	52 (1/51)	15 (5/10)	0	4 (4/0)	0	6 (0/6)
Regionalized-2	7	6	91 (5/86)	30 (13/17)	0	1 (1/0)	1 (1/0)	12 (2/10)	64 (1/63)	19 (6/13)	0	4 (4/0)	0	8 (0/8)
Regionalized-3	7	1	57 (3/54)	19 (8/11)	0	1 (1/0)	1 (1/0)	7 (1/6)	37 (1/36)	13 (6/7)	0	4 (4/0)	0	4 (0/4)
Regionalized-4	4	6	91 (5/86)	30 (13/17)	0	1 (1/0)	1 (1/0)	12 (2/10)	64 (1/63)	19 (6/13)	0	4 (4/0)	0	8 (0/8)
Centralized	1	1	293 (25/268)	118 (64/54)	0	6 (5/1)	6 (6/0)	38 (6/32)	213 (3/210)	75 (33/42)	0	23 (22/1)	2 (2/0)	25 (0/25)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-5.1-8. Hanford—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized-1	11	12	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	1	4	0	2	0	0	--	--	--	--	--	--
Decentralized	37	16	1	12	0	22	1	0	0	0	0	0	0	0
Regionalized-1	11	12	1	13	0	23	1	0	0	0	0	0	0	0
Regionalized-2	7	6	1	14	0	25	1	0	0	0	0	0	0	0
Regionalized-3	7	1	1	14	0	25	1	0	0	0	0	0	0	0
Regionalized-4	4	6	1	14	0	25	1	0	0	0	0	0	0	0
Centralized	1	1	3	82	1	147	5	1	0	0	0	0	2	0

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Hanford is in an attainment area for all criteria pollutants, therefore the GCR doe not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the No Action and minimum treatment (no incineration) alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-5.1-9. Hanford—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	1	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	1	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	1	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	1	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2 Trichloro,1,1	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-5.1-10. Hanford—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	3038	<0.1	<0.1	2573	<0.1	<0.1	- -
Decentralized	37	16	17456	0.2	<0.1	9054	0.1	<0.1	- -
Regionalized-1	11	12	17521	0.2	<0.1	8801	0.1	<0.1	- -
Regionalized-2	7	6	18548	0.2	<0.1	10166	0.1	<0.1	- -
Regionalized-3	7	1	13231	0.1	<0.1	7690	0.1	<0.1	- -
Regionalized-4	4	6	18548	0.2	<0.1	10166	0.1	<0.1	- -
Centralized	1	1	87637	0.9	<0.1	43085	0.5	<0.1	- -

Notes:
T = Treatment
D = Disposal
Water supplied by surface water in the Columbia River. Current water use = 9,567,000 gallons/day.
Average flow rate of the Columbia River = 77,560,000,000 gallons/day.
- - = Wastewater discharged to evaporation ponds.
<0.1 indicates that the percentage is less than 0.1%.

Table II-5.1-11. Hanford—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241	Po 210
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	1	0	0	500	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	1	0	0	400	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	2	0	0	700	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	2	0	0	700	0	0
Centralized	1	1	0	0	3	0	0	0	0	0	40	0	0	0	0	0	0	0	40	3	0	10000	0	0

Notes:
T = Treatment
D = Disposal
-- = No disposal at this site for this alternative.

Table II-5.1-12. Hanford—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Remote-Handled)

LLMW Alternatives	T	D*	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LLMW Alternatives	T	D*	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

T = Treatment

D = Disposal

* = In addition to the CH-LLMW disposal sites indicated below, disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR and SRS) for all alternatives except No Action.

"--" = No disposal at this site for this alternative.

Table II-5.1-13. Hanford—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	100	0	60	0	0
Regionalized-1	11	12	0	0	0	100	0	60	0	0
Regionalized-2	7	6	0	0	0	100	0	60	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	100	0	70	0	0
Centralized	1	1	0	0	0	100	0	100	0	0

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	80	0	0	90	0	20	0
Regionalized-1	11	12	70	0	0	90	0	20	0
Regionalized-2	7	6	80	0	0	90	0	30	0
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	80	0	0	100	0	30	0
Centralized	1	1	200	0	0	400	0	40	0

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-5.1-14. Hanford—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Remote-Handled)

LLMW Alternatives	T	D *	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0

LLMW Alternatives	T	D *	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
* = In addition to the CH-LLMW disposal sites indicated below, disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR and SRS) for all alternatives except No Action.
"--" = No disposal at this site for this alternative.

Table II-5.1-15. Hanford—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	230	187	0.09	2.0	0.03	0.05
Decentralized	37	16	759	772	0.36	8.2	0.13	0.18
Regionalized-1	11	12	828	842	0.39	9.0	0.14	0.20
Regionalized-2	7	6	864	878	0.41	9.4	0.14	0.22
Regionalized-3	7	1	631	642	0.30	6.9	0.11	0.14
Regionalized-4	4	6	864	878	0.41	9.4	0.14	0.24
Centralized	1	1	3507	3567	1.66	38.1	0.58	0.76

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.

Table II-5.1-16. Hanford—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	T	D	Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
			Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	1.8	0.03	3038	0.00	2573	1.29	1.14	0.21	86	1
Decentralized	37	16	10.2	0.17	17456	0.02	9054	4.53	1.57	0.24	409	3
Regionalized-1	11	12	10.4	0.17	17521	0.02	8801	4.40	1.56	0.28	506	4
Regionalized-2	7	6	10.9	0.18	18548	0.02	10166	5.08	1.58	0.29	667	5
Regionalized-3	7	1	8.1	0.13	13232	0.02	7690	3.85	1.18	0.21	417	3
Regionalized-4	4	6	10.9	0.18	18548	0.02	10166	5.08	1.66	0.30	473	3
Centralized	1	1	50.2	0.83	87637	0.11	43085	21.54	8.33	1.52	2081	14

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
FTE = Full-time equivalent
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-5.1-17. Hanford—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	260	18	37	182	23	113	147	0
Decentralized	37	16	859	79	187	543	50	610	0	249
Regionalized-1	11	12	937	92	240	548	56	697	0	240
Regionalized-2	7	6	977	98	234	585	60	714	0	263
Regionalized-3	7	1	714	76	207	400	31	714	0	0
Regionalized-4	4	6	977	98	234	585	60	714	0	263
Centralized	1	1	3968	347	1017	2311	294	2926	0	1042

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In current 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.5.2 Hanford LLW

Thirteen of the 14 impact categories apply to LLW at Hanford. These impacts are presented in the following tables.

Impact Category

No.	Description	Table No.	Page No.
1.	Hanford—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-5.2-1	5-21
2.	Hanford—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-5.2-2	5-22
3.	Hanford—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-5.2-3	5-23
4.	Hanford—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-5.2-4	5-24
5.	Hanford—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-5.2-5	5-25
7.	Hanford—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-5.2-6	5-26
8.	Hanford—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-5.2-7	5-27
9.	Hanford—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-5.2-8	5-28
10.	Hanford—LLW—Impacts on Water Resources Due to Increased Water Use	II-5.2-9	5-29
11.	Hanford—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-5.2-10	5-30
13.	Hanford—LLW—Socioeconomic Impacts for Treatment and Disposal	II-5.2-11	5-31
14.	Hanford—LLW—Infrastructure Impacts for Treatment and Disposal	II-5.2-12	5-32
15.	Hanford—LLW—Cost	II-5.2-13	5-33

Table II-5.2-1. Hanford—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	1.5E-01	1.7E-01	4.2E-07	1.5E-08	6.7E-01	4.4E-01
Decentralized		16	9.9E-02	1.2E-01	2.7E-06	9.6E-08	3.7E-01	1.8E-01
Regionalized-1		12	9.9E-02	1.2E-01	2.7E-06	9.6E-08	3.7E-01	1.8E-01
Regionalized-2	11	12	2.0E-01	3.2E-01	3.6E-06	1.3E-07	3.1E-01	1.2E-01
Regionalized-3		6	9.9E-02	1.2E-01	2.7E-06	9.6E-08	3.7E-01	1.8E-01
Regionalized-4	7	6	2.1E-01	3.3E-01	5.0E-02	4.9E-04	3.1E-01	1.2E-01
Regionalized-5	4	6	2.1E-01	3.3E-01	5.0E-02	4.9E-04	3.1E-01	1.2E-01
Regionalized-6		2	9.9E-02	1.2E-01	2.7E-06	9.6E-08	1.1E+00	6.0E-01
Regionalized-7		2	1.0E-01	1.8E-01	4.2E-06	1.5E-07	- -	- -
Centralized-1		1	9.9E-02	1.2E-01	2.7E-06	9.6E-08	2.8E+00	1.4E+00
Centralized-2		1	1.0E-01	1.8E-01	4.2E-06	1.5E-07	- -	- -
Centralized-3	7	1	2.1E-01	3.3E-01	5.0E-02	6.1E-04	1.8E+00	8.9E-01
Centralized-4	7	1	2.1E-01	3.3E-01	5.0E-02	6.1E-04	- -	- -
Centralized-5	1	1	1.5E+00	2.1E+00	7.5E-02	9.7E-04	1.8E+00	8.8E-01

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the Alternative
** Ten sites use existing facilities for Volume Reduction

Table II-5.2-2. Hanford—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Worker			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	8.3E-04	1.4E-06	8.3E-08	3.0E-05	5.1E-08	3.0E-09	3.9E+02	5.4E-01	2.3E-02
Decentralized		16	5.4E-03	9.1E-06	5.4E-07	1.9E-04	3.3E-07	1.9E-08	2.5E+02	3.5E-01	1.5E-02
Regionalized-1		12	5.4E-03	9.1E-06	5.4E-07	1.9E-04	3.3E-07	1.9E-08	2.5E+02	3.5E-01	1.5E-02
Regionalized-2	11	12	7.1E-03	1.2E-05	7.1E-07	2.6E-04	4.4E-07	2.6E-08	4.9E+02	6.9E-01	3.0E-02
Regionalized-3		6	5.4E-03	9.1E-06	5.4E-07	1.9E-04	3.3E-07	1.9E-08	2.5E+02	3.5E-01	1.5E-02
Regionalized-4	7	6	9.4E+01	1.6E-01	9.4E-03	9.7E-01	1.7E-03	9.7E-05	5.2E+02	7.2E-01	3.1E-02
Regionalized-5	4	6	9.4E+01	1.6E-01	9.4E-03	9.7E-01	1.7E-03	9.7E-05	5.2E+02	7.2E-01	3.1E-02
Regionalized-6		2	5.4E-03	9.1E-06	5.4E-07	1.9E-04	3.3E-07	1.9E-08	2.5E+02	3.5E-01	1.5E-02
Regionalized-7		2	8.3E-03	1.4E-05	8.3E-07	3.0E-04	5.1E-07	3.0E-08	2.6E+02	3.6E-01	1.6E-02
Centralized-1		1	5.4E-03	9.1E-06	5.4E-07	1.9E-04	3.3E-07	1.9E-08	2.5E+02	3.5E-01	1.5E-02
Centralized-2		1	8.3E-03	1.4E-05	8.3E-07	3.0E-04	5.1E-07	3.0E-08	2.6E+02	3.6E-01	1.6E-02
Centralized-3	7	1	1.0E+02	1.7E-01	1.0E-02	1.2E+00	2.1E-03	1.2E-04	5.2E+02	7.2E-01	3.1E-02
Centralized-4	7	1	1.0E+02	1.7E-01	1.0E-02	1.2E+00	2.1E-03	1.2E-04	5.2E+02	7.2E-01	3.1E-02
Centralized-5	1	1	1.5E+02	2.5E-01	1.5E-02	1.9E+00	3.3E-03	1.9E-04	3.8E+03	5.3E+00	2.3E-01

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-3. Hanford—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	1.7E+03	2.3E+00	1.0E-01
Decentralized		16	9.3E+02	1.3E+00	5.6E-02
Regionalized-1		12	9.3E+02	1.3E+00	5.6E-02
Regionalized-2	11	12	7.8E+02	1.1E+00	4.7E-02
Regionalized-3		6	9.3E+02	1.3E+00	5.6E-02
Regionalized-4	7	6	7.8E+02	1.1E+00	4.7E-02
Regionalized-5	4	6	7.8E+02	1.1E+00	4.7E-02
Regionalized-6		2	2.9E+03	4.0E+00	1.7E-01
Regionalized-7		2	- -	- -	- -
Centralized-1		1	6.9E+03	9.7E+00	4.2E-01
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	4.4E+03	6.2E+00	2.7E-01
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	4.4E+03	6.2E+00	2.6E-01

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-4. Hanford—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	8.6E-12	2.6E-11	1.4E-03
Decentralized		16	5.5E-11	1.7E-10	2.5E-04
Regionalized-1		12	5.5E-11	1.7E-10	2.5E-04
Regionalized-2	11	12	7.3E-11	2.2E-10	1.1E-03
Regionalized-3		6	5.5E-11	1.7E-10	2.5E-04
Regionalized-4	7	6	9.6E-07	8.5E-07	3.4E-03
Regionalized-5	4	6	9.6E-07	8.5E-07	3.4E-03
Regionalized-6		2	5.5E-11	1.7E-10	4.1E-03
Regionalized-7		2	8.5E-11	2.6E-10	- -
Centralized-1		1	5.5E-11	1.7E-10	1.2E-03
Centralized-2		1	8.5E-11	2.6E-10	- -
Centralized-3	7	1	1.0E-06	1.1E-06	2.3E-03
Centralized-4	7	1	1.0E-06	1.1E-06	- -
Centralized-5	1	1	1.5E-06	1.7E-06	2.3E-03

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-5. Hanford—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite MEI			Noninvolved Worker MEI			Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	1.7E-08	2.9E-11	1.7E-12	5.2E-08	8.9E-11	5.2E-12	2.8E+00	4.8E-03	2.8E-04
Decentralized		16	1.1E-07	1.9E-10	1.1E-11	3.3E-07	5.6E-10	3.3E-11	5.0E-01	8.6E-04	5.0E-05
Regionalized-1		12	1.1E-07	1.9E-10	1.1E-11	3.3E-07	5.6E-10	3.3E-11	5.0E-01	8.6E-04	5.0E-05
Regionalized-2	11	12	1.5E-07	2.5E-10	1.5E-11	4.4E-07	7.5E-10	4.4E-11	2.3E+00	3.9E-03	2.3E-04
Regionalized-3		6	1.1E-07	1.9E-10	1.1E-11	3.3E-07	5.6E-10	3.3E-11	5.0E-01	8.6E-04	5.0E-05
Regionalized-4	7	6	1.9E-03	3.3E-06	1.9E-07	1.7E-03	2.9E-06	1.7E-07	6.8E+00	1.2E-02	6.8E-04
Regionalized-5	4	6	1.9E-03	3.3E-06	1.9E-07	1.7E-03	2.9E-06	1.7E-07	6.8E+00	1.2E-02	6.8E-04
Regionalized-6		2	1.1E-07	1.9E-10	1.1E-11	3.3E-07	5.6E-10	3.3E-11	8.1E+00	1.4E-02	8.1E-04
Regionalized-7		2	1.7E-07	2.9E-10	1.7E-11	5.2E-07	8.8E-10	5.2E-11	--	--	--
Centralized-1		1	1.1E-07	1.9E-10	1.1E-11	3.3E-07	5.6E-10	3.3E-11	2.4E+00	4.1E-03	2.4E-04
Centralized-2		1	1.7E-07	2.9E-10	1.7E-11	5.2E-07	8.8E-10	5.2E-11	--	--	--
Centralized-3	7	1	2.1E-03	3.5E-06	2.1E-07	2.1E-03	3.6E-06	2.1E-07	4.6E+00	7.8E-03	4.6E-04
Centralized-4	7	1	2.1E-03	3.5E-06	2.1E-07	2.1E-03	3.6E-06	2.1E-07	--	--	--
Centralized-5	1	1	3.1E-03	5.2E-06	3.1E-07	3.4E-03	5.8E-06	3.4E-07	4.6E+00	7.8E-03	4.6E-04

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-6. Hanford—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	20 (11/9)	33 (30/2)	0	2 (2/0)	3 (3/0)	4 (3/1)	44 (0/44)	9 (0/9)	0	0	0	5 (0/5)
Decentralized		16	44 (7/37)	26 (18/7)	0	1 (1/0)	2 (2/0)	6 (2/4)	47 (0/47)	9 (0/9)	0	0	0	6 (0/6)
Regionalized-1		12	44 (7/37)	26 (18/7)	0	1 (1/0)	2 (2/0)	6 (2/4)	47 (0/47)	9 (0/9)	0	0	0	6 (0/6)
Regionalized-2	11	12	80 (7/73)	34 (19/15)	0	2 (2/0)	2 (2/0)	11 (2/9)	79 (0/79)	17 (1/16)	0	0	0	9 (0/9)
Regionalized-3		6	44 (7/37)	26 (18/7)	0	1 (1/0)	2 (2/0)	6 (2/4)	47 (0/47)	9 (0/9)	0	0	0	6 (0/6)
Regionalized-4	7	6	84 (8/76)	36 (21/150)	0	2 (2/0)	2 (2/0)	11 (2/9)	81 (0/81)	16 (0/16)	0	0	0	10 (0/10)
Regionalized-5	4	6	84 (8/76)	36 (21/15)	0	2 (2/0)	2 (2/0)	11 (2/9)	81(0/81)	16 (0/16)	0	0	0	10 (0/10)
Regionalized-6		2	99 (13/86)	51 (34/17)	0	3 (3/0)	3 (3/0)	13 (3/10)	115 (1/114)	28 (2/26)	0	0	0	14 (0/14)
Regionalzied-7		2	13 (2/11)	8 (6/2)	0	0	1 (1/0)	2 (1/1)	13 (0/13)	4 (0/4)	0	0	0	2 (0/2)
Centralized-1		1	197 (37/160)	128 (96/32)	0	8 (8/0)	9 (9/0)	28 (9/19)	238 (3/235)	71 (7/64)	0	2 (1/1)	0	30 (1/29)
Centralized-2		1	13 (2/11)	8 (6/2)	0	0	1 (1/0)	2 (1/1)	13 (0/13)	4 (0/4)	0	0	0	2 (0/2)
Centralized-3	7	1	186 (29/157)	108 (77/31)	0	6 (6/0)	7 (7/0)	26 (7/19)	202 (3/199)	47 (7/40)	0	1 (1/0)	0	25 (1/24)
Centralized-4	7	1	66 (6/60)	27 (15/12)	0	1 (1/0)	1 (1/0)	8 (1/7)	70 (0/70)	30 (0/30)	0	1 (0/1)	0	10 (0/10)
Centralized-5	1	1	431 (58/373)	225 (151/74)	0	13 (12/1)	14 (14/0)	60 (15/45)	442 (2/440)	116 (11/105)	0	7 (5/2)	0	54 (0/54)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-7. Hanford—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	1	0	0	0	0	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1		12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	11	12	0	1	0	1	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	1	6	0	3	0	0	--	--	--	--	--	--
Regionalized-7		2	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-1		1	3	19	0	8	0	1	--	--	--	--	--	--
Centralized-2		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	3	19	0	8	0	1	0	0	0	0	0	0
Centralized-4	7	1	0	1	0	1	0	0	0	0	0	0	0	0
Centralized-5	1	1	2	27	0	36	1	1	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Hanford is in an attainment area for all criteria pollutants, therefore the GCR do not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the No Action and minimum treatment (no incineration) alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-8. Hanford—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	2	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	2	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	2	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	2	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	3	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-9. Hanford—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	9236	0.1	<0.1	13096	0.1	<0.1	--
Decentralized		16	17930	0.2	<0.1	8772	0.1	<0.1	--
Regionalized-1		12	17930	0.2	<0.1	8772	0.1	<0.1	--
Regionalized-2	11	12	22349	0.2	<0.1	10996	0.1	<0.1	--
Regionalized-3		6	17930	0.2	<0.1	8772	0.1	<0.1	--
Regionalized-4	7	6	22172	0.2	<0.1	11331	0.1	<0.1	--
Regionalized-5	4	6	22172	0.2	<0.1	11331	0.1	<0.1	--
Regionalized-6		2	32371	0.3	<0.1	12256	0.1	<0.1	--
Regionalized-7		2	6887	0.1	<0.1	1615	<0.1	<0.1	--
Centralized-1		1	82007	0.9	<0.1	16522	0.2	<0.1	--
Centralized-2		1	6887	0.1	<0.1	1615	<0.1	<0.1	--
Centralized-3	7	1	86265	0.9	<0.1	31870	0.3	<0.1	--
Centralized-4	7	1	16326	0.2	<0.1	7153	0.1	<0.1	--
Centralized-5	1	1	199473	2.1	<0.1	101650	1.1	<0.1	--

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
Water supplied by surface water in the Columbia River. Current water use = 9,567,000 gallons/day.
Average flow rate of the Columbia River = 77,560,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
-- = Construction is not considered under No Action Alternative; Wastewater discharged to evaporation ponds.
<0.1 indicates that the percentage is less than 0.1%.

Table II-5.2-10. Hanford—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 226	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized		16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	0	0	0	0	0	0	0	0	0	0
Centralized-1		1	0	2	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	4	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	4	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	0	0	1	0	0	0	0	0	10	0	0	0	0	0	0	0	10	1	0	3000	0	0
Decentralized		16	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	600	0	0
Regionalized-1		12	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	600	0	0
Regionalized-2	11	12	0	0	2	0	0	0	0	0	4	0	0	0	0	0	0	0	8	2	0	3000	0	0
Regionalized-3		6	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	600	0	0
Regionalized-4	7	6	0	0	2	0	0	0	0	0	30	0	0	0	0	0	0	0	30	2	0	8000	0	0
Regionalized-5	4	6	0	0	2	0	0	0	0	0	30	0	0	0	0	0	0	0	30	2	0	8000	0	0
Regionalized-6		2	0	0	8	0	0	0	0	1	10	0	0	0	1	0	0	0	40	7	0	9000	0	0
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	9	0	0	3000	0	0
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	0	4	0	0	0	0	0	6	0	0	0	0	0	0	0	20	4	0	5000	0	0
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	0	4	0	0	0	0	0	6	0	0	0	0	0	0	0	20	4	0	5000	0	0

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
- - = Disposal is not considered for this Alternative.

Table II-5.2-11. Hanford—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	1081	880	0.41	9.4	0.14	0.25
Decentralized		16	756	769	0.36	8.2	0.13	0.16
Regionalized-1		12	756	769	0.36	8.2	0.13	0.16
Regionalized-2	11	12	1186	1206	0.56	12.9	0.20	0.28
Regionalized-3		6	756	769	0.36	8.2	0.13	0.16
Regionalized-4	7	6	1219	1240	0.58	13.2	0.20	0.29
Regionalized-5		6	1219	1240	0.58	13.2	0.20	0.29
Regionalized-6		2	1823	1854	0.87	19.8	0.30	0.38
Regionalized-7		2	210	214	0.10	2.3	0.04	0.04
Centralized-1		1	3591	3653	1.70	39.0	0.60	0.75
Centralized-2		1	210	214	0.10	2.3	0.04	0.04
Centralized-3	7	1	3153	3207	1.50	34.2	0.53	0.69
Centralized-4	7	1	884	899	0.42	9.6	0.15	0.21
Centralized-5	1	1	7036	7157	3.34	76.4	1.17	1.50

NOTES:
T = Treatment
D = Disposal
ROI = Region of Influence
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-12. Hanford—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	22.2	0.37	13096	0.02	13096	6.55	2.00	0.37	295	2
Decentralized		16	10.3	0.17	17930	0.02	8772	4.39	2.70	0.49	287	2
Regionalized-1		12	10.3	0.17	17930	0.02	8772	4.39	2.70	0.49	287	2
Regionalized-2	11	12	11.6	0.19	22349	0.03	10996	5.50	3.40	0.62	564	4
Regionalized-3		6	10.3	0.17	17930	0.02	8772	4.39	2.70	0.49	287	2
Regionalized-4	7	6	12.7	0.21	22172	0.03	11331	5.67	3.50	0.64	591	4
Regionalized-5	4	6	12.7	0.21	22172	0.03	11331	5.67	3.50	0.64	591	4
Regionalized-6		2	15.5	0.25	32371	0.04	12256	6.30	10.98	2.00	663	5
Regionalized-7		2	3.7	0.06	6887	0.01	1615	0.81	0.83	0.15	84	1
Centralized-1		1	37.5	0.62	82007	0.10	16522	8.26	33.02	6.00	1238	9
Centralized-2		1	3.7	0.06	6887	0.01	1615	0.81	0.83	0.15	84	1
Centralized-3	7	1	32.7	0.54	86265	0.11	31870	15.94	34.62	6.29	1215	9
Centralized-4	7	1	8.3	0.13	16326	0.02	7153	3.58	1.90	0.35	468	3
Centralized-5	1	1	86.4	1.40	199473	0.25	101650	50.83	19.80	3.60	2891	20

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-5.2-13. Hanford—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	1223	11	37	1066	109	376	0	847
Decentralized		16	856	59	117	599	80	238	0	618
Regionalized-1		12	856	59	117	599	80	238	0	618
Regionalized-2	11	12	1342	124	224	881	112	962	0	380
Regionalized-3		6	856	59	117	599	80	238	0	618
Regionalized-4	7	6	1379	135	228	901	115	1000	0	380
Regionalized-5	4	6	1379	135	228	901	115	1000	0	380
Regionalized-6		2	2062	155	242	1275	391	238	0	1824
Regionalized-7		2	238	18	57	138	24	238	0	0
Centralized-1		1	4063	301	433	2556	774	238	0	3825
Centralized-2		1	238	18	57	138	24	238	0	0
Centralized-3	7	1	3568	307	420	2475	365	1000	0	2568
Centralized-4	7	1	1000	100	192	653	54	1000	0	0
Centralized-5	1	1	7961	674	1372	5246	669	5393	0	2568

Notes:
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In current 1994 dollars.
Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.5.3 Hanford TRUW

Twelve of the 14 impact categories apply to TRUW at Hanford. These impacts are presented in the following tables.

Impact Category

No.	Description	Table No.	Page No.
1.	Hanford—TRUW—Treatment: Estimated Number of Fatalities	II-5.3-1	5-35
2.	Hanford—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-5.3-2	5-36
4.	Hanford—TRUW—Treatment: MEI Probability of Cancer Fatality	II-5.3-3	5-37
5.	Hanford—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-5.3-4	5-38
6.	Hanford—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-5.3-5	5-39
7.	Hanford—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-5.3-6	5-40
8.	Hanford—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-5.3-7	5-41
9.	Hanford—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-5.3-8	5-42
10.	Hanford—TRUW—Impacts on Water Resources Due to Increased Water Use	II-5.3-9	5-43
13.	Hanford—TRUW—Socioeconomic Impacts for Treatment	II-5.3-10	5-44
14.	Hanford—TRUW—Infrastructure Impacts for Treatment	II-5.3-11	5-45
15.	Hanford—TRUW—Cost	II-5.3-12	5-46

Table II-5.3-1. Hanford—TRUW—Treatment: Estimated Number of Fatalities

40 TRUW Alternatives	Treatment						
	Number of Sites			WM Worker		Offsite Population	Noninvolved Workers
	CH Treat	RH Treat	Treatment Standard	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure
No Action **	16	5	WIPP WAC	1.2E-01	7.0E-02	5.3E-06	3.5E-07
Decentralized ***	16	5	WIPP WAC	1.3E-01	2.6E-01	2.3E-05	1.1E-06
Regionalized-1	5	2	Reduce Gas	1.3E-01	3.9E-01	4.1E-05	2.0E-06
Regionalized-2	5	2	LDR	1.3E-01	5.1E-01	1.7E-01	8.2E-03
Regionalized-3	3	2	LDR	1.3E-01	5.1E-01	1.7E-01	8.2E-03
Centralized	WIPP	2	LDR	1.6E-01	3.2E-01	6.5E-04	3.1E-05

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-5.3-2. Hanford—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	1.5E-02	2.5E-05	2.6E-11	1.5E-06	7.0E-04	1.2E-06	1.6E-11	7.0E-08	3.1E+02	4.3E-01	1.8E-08	1.8E-02
Decentralized***	16	5	WIPP WAC	4.6E-02	7.9E-05	8.4E-11	4.6E-06	2.3E-03	3.8E-06	5.0E-11	2.3E-07	3.1E+02	4.4E-01	2.2E-08	1.9E-02
Regionalized-1	5	2	Reduce Gas	8.2E-02	1.4E-04	1.3E-10	8.2E-06	4.0E-03	6.8E-06	7.9E-11	4.0E-07	3.3E+02	4.5E-01	1.1E-07	2.0E-02
Regionalized-2	5	2	LDR	3.3E+02	5.7E-01	1.3E-10	3.3E-02	1.6E+01	2.8E-02	7.5E-11	1.6E-03	3.2E+02	4.5E-01	1.9E-07	1.9E-02
Regionalized-3	3	2	LDR	3.3E+02	5.7E-01	1.3E-10	3.3E-02	1.6E+01	2.8E-02	7.5E-11	1.6E-03	3.2E+02	4.5E-01	1.9E-07	1.9E-02
Centralized	WIPP	2	LDR	1.3E+00	2.2E-03	7.9E-11	1.3E-04	6.2E-02	1.1E-04	4.7E-11	6.2E-06	4.1E+02	5.8E-01	7.1E-08	2.5E-02

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-5.3-3. Hanford—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	1.5E-10	6.1E-10
Decentralized***	16	5	WIPP WAC	4.8E-10	1.9E-09
Regionalized-1	5	2	Reduce Gas	8.5E-10	3.4E-09
Regionalized-2	5	2	LDR	3.4E-06	1.4E-05
Regionalized-3	3	2	LDR	3.4E-06	1.4E-05
Centralized	WIPP	2	LDR	1.3E-08	5.3E-08

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal of WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-5.3-4. Hanford—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	3.0E-07	5.1E-10	<9.9E-14	3.0E-11	1.2E-09	2.1E-06	3.1E-14	1.2E-10
Decentralized ***	16	5	WIPP WAC	9.6E-07	1.6E-09	<9.9E-14	9.6E-11	3.9E-06	6.6E-09	9.8E-14	3.9E-10
Regionalized-1	5	2	Reduce Gas	1.7E-06	2.9E-09	<9.9E-14	1.7E-10	6.9E-06	1.2E-08	1.6E-13	6.9E-10
Regionalized-2	5	2	LDR	6.8E-03	1.2E-05	<9.9E-14	6.8E-07	2.8E-02	4.8E-05	1.5E-13	2.8E-06
Regionalized-3	3	2	LDR	6.8E-03	1.2E-05	<9.9E-14	6.8E-07	2.8E-02	4.8E-05	1.5E-13	2.8E-06
Centralized	WIPP	2	LDR	2.7E-05	4.6E-08	<9.9E-14	2.7E-09	1.1E-04	1.8E-07	9.2E-14	1.1E-08

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal of WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites then to WIPP.
MEI = Maximally Exposed Individual

Table II-5.3-5. Hanford—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

Exposure Index = TRUW Alternatives	Number of Sites		Treatment Standard	Treatment		
	CH Treat	RH Treat		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	7.2E-13	2.5E-11	8.0E-07
Decentralized***	16	5	WIPP WAC	4.5E-12	1.6E-10	1.6E-06
Regionalized-1	5	2	Reduce Gas	7.2E-12	2.5E-10	1.6E-06
Regionalized-2	5	2	LDR	7.0E-12	2.5E-10	1.4E-05
Regionalized-3	3	2	LDR	7.0E-12	2.5E-10	1.4E-05
Centralized	WIPP	2	LDR	5.1E-12	1.8E-10	1.6E-06

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-5.3-6. Hanford—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	36 (0/36)	7 (0/7)	0	0	0	4 (0/4)
Decentralized***	16	5	WIPP WAC	103 (32/71)	97 (82/14)	0	7 (7/0)	8 (8/0)	17 (8/9)	71 (0/71)	15 (1/14)	0	0	0	9 (0/9)
Regionalized-1	5	2	Reduce Gas	118 (33/85)	103 (86/17)	0	7 (7/0)	8 (8/0)	18 (8/10)	82 (0/82)	17 (1/16)	0	0	0	10 (0/10)
Regionalized-2	5	2	LDR	155 (36/119)	117 (94/24)	0	7 (7/0)	9 (9/0)	23 (9/14)	92 (0/92)	19 (1/18)	0	0	0	11 (0/11)
Regionalized-3	3	2	LDR	155 (36/119)	117 (94/24)	0	7 (7/0)	9 (9/0)	23 (9/14)	92 (0/92)	19 (1/18)	0	0	0	11 (0/11)
Centralized	WIPP	2	LDR	109 (31/78)]	96 (80/16)	0	6 (6/0)	8 (8/0)	17 (8/9)	82 (0/82)	17 (1/16)	0	0	0	10 (0/10)

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-5.3-7. Hanford—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--
Centralized	WIPP	2	LDR	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	0	1	0	0	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	0	2	0	1	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	2	0	1	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	2	0	2	0	0	0	0	0	0	0	0
Regionalized-3	3	2	LDR	0	2	0	2	0	0	0	0	0	0	0	0
Centralized	WIPP	2	LDR	0	1	0	1	0	0	0	0	0	0	0	0

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Hanford is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for alternatives that do not involve treatment to LDR (incineration) are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-5.3-8. Hanford—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance												
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	7	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	7	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-5.3-9. Hanford—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	2069	<0.1	<0.1	- -
Decentralized***	16	5	WIPP WAC	52728	0.6	<0.1	11744	0.1	<0.1	- -
Regionalized-1	5	2	Reduce Gas	56413	0.6	<0.1	13956	0.1	<0.1	- -
Regionalized-2	5	2	LDR	64729	0.7	<0.1	15519	0.2	<0.1	- -
Regionalized-3	3	2	LDR	64729	0.7	<0.1	15519	0.2	<0.1	- -
Centralized	WIPP	2	LDR	52910	0.6	<0.1	6020	0.1	<0.1	- -

Notes:
Water supplied by surface water in the Columbia River. Current water use = 9,567,000 gallons/day.
Average flow rate of the Columbia River = 77,560,000,000 gallons/day.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Wastewater discharged to evaporation ponds.
<0.1 indicates that the percentage is less than 0.1%.

Table II-5.3-10. Hanford—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	254	207	0.10	2.2	0.03	0.14
Decentralized***	16	5	WIPP WAC	1600	1628	0.76	17.4	0.27	0.28
Regionalized-1	5	2	Reduce Gas	1875	1908	0.89	20.4	0.31	0.33
Regionalized-2	5	2	LDR	2202	2240	1.05	23.9	0.37	0.39
Regionalized-3	3	2	LDR	2202	2240	1.05	23.9	0.37	0.39
Centralized	WIPP	2	LDR	1602	1630	0.76	17.4	0.27	0.28

Notes:
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-5.3-11. Hanford—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0.0	0.00	2796	0.00	2796	1.40	0.3	0.05	0	0.00
Decentralized***	16	5	WIPP WAC	21.8	0.36	52728	0.07	11744	5.87	2.6	0.47	788	5.50
Regionalized-1	5	2	Reduce Gas	23.5	0.39	56413	0.07	13956	6.98	2.6	0.48	986	6.80
Regionalized-2	5	2	LDR	24.7	0.41	64729	0.08	15519	7.76	3.6	0.66	1317	9.10
Regionalized-3	3	2	LDR	24.7	0.41	64729	0.08	15519	7.76	3.6	0.66	1317	9.10
Centralized	WIPP	2	LDR	21.0	0.35	52910	0.07	6020	3.01	4.9	0.88	874	6.10

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-5.3-12. Hanford—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	287	0	0	252	35	0	235	52
Decentralized***	16	5	WIPP - WAC	1810	110	403	960	338	584	1188	39
Regionalized-1	5	2	Reduce Gas	2122	156	480	1116	371	584	1446	93
Regionalized-2	5	2	LDR	2491	187	679	1241	384	584	1813	95
Regionalized-3	3	2	LDR	2491	187	679	1241	384	584	1813	95
Centralized	WIPP	2	LDR	1813	128	445	917	323	584	1180	49

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP to be assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.5.4 Hanford HLW

Nine of the 14 impact categories apply to HLW at Hanford. These impacts are presented in the following tables.

Impact Category

No.	Description	Table No.	Page No.
1.	Hanford—HLW—Storage: Estimated Number of Fatalities	II-5.4-1	5-48
2.	Hanford—HLW—Storage: Estimated Number of Cancer Incidences and Genetic Effects	II-5.4-2	5-49
7.	Hanford—HLW—Emissions in Tons per Year of Criteria Air Pollutants	II-5.4-3	5-50
8.	Hanford—HLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-5.4-4	5-51
9.	Hanford—HLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-5.4-5	5-52
10.	Hanford—HLW—Impacts on Water Resources Due to Increased Water Use	II-5.4-6	5-53
13.	Hanford—HLW—Socioeconomic Impacts for Storage	II-5.4-7	5-54
14.	Hanford—HLW—Infrastructure Impacts for Storage	II-5.4-8	5-55
15.	Hanford—HLW—Cost	II-5.4-9	5-56

Table II-5.4-1. Hanford—HLW—Storage: Estimated Number of Fatalities

HLW Alternatives	Number of Sites	WM Worker	
	S	Radiation Exposure	Physical Hazards
No Action	4	1.1E+00	4.2E-01
Decentralized	4	1.7E+00	6.4E-01
Regionalized-1	3	1.7E+00	6.4E-01
Regionalized-2	3	1.8E+00	6.7E-01
Centralized	1	2.1E+00	7.5E-01
Note: S = Storage			

Table II-5.4-2. Hanford—HLW—Storage: Estimated Number of Cancer Incidences and Genetic Effects

HLW Alternatives	Number of Sites	WM Worker		
	S	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	4	2.7E+03	3.8E+00	1.6E-01
Decentralized	4	4.4E+03	6.1E+00	2.6E-01
Regionalized-1	3	4.4E+03	6.1E+00	2.6E-01
Regionalized-2	3	4.5E+03	6.4E+00	2.7E-01
Centralized	1	5.2E+03	7.2E+00	3.1E-01
Notes: S = Storage				

Table II-5.4-3. Hanford—HLW—Emissions in Tons per Year of Criteria Air Pollutants

HLW Alternatives	Number of Sites S	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	4	2 (1/1)	3 (3/0)	0	0	0	0	13 (0/13)	3 (0/3)	0	0	0	2 (0/2)
Decentralized	4	9 (5/4)	14 (14/0)	0	1 (1/0)	1 (1/0)	1 (1/0)	16 (0/16)	3 (0/3)	0	0	0	2 (0/2)
Regionalized-1	3	9 (5/4)	14 (14/0)	0	1 (1/0)	1 (1/0)	1 (1/0)	16 (0/16)	3 (0/3)	0	0	0	2 (0/2)
Regionalized-2	3	9 (5/4)	14 (14/0)	0	1 (1/0)	1 (1/0)	1 (1/0)	16 (0/16)	4 (0/4)	0	0	0	2 (0/2)
Centralized	1	11 (6/5)	15 (15/0)	0	1 (1/0)	1 (1/0)	1 (1/0)	17 (0/17)	4 (0/4)	0	0	0	2 (0/2)

Notes:
S = Storage
Data is based on repository beginning to accept HLW canisters in 2015.
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)

13.	INEL—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-6.1-15	6-17
14.	INEL—LLMW—Infrastructure Impacts for Treatment and Disposal	II-6.1-16	6-18
15.	INEL—LLMW—Cost	II-6.1-17	6-19

II.6.0 INEL

INEL currently is custodian of significant volumes of LLMW, LLW, TRUW, HLW, and HW. Each of the waste types is treated independently in the following sections.

II.6.1 INEL LLMW

Seventeen tables immediately following portray impacts of LLMW at INEL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	INEL—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-6.1-1	6-3
2.	INEL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-6.1-2	6-4
3.	INEL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-6.1-3	6-5
4.	INEL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-6.1-4	6-6
5.	INEL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-6.1-5	6-7
6.	INEL—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure	II-6.1-6	6-8
7.	INEL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-6.1-7	6-9
8.	INEL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-6.1-8	6-10
9.	INEL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-6.1-9	6-11
10.	INEL—LLMW—Impacts on Water Resources Due to Increased Water Use	II-6.1-10	6-12
11.	INEL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-6.1-11	6-13
11.	INEL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Remote-Handled)	II-6.1-12	6-14
12.	INEL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-6.1-13	6-15
12.	INEL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Remote-Handled)	II-6.1-14	6-16

Table II-5.5-11. Hanford—HW—Cost

HW Alternatives	Number of Sites	Total Cost (Millions) (1)	Government Cost by Life-Cycle Component (1)				Cost by Functional Area (1)	
							Treatment & Disposal	
	T		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Government (2) (Millions)	Commercial (Millions)
No Action	2	6	--	--	--	--	--	6
Decentralized	3	6	--	--	--	--	--	6
Regionalized-1	5	70	5	21	35	1	61	8
Regionalized-2	2	--	--	--	--	--	--	--

Notes:
T = Treatment
-- = Not considered for this site.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Functional Areas.
(2) Government costs equal to the sum of the life-cycle components.

Table II-5.5-10. Hanford—HW—Infrastructure Impacts for Treatment

HW Alternatives	Number of Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	2	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	1	0.017	1366	0.00	933	0.47	0.28	0.05	22	0
Regionalized-2	2	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
GPD = Gallons per Day
MW = Megawatts Electric
-- = Treatment is not considered for this alternative.
(1) Based on 1991 Site Employment.

Table II-5.5-9. Hanford—HW—Socioeconomic Impacts for Treatment

HW Alternatives	Number of Sites	Effect of Implementation of Alternatives					
			Jobs		Income		
	T	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	2	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--
Regionalized 1	5	54	63	0.03	0:7	0.01	0.01
Regionalized 2	2	--	--	--	--	--	--

Notes:
T = Treatment
-- = Treatment is not considered for this alternative.
(1) In 1990 dollars.
(2) Compared to 1990 baseline.

Table II-5.5-8. Hanford—HW—Impacts on Water Resources Due to Increased Water Use

HW Alternatives	Number of Sites T	Construction Water Use GPD	Construction % Current Use	Construction % Stream Flow	Operations Water Use GPD	Operations % Current Use	Operations % Stream Flow	Operations Waste Water % Stream Flow
No Action	2	--	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--	--
Regionalized-1	5	1366	<0.1	<0.1	933	<0.1	<0.1	--
Regionalized-2	2	--	--	--	--	--	--	--

Notes:
T = Treatment
Water supplied by surface water in the Columbia River. Current water use = 9,567,000 gallons/day.
Average flow rate of the Columbia River = 77,560,000,000 gallons/day.
- - = Treatment is not considered for this alternative, and where treatment is considered wastewater is dischaged to evaporation ponds.
<0.1 indicates that the percentage is less than 0.1%.

Table II-5.5-7. Hanford—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HW Alternatives	Number of Sites	Operations & Maintenance											
	T	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	2	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	--	--	--	0	--	--	0	0	--	--	--	--
Regionalized-2	2	--	--	--	--	--	--	--	--	--	--	--	--

HW Alternatives	Number of Sites	Operations & Maintenance									
	T	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	2	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	--	0	--	--	0	--	0	0	0	9
Regionalized-2	2	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
Percentages <1% are shown as zeros.
-- = Emissions of certain hazardous or toxic air pollutants, including radionuclides, from HW treatment facilities are assumed to be negligible.

Table II-5.5-6. Hanford—HW—Percent of Standard/Guideline for Criteria Air Pollutants

HW Alternatives	Number of Sites	Construction					
		Percent of Tons/Year General Conformity Rule (1)					
	T	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--
Regionalized-1	5	--	--	--	--	--	--
Regionalized-2	2	--	--	--	--	--	--

HW Alternatives	Number of Sites	Operations & Maintenance											
		Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	0	1	0	8	4	0	0	0	0	0	0	0
Regionalized-2	2	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Hanford is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the Regionalized-2 Alternative are assumed to be negligible since no waste is treated at Hanford under this alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-5.5-5. Hanford—HW—Emissions in Tons per Year of Criteria Air Pollutants

HW Alternatives	Number of Sites T	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	6 (4/2)	10 (10/0)	0	1 (1/0)	1 (1/0)	1 (1/0)	0	0	0	1 (1/0)	2 (2/0)	0
Regionalized-2	2	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)

Table II-5.5-4. Hanford—HW—Treatment: Noncancer Health Risk From Chemical Exposure

HW Alternatives	Number of Sites	Treatment		
	T	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action	2	--	--	--
Decentralized	3	--	--	--
Regionalized-1	5	1.9E-03	6.7E-02	5.9E+00
Regionalized-2	2	--	--	--

Notes:
T = Treatment
MEI = Maximally Exposed Individual
-- = Treatment is not considered for this alternative.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-5.5-3. Hanford—HW—Treatment: MEI Probability of Cancer Incidences

HW Alternatives	Number of Sites	Treatment	
	T	Offsite MEI Cancer Incidence Probability	Noninvolved MEI Cancer Incidence Probability
No Action	2	- -	- -
Decentralized	3	- -	- -
Regionalized-1	5	1.4E-07	5.0E-06
Regionalized-2	2	- -	- -

Notes:
T = Treatment
MEI = Maximally Exposed Individual
- - = Treatment is not considered for this alternative.

Table II-5.5-2. Hanford—HW—Treatment: Estimated Number of Cancer Incidences

HW Alternatives	Number of Sites	Treatment		
	T	Offsite Population Chemical Cancer Incidence	Noninvolved Worker Chemical Cancer Incidence	WM Worker Chemical Cancer Incidence
No Action	2	- -	- -	- -
Decentralized	3	- -	- -	- -
Regionalized-1	5	4.3E-03	2.6E-03	2.9E-01
Regionalized-2	2	- -	- -	- -

Notes:
T = Treatment
- - = Treatment is not considered for this alternative.

Table II-5.5-1. Hanford—HW—Treatment: Estimated Number of Fatalities

HW Alternatives	Number of Sites	WM Worker
	T	Physical Hazards
No Action	2	- -
Decentralized	3	- -
Regionalized-1	5	1.8E-02
Regionalized-2	2	- -

Notes:
- - = Treatment is not considered for this alternative
T = Treatment

II.5.5 Hanford HW

Eleven of the 14 impact categories apply to HW at Hanford. These impacts are presented in the following tables.

Impact Category

No.	Description	Table No.	Page No.
1.	Hanford—HW—Treatment: Estimated Number of Fatalities	II-5.5-1	5-58
3.	Hanford—HW—Treatment: Estimated Number of Cancer Incidences	II-5.5-2	5-59
5.	Hanford—HW—Treatment: MEI Probability of Cancer Incidences	II-5.5-3	5-60
6.	Hanford—HW—Treatment: Noncancer Health Risk From Chemical Exposure	II-5.5-4	5-61
7.	Hanford—HW—Emissions in Tons per Year of Criteria Air Pollutants	II-5.5-5	5-62
8.	Hanford—HW—Percent of Standard/Guideline for Criteria Air Pollutants	II-5.5-6	5-63
9.	Hanford—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-5.5-7	5-64
10.	Hanford—HW—Impacts on Water Resources Due to Increased Water Use	II-5.5-8	5-65
13.	Hanford—HW—Socioeconomic Impacts for Treatment	II-5.5-9	5-66
14.	Hanford—HW—Infrastructure Impacts for Treatment	II-5.5-10	5-67
15.	Hanford—HW—Cost	II-5.5-11	5-68

Table II-5.4-9. Hanford—HLW—Cost

HLW Alternatives	Number of Sites	Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)		Cost by Functional Area (1)	
	S		Construction (Millions) (2)	Operations & Maintenance (3) (Millions)	Storage (Millions)	Handling (Millions)
No Action	4	826	22	804	37	789
Decentralized	4	1426	280	1146	486	940
Regionalized-1	3	1426	280	1146	486	940
Regionalized-2	3	1463	280	1183	497	966
Centralized	1	1734	360	1374	688	1046
Centralized Delayed Acceptance	1	1780	400	1380	730	1050

Notes:
S = Storage
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of Life Cycle Components = Sum of Functional Areas.
(2) Construction costs are for the interim storage facilities.
(3) Operations and maintenance costs include operation and maintenance of the interim storage facilities, and the handling of canisters (unloading/loading of canisters into or out of the interim storage facilities).

Table II-5.4-8. Hanford—HLW—Infrastructure Impacts for Storage

HLW Alternatives	Number of Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
	S	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	4	1	0.02	3,200	<0.01	3,200	1.6	0.06	0.02	12	0
Decentralized	4	14	0.23	8,000	0.01	8,000	4.0	0.10	0.03	39	0
Regionalized-1	3	14	0.23	8,000	0.01	8,000	4.0	0.10	0.03	39	0
Regionalized-2	3	14	0.23	8,000	0.01	8,000	4.0	0.10	0.03	40	0
Centralized	1	16	0.26	8,000	0.01	8,000	4.0	0.10	0.03	43	0

Notes:
S = Storage
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.

Table II-5.4-7. Hanford—HLW—Socioeconomic Impacts for Storage

HLW Alternatives	Number of Sites	Effect of Implementation of Alternatives					
			Jobs		Income		
	S	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	4	130	127	0.06	1.4	0.02	0.04
Decentralized	4	292	285	0.13	3.0	0.05	0.08
Regionalized-1	3	292	285	0.13	3.0	0.05	0.08
Regionalized-2	3	298	291	0.14	3.1	0.05	0.08
Centralized	1	318	310	0.14	3.3	0.05	0.08

Notes:
S = Storage
(1) In 1990 dollars. The economic multiplier analysis only was applied to costs through 2015.
(2) Compared to 1990 baseline.

Table II-5.4-6. Hanford—HLW—Impacts on Water Resources Due to Increased Water Use

HLW Alternatives	Number of Sites S	Construction Water Use GPD	Construction % Current Use	Construction % Stream Flow	Operations Water Use GPD	Operations % Current Use	Operations % Stream Flow	Operations Waste Water % Stream Flow
No Action	4	22	<0.1	<0.1	3,200	<0.1	<0.1	- -
Decentralized	4	27	<0.1	<0.1	8,000	<0.1	<0.1	- -
Regionalized-1	3	27	<0.1	<0.1	8,000	<0.1	<0.1	- -
Regionalized-2	3	27	<0.1	<0.1	8,000	<0.1	<0.1	- -
Centralized	1	28	<0.1	<0.1	8,000	<0.1	<0.1	- -

Notes:
S = Storage
Water supplied by surface water in the Columbia River. Current water use = 9,567,000 gallons/day.
Average flow rate of the Columbia River = 77,560,000,000 gallons/day.
Data is based on repository beginning to accept HLW canisters in 2015.
- - = Wastewater discharged to evaporation ponds.
<0.1 indicates that the percentage is less than 0.1%.

Table II-5.4-5. Hanford—HLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HLW Alternatives	Number of Sites	Operations & Maintenance											
	S	Total Radio-nuclides	Other Hazardous and Toxic Air Pollutants	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	4	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--	--	--

HLW Alternatives	Number of Sites	Operations & Maintenance									
	S	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	4	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--

Notes:
S = Storage
-- = Emissions of hazardous and toxic air pollutants, including radionuclides, from HLW storage facilities are assumed to be negligible.

Table II-5.4-4. Hanford—HLW—Percent of Standard/Guideline for Criteria Air Pollutants

HLW Alternatives	Number of Sites	Construction					
		Percent of Tons/Year General Conformity Rule (1)					
	S	CO	NO2	Pb	PM10	SO2	VOC
No Action	4	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--

HLW Alternatives	Number of Sites	Operations & Maintenance										
		Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)				
	S	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2
No Action	4	--	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--	--

Notes:
S = Storage
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Hanford is in an attainment area for all criteria pollutants, therfore the GCR does not apply.
(2) Stationary-source emissions from HLW storage facilities are assumed to be negligible.
(3) Stationary-source emissions from HLW storage facilities are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-6.1-1. INEL—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	1.2E-01	6.0E-02	5.6E-04	1.5E-04	- -	- -
Decentralized	37	16	1.0E-01	4.3E-01	5.2E-05	7.0E-06	1.4E-01	4.6E-02
Regionalized-1	11	12	1.0E-01	4.3E-01	5.2E-05	7.0E-06	1.4E-01	4.6E-02
Regionalized-2	7	6	1.1E-01	5.5E-01	6.3E-04	4.5E-05	1.7E-01	5.5E-02
Regionalized-3	7	1	1.1E-01	5.5E-01	6.3E-04	4.5E-05	- -	- -
Regionalized-4	4	6	1.2E-01	8.8E-01	6.7E-04	4.8E-05	2.9E-01	1.0E-01
Centralized	1	1	7.1E-02	7.5E-02	4.9E-06	3.5E-07	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-6.1-2. INEL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	4	-	1.1E+00	1.9E-03	1.9E-06	1.1E-04	3.0E-01	5.2E-04	2.6E-06	3.0E-05	3.0E+02	4.2E-01	2.2E-05	1.8E-02
Decentralized	3	16	1.1E-01	1.8E-04	1.8E-07	1.1E-05	1.4E-02	2.4E-05	2.4E-07	1.4E-06	2.6E+02	3.6E-01	4.0E-04	1.6E-02
Regionalized -1	37	12	1.1E-01	1.8E-04	1.8E-07	1.1E-05	1.4E-02	2.4E-05	2.4E-07	1.4E-06	2.6E+02	3.6E-01	4.0E-04	1.6E-02
Regionalized-2	7	6	1.3E+00	2.1E-03	2.0E-07	1.3E-04	9.0E-02	1.5E-04	2.7E-07	9.0E-06	2.8E+02	3.9E-01	5.1E-04	1.7E-02
Regionalized-3	7	1	1.3E+00	2.1E-03	1.6E-07	1.3E-04	9.0E-02	1.5E-04	2.2E-07	9.0E-06	2.8E+02	3.9E-01	5.1E-04	1.7E-02
Regionalized-4	4	6	1.3E+00	2.3E-03	4.7E-07	1.3E-04	9.7E-02	1.6E-04	6.1E-07	9.7E-06	3.0E+02	4.2E-01	1.2E-03	1.8E-02
Centralized	1	1	9.9E-03	1.7E-05	4.9E-09	9.9E-07	6.9E-04	1.2E-06	6.4E-09	6.9E-08	1.8E+02	2.5E-01	7.0E-06	1.1E-02

Notes:
T = Treatment
D = Disposal

Table II-6.1-3. INEL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	3.5E+02	4.9E-01	2.1E-02
Regionalized-1	11	12	3.5E+02	4.9E-01	2.1E-02
Regionalized-2	7	6	4.1E+02	5.8E-01	2.5E-02
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	7.2E+02	1.0E+00	4.4E-02
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-6.1-4. INEL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	7.0E-08	1.3E-07	- -
Decentralized	37	16	6.5E-09	6.0E-09	<9.9E-14
Regionalized-1	11	12	6.5E-09	6.0E-09	<9.9E-14
Regionalized-2	7	6	7.8E-08	3.9E-08	<9.9E-14
Regionalized-3	7	1	7.8E-08	3.9E-08	- -
Regionalized-4	4	6	8.4E-08	4.2E-08	<9.9E-14
Centralized	1	1	6.1E-10	3.0E-10	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-6.1-5. INEL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	1.4E-04	2.4E-07	2.7E-10	1.4E-08	2.6E-04	4.4E-07	2.1E-09	2.6E-08	--	--	--	--
Decentralized	37	16	1.3E-05	2.2E-08	2.5E-11	1.3E-09	1.2E-05	2.0E-08	2.0E-10	1.2E-09	<9.9E-14	<9.9E-14	7.4E-06	<9.9E-14
Regionalized-1	11	12	1.3E-05	2.2E-08	2.5E-11	1.3E-09	1.2E-05	2.0E-08	2.0E-10	1.2E-09	<9.9E-14	<9.9E-14	7.4E-06	<9.9E-14
Regionalized-2	7	6	1.6E-04	2.7E-07	2.6E-07	1.6E-08	7.8E-05	1.3E-07	2.2E-10	7.8E-09	<9.9E-14	<9.9E-14	7.6E-06	<9.9E-14
Regionalized-3	7	1	1.6E-04	2.7E-07	2.2E-11	1.6E-08	7.8E-05	1.3E-07	1.8E-10	7.8E-09	--	--	--	--
Regionalized-4	4	6	1.7E-04	2.8E-07	6.4E-11	1.7E-08	1.2E-05	1.4E-07	5.1E-10	8.3E-09	<9.9E-14	<9.9E-14	4.1E-06	<9.9E-14
Centralized	1	1	1.2E-06	2.1E-09	6.7E-13	1.2E-10	6.0E-07	1.0E-09	5.3E-12	5.9E-11	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.

Table II-6.1-6. INEL—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	2.6E-07	2.1E-06	2.0E-04	- -
Decentralized	37	16	4.1E-08	3.2E-07	1.1E-03	8.1E-02
Regionalized-1	11	12	4.1E-08	3.2E-07	1.1E-03	8.1E-02
Regionalized-2	7	6	4.3E-08	3.5E-07	1.3E-03	8.4E-02
Regionalized-3	7	1	3.4E-08	2.7E-07	1.3E-03	- -
Regionalized-4	4	6	5.3E-08	4.2E-07	1.6E-03	4.5E-02
Centralized	1	1	7.7E-10	6.2E-09	4.3E-05	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for No Action Alternative for LLMW.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-6.1-7. INEL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	122 (45/77)	132 (117/15)	0	9 (9/0)	11 (11/0)	21 (12/9)	20 (2/18)	8 (4/4)	0	1 (1/0)	0	2 (0/2)
Decentralized	37	16	187 (83/104)	236 (215/21)	0	17 (17/0)	21 (21/0)	33 (21/12)	53 (2/51)	16 (6/10)	0	2 (2/0)	0	6 (0/6)
Regionalized-1	11	12	187 (83/104)	236 (215/21)	0	17 (17/0)	21 (21/0)	33 (21/12)	53 (2/51)	16 (6/10)	0	2 (2/0)	0	6 (0/6)
Regionalized-2	7	6	113 (20/93)	72 (53/19)	0	4 (4/0)	5 (5/0)	16 (5/11)	55 (1/54)	15 (4/11)	0	2 (2/0)	0	7 (0/7)
Regionalized-3	7	1	104 (19/85)	66 (49/17)	0	4 (4/0)	5 (5/0)	15 (5/10)	43 (1/42)	12 (4/8)	0	2 (2/0)	0	5 (0/5)
Regionalized-4	4	6	160 (23/137)	88 (61/27)	0	5 (5/0)	6 (6/0)	22 (6/16)	87 (1/86)	27 (10/17)	0	7 (7/0)	1 (1/0)	10 (0/10)
Centralized	1	1	34 (16/18)	45 (41/4)	0	3 (3/0)	4 (4/0)	6 (4/2)	8 (0/8)	3 (1/2)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-6.1-8. INEL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized-1	11	12	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	1	10	0	7	0	1	0	0	0	0	0	0
Decentralized	37	16	2	15	0	13	0	1	0	0	0	0	0	0
Regionalized-1	11	12	2	15	0	13	0	1	0	0	0	0	0	0
Regionalized-2	7	6	1	9	0	14	0	0	0	0	0	0	0	0
Regionalized-3	7	1	1	9	0	14	0	0	0	0	0	0	0	0
Regionalized-4	4	6	1	25	0	45	1	0	0	0	0	0	0	0
Centralized	1	1	0	3	0	2	0	0	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) INEL is in an attainment area for all criteria pollutants, therfore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-6.1-9. INEL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2 Trichloro,1,1	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	--	--	--
Decentralized	37	16	--	0	0	0	--	0	0	--	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	--	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	--	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	--	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	--	--	--
Centralized	1	1	--	0	0	0	--	0	0	--	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-6.1-10. INEL—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	73350	1.3	--	4304	0.1	--	--
Decentralized	37	16	110206	1.9	--	7907	0.1	--	--
Regionalized-1	11	12	110206	1.9	--	7907	0.1	--	--
Regionalized-2	7	6	41313	0.7	--	8352	0.1	--	--
Regionalized-3	7	1	38333	0.7	--	7309	0.1	--	--
Regionalized-4	4	6	52175	0.9	--	13239	0.2	--	--
Centralized	1	1	21517	0.4	--	1258	<0.1	--	--

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Snake River Plain Aquifer. Current water use = 5,700,000 gallons/day.
Wastewater discharged to onsite evaporation ponds.
-- = Stream Flow and Waste Water Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-6.1-11. INEL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites T	D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LLMW Alternatives	Number of Sites T	D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
-- = No disposal of CH-LLMW at this site for this alternative.

Table II-6.1-12. INEL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Remote-Handled)

LLMW Alternatives	T	D *	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LLMW Alternatives	T	D *	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
* = In addition to the CH-LLMW disposal sites indicated below, disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR and SRS) for all alternatives except No Action.
- - = No disposal at this site for this alternative.

Table II-6.1-13. INEL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	1	0	8	0	0
Regionalized-1	11	12	0	0	0	1	0	8	0	0
Regionalized-2	7	6	0	0	0	1	0	8	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	4	0	0
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	4	0	0	10	0	0	0
Regionalized-1	11	12	4	0	0	10	0	0	0
Regionalized-2	7	6	4	0	0	10	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	2	0	0	5	0	0	0
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-6.1-14. INEL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Remote-Handled)]

LLMW Alternatives	T	D *	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0

LLMW Alternatives	T	D *	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
* = In addition to the CH-LLMW disposal sites indicated below, disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR and SRS) for all alternatives except No Action.
"--" = No disposal at this site for this alternative.

Table II-6.1-15. INEL—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	798	618	0.62	6.7	0.23	0.35
Decentralized	37	16	1623	1572	1.58	16.9	0.58	0.18
Regionalized-1	11	12	1629	1576	1.58	17.0	0.59	0.48
Regionalized-2	7	6	1573	1525	1.53	16.4	0.57	0.48
Regionalized-3	7	1	1396	1352	1.36	14.5	0.51	0.39
Regionalized-4	4	6	2100	2034	2.04	21.9	0.76	0.24
Centralized	1	1	739	715	0.72	7.7	0.27	0.07

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-6.1-16. INEL—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	33.3	0.14	73350	0.24	4304	0.43	10.34	24.73	588	5
Decentralized	37	16	55.6	0.24	110206	0.36	7907	0.74	5.25	12.56	798	7
Regionalized-1	11	12	55.6	0.24	110206	0.36	7907	0.74	5.25	12.56	798	7
Regionalized-2	7	6	23.5	0.10	41313	0.13	8352	0.84	1.70	4.06	716	6
Regionalized-3	7	1	21.6	0.09	38333	0.12	7309	0.73	1.70	4.06	646	5
Regionalized-4	4	6	30.6	0.13	52175	0.17	13239	1.32	2.59	6.20	1055	9
Centralized	1	1	12.2	0.05	21517	0.07	1258	0.13	0.32	0.77	137	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-6.1-17. INEL—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	903	75	319	364	145	404	499	0
Decentralized	37	16	1837	180	668	918	70	1382	0	455
Regionalized-1	11	12	1842	181	668	923	70	1383	0	460
Regionalized-2	7	6	1780	176	621	887	96	1455	0	325
Regionalized-3	7	1	1580	157	602	760	61	1462	0	118
Regionalized-4	4	6	2377	217	807	1214	138	1868	0	508
Centralized	1	1	836	79	333	382	41	718	0	118

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.6.2 INEL LLW

Thirteen tables immediately following portray the impacts of LLW at INEL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	INEL—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-6.2-1	6-21
2.	INEL—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-6.2-2	6-22
3.	INEL—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-6.2-3	6-23
4.	INEL—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-6.2-4	6-24
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Table II-6.2-1. INEL—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	2.5E-01	3.7E-01	1.4E-06	3.0E-06	6.4E-01	2.1E-01
Decentralized		16	1.7E-01	1.5E-01	8.0E-07	2.4E-07	4.2E-01	2.5E-01
Regionalized-1		12	1.7E-01	1.5E-01	8.0E-07	2.4E-07	4.2E-01	2.5E-01
Regionalized-2	11	12	1.7E-01	3.7E-01	1.4E-06	4.0E-07	3.4E-01	1.5E-01
Regionalized-3		6	1.7E-01	1.5E-01	8.0E-07	2.4E-07	4.2E-01	2.5E-01
Regionalized-4	7	6	1.7E-01	3.7E-01	1.4E-06	4.0E-07	3.4E-01	1.5E-01
Regionalized-5	4	6	5.3E-01	8.1E-01	4.1E-04	1.2E-04	3.6E-01	1.6E-01
Regionalized-6		2	2.1E-01	2.3E-01	1.3E-06	3.9E-07	--	--
Regionalized-7		2	2.1E-01	2.3E-01	1.3E-06	3.9E-07	--	--
Centralized-1		1	2.1E-01	2.3E-01	1.3E-06	3.9E-07	--	--
Centralized-2		1	2.1E-01	2.3E-01	1.3E-06	3.9E-07	--	--
Centralized-3	7	1	1.7E-01	3.7E-01	1.4E-06	4.0E-07	--	--
Centralized-4	7	1	1.7E-01	3.7E-01	1.4E-06	4.0E-07	--	--
Centralized-5	1	1	1.7E-01	1.5E-01	8.0E-07	2.4E-07	--	--

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-6.2-2. INEL—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	2.7E-03	4.7E-06	2.7E-07	8.1E-04	1.4E-06	8.1E-08	6.2E+02	8.7E-01	3.7E-02
Decentralized		16	1.6E-03	2.7E-06	1.6E-07	4.8E-04	8.1E-07	4.8E-08	4.1E+02	5.8E-01	2.5E-02
Regionalized-1		12	1.6E-03	2.7E-06	1.6E-07	4.8E-04	8.1E-07	4.8E-08	4.1E+02	5.8E-01	2.5E-02
Regionalized-2	11	12	2.7E-03	4.6E-06	2.7E-07	8.1E-04	1.4E-06	8.1E-08	4.2E+02	5.8E-01	2.5E-02
Regionalized-3		6	1.6E-03	2.7E-06	1.6E-07	4.8E-04	8.1E-07	4.8E-08	4.1E+02	5.8E-01	2.5E-02
Regionalized-4	7	6	2.7E-03	4.6E-06	2.7E-07	8.1E-04	1.4E-06	8.1E-08	4.2E+02	5.8E-01	2.5E-02
Regionalized-5	4	6	8.2E-01	1.4E-03	8.2E-05	2.3E-01	4.0E-04	2.3E-05	1.3E+03	1.9E+00	8.0E-02
Regionalized-6		2	2.6E-03	4.4E-06	2.6E-07	7.7E-04	1.3E-06	7.7E-08	5.2E+02	7.2E-01	3.1E-01
Regionalized-7		2	2.6E-03	4.4E-06	2.6E-07	7.7E-04	1.3E-06	7.7E-08	5.2E+02	7.2E-01	3.1E-01
Centralized-1		1	2.6E-03	4.4E-06	2.6E-07	7.7E-04	1.3E-06	7.7E-08	5.2E+02	7.2E-01	3.1E-01
Centralized-2		1	2.6E-03	4.4E-06	2.6E-07	7.7E-04	1.3E-06	7.7E-08	5.2E+02	7.2E-01	3.1E-01
Centralized-3	7	1	2.7E-03	4.6E-06	2.7E-07	8.1E-04	1.4E-06	8.1E-08	4.2E+02	5.8E-01	2.5E-02
Centralized-4	7	1	2.7E-03	4.6E-06	2.7E-07	8.1E-04	1.4E-06	8.1E-08	4.2E+02	5.8E-01	2.5E-02
Centralized-5	1	1	1.6E-03	2.7E-06	1.6E-07	4.8E-04	8.1E-07	4.8E-08	4.1E+02	5.8E-01	2.5E-02

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-6.2-3. INEL—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	1.6E+03	2.2E+00	9.6E-02
Decentralized		16	1.0E+03	1.5E+00	6.3E-02
Regionalized-1		12	1.0E+03	1.5E+00	6.3E-02
Regionalized-2	11	12	8.6E+02	1.2E+00	5.2E-02
Regionalized-3		6	1.0E+03	1.5E+00	6.3E-02
Regionalized-4	7	6	8.6E+02	1.2E+00	5.2E-02
Regionalized-5	4	6	9.0E+02	1.3E+00	5.4E-02
Regionalized-6		2	--	--	--
Regionalized-7		2	--	--	--
Centralized-1		1	--	--	--
Centralized-2		1	--	--	--
Centralized-3	7	1	--	--	--
Centralized-4	7	1	--	--	--
Centralized-5	1	1	--	--	--

Notes:
T = Treatment
D = Disposal
-- = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-6.2-4. INEL—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	1.7E-10	3.4E-10	<9.9E-14
Decentralized		16	9.9E-11	2.0E-10	<9.9E-14
Regionalized-1		12	9.9E-11	2.0E-10	<9.9E-14
Regionalized-2	11	12	1.7E-10	3.4E-10	<9.9E-14
Regionalized-3		6	9.9E-11	2.0E-10	<9.9E-14
Regionalized-4	7	6	1.7E-10	3.4E-10	<9.9E-14
Regionalized-5	4	6	5.1E-08	1.0E-07	<9.9E-14
Regionalized-6		2	1.6E-10	3.2E-10	- -
Regionalized-7		2	1.6E-10	3.2E-10	- -
Centralized-1		1	1.6E-10	3.2E-10	- -
Centralized-2		1	1.6E-10	3.2E-10	- -
Centralized-3	7	1	1.7E-10	3.4E-10	- -
Centralized-4	7	1	1.7E-10	3.4E-10	- -
Centralized-5	1	1	9.9E-11	2.0E-10	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-6.2-5. INEL—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	3.4E-07	5.8E-10	3.4E-11	6.7E-07	1.1E-09	6.7E-11	<9.9E-14	<9.9E-14	<9.9E-14
Decentralized		16	2.0E-07	3.4E-10	2.0E-11	4.0E-07	6.8E-10	4.0E-11	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-1		12	2.0E-07	3.4E-10	2.0E-11	4.0E-07	6.8E-10	4.0E-11	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-2	11	12	3.3E-07	5.7E-10	3.3E-11	6.7E-07	1.1E-09	6.7E-11	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-3		6	2.0E-07	3.4E-10	2.0E-11	4.0E-07	6.8E-10	4.0E-11	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-4	7	6	3.3E-07	5.7E-10	3.3E-11	6.7E-07	1.1E-09	6.7E-11	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-5	4	6	1.0E-04	1.7E-07	1.0E-08	2.0E-04	3.4E-07	2.0E-08	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-6		2	3.2E-07	5.4E-10	3.2E-11	6.4E-07	1.1E-09	6.4E-11	- -	- -	- -
Regionalized-7		2	3.2E-07	5.4E-10	3.2E-11	6.4E-07	1.1E-09	6.4E-11	- -	- -	- -
Centralized-1		1	3.2E-07	5.4E-10	3.2E-11	6.4E-07	1.1E-09	6.4E-11	- -	- -	- -
Centralized-2		1	3.2E-07	5.4E-10	3.2E-11	6.4E-07	1.1E-09	6.4E-11	- -	- -	- -
Centralized-3	7	1	3.3E-07	5.7E-10	3.3E-11	6.7E-07	1.1E-09	6.7E-11	- -	- -	- -
Centralized-4	7	1	3.3E-07	5.7E-10	3.3E-11	6.7E-07	1.1E-09	6.7E-11	- -	- -	- -
Centralized-5	1	1	2.0E-07	3.4E-10	2.0E-11	4.0E-07	6.8E-10	4.0E-11	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-6.2-6. INEL—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	26 (5/21)	16 (12/4)	0	1 (1/0)	1 (1/0)	4 (1/3)	59 (0/59)	12 (0/12)	0	0	0	7 (0/7)
Decentralized		16	48 (8/40)	28 (20/8)	0	2 (2/0)	2 (2/0)	7 (2/5)	65 (0/65)	13 (0/13)	0	0	0	8 (0/8)
Regionalized-1		12	48 (8/40)	28 (20/8)	0	2 (2/0)	2 (2/0)	7 (2/5)	65 (0/65)	13 (0/13)	0	0	0	8 (0/8)
Regionalized-2	11	12	68 (9/59)	35 (23/12)	0	2 (2/0)	2 (2/0)	9 (2/7)	91 (0/91)	19 (1/18)	0	1 (1/0)	0	11 (0/11)
Regionalized-3		6	48 (8/40)	28 (20/8)	0	2 (2/0)	2 (2/0)	7 (2/5)	63 (0/63)	13 (0/13)	0	0	0	8 (0/8)
Regionalized-4	7	6	68 (9/59)	35 (23/12)	0	2 (2/0)	2 (2/0)	9 (2/7)	91 (0/91)	19 (1/18)	0	1 (1/0)	0	11 (0/11)
Regionalized-5	4	6	148 (21/127)	79 (54/25)	0	4 (4/0)	5 (5/0)	20 (5/15)	182 (1/181)	40 (2/38)	0	3 (3/0)	0	22 (0/22)
Regionalized-6		2	44 (4/40)	18 (10/8)	0	1 (1/0)	1 (1/0)	6 (1/5)	33 (0/33)	8 (0/8)	0	0	0	4 (4/0)
Regionalzied-7		2	44 (4/40)	18 (10/8)	0	1 (1/0)	1 (1/0)	6 (1/5)	33 (0/33)	8 (0/8)	0	0	0	4 (4/0)
Centralized-1		1	44 (4/40)	18 (10/8)	0	1 (1/0)	1 (1/0)	6 (1/5)	33 (0/33)	8 (0/8)	0	0	0	4 (4/0)
Centralized-2		1	44 (4/40)	18 (10/8)	0	1 (1/0)	1 (1/0)	6 (1/5)	33 (0/33)	8 (0/8)	0	0	0	4 (4/0)
Centralized-3	7	1	65 (6/59)	28 (16/12)	0	1 (1/0)	2 (2/0)	9 (2/7)	65 (0/65)	15 (1/14)	0	1 (1/0)	0	8 (0/8)
Centralized-4	7	1	65 (6/59)	28 (16/12)	0	1 (1/0)	2 (2/0)	9 (2/7)	65 (0/65)	15 (1/14)	0	1 (1/0)	0	8 (0/8)
Centralized-5	1	1	44 (4/40)	18 (10/8)	0	1 (1/0)	1 (1/0)	6 (1/5)	33 (0/33)	8 (0/8)	0	0	0	4 (4/0)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-6.2-7. INEL—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalzied-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2	Pb (4)	PM10	SO2 (4)	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	2	0	2	0	0	0	0	0	0	0	0
Decentralized		16	0	1	0	1	0	0	--	--	--	--	--	--
Regionalized-1		12	0	1	0	1	0	0	--	--	--	--	--	--
Regionalized-2	11	12	0	4	0	4	0	0	0	0	0	0	0	0
Regionalized-3		6	0	1	0	1	0	0	--	--	--	--	--	--
Regionalized-4	7	6	0	4	0	4	0	0	0	0	0	0	0	0
Regionalized-5	4	6	1	5	0	22	1	0	0	0	0	0	0	0
Regionalized-6		2	0	1	0	0	0	0	--	--	--	--	--	--
Regionalzied-7		2	0	1	0	0	0	0	--	--	--	--	--	--
Centralized-1		1	0	1	0	0	0	0	--	--	--	--	--	--
Centralized-2		1	0	1	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	0	3	0	4	0	0	0	0	0	0	0	0
Centralized-4	7	1	0	3	0	4	0	0	0	0	0	0	0	0
Centralized-5	1	1	0	1	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide. VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) INEL is in an attainment area for all criteria pollutants, therefore the GCR do not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the No Action and minimum treatment (no incineration) alternatives, and the Centralized - 5 Alternative, are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** Ten sites use existing facilities for Volume Reduction.

Table II-6.2-8. INEL—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Other Hazardous and Toxic Air Pollutants	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-6.2-9. INEL—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	3434	0.1	--	4458	0.1	--	--
Decentralized		16	21632	0.4	--	8483	0.1	--	--
Regionalized-1		12	21632	0.4	--	8483	0.1	--	--
Regionalized-2	11	12	25442	0.4	--	12725	0.2	--	--
Regionalized-3		6	21632	0.4	--	8483	0.1	--	--
Regionalized-4	7	6	25442	0.4	--	12725	0.2	--	--
Regionalized-5	4	6	63961	1.1	--	28247	0.5	--	--
Regionalized-6		2	12191	0.2	--	4514	0.1	--	--
Regionalized-7		2	12191	0.2	--	4514	0.1	--	--
Centralized-1		1	12191	0.2	--	4514	0.1	--	--
Centralized-2		1	12191	0.2	--	4514	0.1	--	--
Centralized-3	7	1	19535	0.3	--	10059	0.2	--	--
Centralized-4	7	1	19535	0.3	--	10059	0.2	--	--
Centralized-5	1	1	12191	0.2	--	4514	0.1	--	--

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
Water supplied by groundwater in the Snake River Plain Aquifer. Current water use = 5,700,000 gallons/day.
Wastewater discharged to onsite evaporation ponds.
** Ten sites use existing facilities for Volume Reduction.
-- = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-6.2-10. INEL—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-6.2-11. INEL—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	1418	1098	1.10	11.8	0.41	0.32
Decentralized		16	1120	1085	1.09	11.7	0.41	0.50
Regionalized-1		12	1120	1085	1.09	11.7	0.41	0.50
Regionalized-2	11	12	1355	1312	1.32	14.1	0.49	0.66
Regionalized-3		6	1120	1085	1.09	11.7	0.41	0.50
Regionalized-4	7	6	1530	1481	1.49	15.9	0.55	0.66
Regionalized-5		6	3079	2981	2.99	32.1	1.11	3.20
Regionalized-6		2	613	593	0.60	6.4	0.22	0.26
Regionalized-7		2	613	593	0.60	6.4	0.22	0.26
Centralized-1		1	613	593	0.60	6.4	0.22	0.26
Centralized-2		1	613	593	0.60	6.4	0.22	0.26
Centralized-3	7	1	984	952	0.96	10.3	0.36	0.44
Centralized-4	7	1	984	952	0.96	10.3	0.36	0.44
Centralized-5	1	1	613	593	0.60	6.4	0.22	0.26

Note:
T = Treatment
D = Disposal
ROI = Region of Influence
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction

Table II-6.2-12. INEL—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	7.5	0.03	4458	0.01	4458	0	1.42	3.4	164	1
Decentralized		16	12.5	0.05	21632	0.07	8483	0	2.41	5.78	488	4
Regionalized-1		12	12.5	0.05	21632	0.07	8483	0	2.41	5.78	488	4
Regionalized-2	11	12	13.9	0.06	21520	0.08	12725	0	2.98	7.14	555	5
Regionalized-3		6	12.5	0.56	21632	0.07	8483	0	2.41	5.78	488	4
Regionalized-4	7	6	13.9	0.06	21520	0.08	12725	0	3.00	7.17	555	5
Regionalized-5	4	6	26.5	0.11	63961	0.21	28247	0	7.30	17.47	2702	23
Regionalized-6		2	7.9	0.03	12191	0.04	4514	0	1.26	3.02	330	3
Regionalized-7		2	7.9	0.03	12191	0.04	4514	0	1.26	3.02	330	3
Centralized-1		1	7.9	0.03	12191	0.04	4514	0	1.26	3.02	330	3
Centralized-2		1	7.9	0.03	12191	0.04	4514	0	1.26	3.02	330	3
Centralized-3	7	1	11.9	0.05	15530	0.06	10059	0	3.00	7.18	454	4
Centralized-4	7	1	11.9	0.05	15530	0.06	10059	0	3.00	7.18	454	4
Centralized-5	1	1	7.9	0.03	12191	0.04	4514	0	1.26	3.02	281	2

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-6.2-13. INEL—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	1604	27	80	1399	98	1010	0	594
Decentralized		16	1267	100	205	819	144	655	0	612
Regionalized-1		12	1267	100	205	819	144	655	0	612
Regionalized-2	11	12	1533	112	236	1044	141	1113	0	420
Regionalized-3		6	1267	100	205	819	144	655	0	612
Regionalized-4	7	6	1731	135	257	1163	177	1113	0	619
Regionalized-5	4	6	3484	288	641	2332	222	2865	0	618
Regionalized-6		2	693	57	157	439	40	693	0	0
Regionalized-7		2	693	57	157	439	40	693	0	0
Centralized-1		1	693	57	157	439	40	693	0	0
Centralized-2		1	693	57	157	439	40	693	0	0
Centralized-3	7	1	1113	88	200	753	72	1113	0	0
Centralized-4	7	1	1113	88	200	753	72	1113	0	0
Centralized-5	1	1	693	57	157	439	40	693	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.6.3 INEL TRUW

Twelve tables immediately following portray the impacts of TRUW at INEL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	INEL—TRUW—Treatment: Estimated Number of Fatalities	II-6.3-1	6-35
2.	INEL—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-6.3-2	6-36
4.	INEL—TRUW—Treatment: MEI Probability of Cancer Fatality	II-6.3-3	6-37
5.	INEL—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-6.3-4	6-38
6.	INEL—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-6.3-5	6-39
7.	INEL—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-6.3-6	6-40
8.	INEL—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-6.3-7	6-41
9.	INEL—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-6.3-8	6-42
10.	INEL—TRUW—Impacts on Water Resources Due to Increased Water Use	II-6.3-9	6-43
13.	INEL—TRUW—Socioeconomic Impacts for Treatment	II-6.3-10	6-44
14.	INEL—TRUW—Infrastructure Impacts for Treatment	II-6.3-11	6-45
15.	INEL—TRUW—Cost	II-6.3-12	6-46

Table II-6.3-1. INEL—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites			WM Worker		Offsite Population	Noninvolved Workers
	CH Treat	RH Treat	Treatment Standard	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure
No Action **	16	5	WIPP WAC	4.0E-06	2.7E-02	6.7E-09	1.7E-09
Decentralized ***	16	5	WIPP WAC	2.5E-01	8.2E-01	1.1E-06	3.4E-07
Regionalized-1	5	2	Reduce Gas	2.5E-01	1.0E+00	1.4E-06	4.3E-07
Regionalized-2	5	2	LDR	2.4E-01	1.6E+00	7.3E-03	2.2E-03
Regionalized-3	3	2	LDR	2.5E-01	1.8E+00	4.1E-02	1.2E-02
Centralized	WIPP	2	LDR	2.4E-01	5.5E-01	1.6E-06	4.7E-07

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-6.3-2. INEL—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	1.3E-05	2.3E-08	1.7E-12	1.3E-09	3.4E-06	5.7E-09	2.3E-12	3.4E-10	9.9E-03	1.4E-05	3.7E-09	6.0E-07
Decentralized***	16	5	WIPP WAC	2.3E-03	3.9E-06	2.3E-09	2.3E-07	6.8E-04	1.2E-06	3.0E-09	6.8E-08	6.3E+02	8.8E-01	9.2E-06	3.8E-02
Regionalized-1	5	2	Reduce Gas	2.9E-03	4.9E-06	2.3E-09	2.9E-07	8.6E-04	1.5E-06	3.1E-09	8.6E-08	6.3E+02	8.8E-01	1.5E-05	3.8E-02
Regionalized-2	5	2	LDR	1.5E+01	2.5E-02	1.7E-09	1.5E-03	4.4E+00	7.5E-03	2.2E-09	4.4E-04	5.9E+02	8.3E-01	2.2E-05	3.6E-02
Regionalized-3	3	2	LDR	8.2E+01	1.4E-01	1.7E-09	8.2E-03	2.5E+01	4.2E-02	2.3E-09	2.5E-03	6.2E+02	8.7E-01	3.3E-05	3.7E-02
Centralized	WIPP	2	LDR	3.2E-03	5.4E-06	6.6E-09	3.2E-07	9.4E-04	1.6E-06	8.7E-09	9.4E-08	6.1E+02	8.5E-01	4.4E-05	3.6E-02

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-6.3-3. INEL—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	8.4E-13	1.5E-12
Decentralized***	16	5	WIPP WAC	1.4E-10	2.9E-10
Regionalized-1	5	2	Reduce Gas	1.8E-10	3.7E-10
Regionalized-2	5	2	LDR	9.1E-07	1.9E-06
Regionalized-3	3	2	LDR	5.1E-06	1.1E-05
Centralized	WIPP	2	LDR	2.0E-10	4.0E-10

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-6.3-4. INEL—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	CH Treat	RH Treat	Treatment Standard	Treatment: Offsite Population MEI Dose (rem)	Offsite Population MEI Radiation Cancer Incidence Probability	Offsite Population MEI Chemical Cancer Incidence Probability	Offsite Population MEI Radiation Genetic Effects Probability	Noninvolved Worker MEI Dose (rem)	Noninvolved Worker MEI Radiation Cancer Incidence Probability	Noninvolved Worker MEI Chemical Cancer Incidence Probability	Noninvolved Worker MEI Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	1.7E-09	2.8E-12	<9.9E-14	1.7E-13	2.9E-09	4.9E-12	<9.9E-14	2.9E-13
Decentralized ***	16	5	WIPP WAC	2.8E-07	4.8E-10	3.2E-13	2.8E-11	5.8E-07	9.9E-10	2.5E-12	5.8E-11
Regionalized-1	5	2	Reduce Gas	3.6E-07	6.1E-10	3.2E-13	3.6E-11	7.4E-07	1.3E-09	2.6E-12	7.4E-11
Regionalized-2	5	2	LDR	1.8E-03	3.1E-06	2.3E-13	1.8E-07	3.7E-03	6.4E-06	1.9E-12	3.7E-07
Regionalized-3	3	2	LDR	1.0E-02	1.7E-05	2.4E-13	1.0E-06	2.1E-02	3.6E-05	1.9E-12	2.1E-06
Centralized	WIPP	2	LDR	3.9E-07	6.7E-10	9.1E-13	3.9E-11	8.1E-07	1.4E-09	7.3E-12	8.1E-11

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal of WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites then to WIPP.
MEI = Maximally Exposed Individual

Table II-6.3-5. INEL—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment		
	CH Treat	RH Treat		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	7.8E-14	6.2E-13	1.1E-07
Decentralized***	16	5	WIPP WAC	1.9E-11	1.5E-10	3.1E-05
Regionalized-1	5	2	Reduce Gas	2.6E-11	2.1E-10	3.1E-05
Regionalized-2	5	2	LDR	4.2E-10	3.3E-09	1.0E-04
Regionalized-3	3	2	LDR	7.9E-10	6.3E-09	2.0E-04
Centralized	WIPP	2	LDR	4.9E-11	4.0E-10	1.9E-04

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-6.3-6. INEL—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -	57 (0/57)	11 (0/11)	0	0	0	7 (0/7)
Decentralized***	16	5	WIPP WAC	116 (41/75)	121 (106/15)	0	8 (8/0)	10 (10/0)	19 (10/9)	72 (0/72)	15 (1/14)	0	0	0	9 (0/9)
Regionalized-1	5	2	Reduce Gas	121 (41/80)	124 (108/16)	0	9 (9/0)	10 (10/0)	20 (10/10)	82 (0/82)	17 (1/16)	0	0	0	10 (0/10)
Regionalized-2	5	2	LDR	140 (43/97)	131 (112/19)	0	9 (9/0)	11 (11/0)	23 (11/12)	87 (0/87)	18 (1/17)	0	0	0	11 (11/0)
Regionalized-3	3	2	LDR	165 (45/120)	142 (118/24)	0	9 (9/0)	11 (11/0)	25 (11/14)	107 (1/107)	22 (1/21)	0	0	0	13 (0/13)
Centralized	WIPP	2	LDR	79 (36/43)	103 (94/9)	0	8 (8/0)	9 (9/0)	14 (9/5)	48 (0/48)	10 (0/10)	0	0	0	6 (0/6)

Notes:

Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.

CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.

(1) Values = total emissions (equipment emissions / worker vehicles emission)

(2) Values = total emissions (stationary-source emissions / mobile-source emission)

** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-6.3-7. INEL—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--
Centralized	WIPP	2	LDR	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	0	1	0	0	0	0	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	0	1	0	1	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	2	0	1	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	2	0	10	4	0	0	0	0	0	0	0
Regionalized-3	3	2	LDR	1	4	0	17	8	0	0	0	0	0	0	0
Centralized	WIPP	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds.
NAAQS = National Ambient Air Quality Standard.
(1) INEL is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for alternatives that do not involve treatment to LDR (incineration) are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-6.3-8. INEL—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	2	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	10	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-6.3-9. INEL—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	--	--	--	3206	0.1	--	--
Decentralized***	16	5	WIPP WAC	65914	1.2	--	9723	0.2	--	--
Regionalized-1	5	2	Reduce Gas	67519	1.2	--	11126	0.2	--	--
Regionalized-2	5	2	LDR	71723	1.3	--	12400	0.2	--	--
Regionalized-3	3	2	LDR	77743	1.4	--	16872	0.3	--	--
Centralized	WIPP	2	LDR	56308	1.0	--	4425	0.1	--	--

Notes:
GPD = Gallons per day
Water supplied by groundwater in the Snake River Plain Aquifer. Current water use = 5,700,000 gallons/day.
Wastewater discharged to onsite evaporation ponds.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
-- = Stream Flow and Waste Water Stream Flow are not considered for this site.

Table II-6.3-10. INEL—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	217	168	0.17	1.8	0.06	0.22
Decentralized***	16	5	WIPP WAC	1492	1445	1.45	15.6	0.54	0.60
Regionalized-1	5	2	Reduce Gas	1610	1559	1.56	16.8	0.58	0.66
Regionalized-2	5	2	LDR	1805	1748	1.75	18.8	0.65	0.74
Regionalized-3	3	2	LDR	2196	2126	2.13	22.9	0.80	0.91
Centralized	WIPP	2	LDR	875	847	0.85	9.1	0.32	0.37

Notes:
(1) In current 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-6.3-11. INEL—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	16	5	WIPP WAC	0	0.00	3206	0.01	3206	0.32	0.53	1.28	0	0.00
Decentralized	16	5	WIPP WAC	28.1	0.13	65914	0.22	9723	0.97	1.96	4.69	754	6.40
Regionalized-1	5	2	Reduce Gas	27.8	0.12	67519	0.22	11126	1.11	2.66	6.36	842	7.10
Regionalized-2	5	2	LDR	28.2	0.13	71723	0.23	12400	1.24	2.78	6.64	1015	8.60
Regionalized-3	3	2	LDR	28.2	0.13	77743	0.25	16872	1.69	2.78	6.64	1257	10.60
Centralized	WIPP	2	LDR	28.2	0.13	56308	0.18	4425	0.44	2.78	6.64	403	3.40

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-6.3-12. INEL—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	246	0	0	206	40	0	199	47
Decentralized***	16	5	WIPP - WAC	1688	83	419	725	461	930	705	54
Regionalized-1	5	2	Reduce Gas	1822	105	450	777	489	930	801	91
Regionalized-2	5	2	LDR	2042	125	549	875	493	930	1023	90
Regionalized-3	3	2	LDR	2485	157	680	1140	508	930	1456	100
Centralized	WIPP	2	LDR	990	33	237	323	397	930	61	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP to be assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In Current 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.6.4 INEL HLW

Nine tables immediately following portray the impacts of HLW at INEL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	INEL—HLW—Storage: Estimated Number of Fatalities	II-6.4-1	6-48
2.	INEL—HLW—Storage: Estimated Number of Cancer Incidences and Genetic Effects	II-6.4-2	6-49
7.	INEL—HLW—Emissions in Tons per Year of Criteria Air Pollutants	II-6.4-3	6-50
8.	INEL—HLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-6.4-4	6-51
9.	INEL—HLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-6.4-5	6-52
10.	INEL—HLW—Impacts on Water Resources Due to Increased Water Use	II-6.4-6	6-53
13.	INEL—HLW—Socioeconomics Impacts for Storage	II-6.4-7	6-54
14.	INEL—HLW—Infrastructure Impacts for Storage	II-6.4-8	6-55
15.	INEL—HLW—Cost	II-6.4-9	6-56

Table II-6.4–1. INEL—HLW—Storage: Estimated Number of Fatalities

HLW Alternatives	Number of Storage Sites	WM Workers	
		Radiation Exposure	Physical Hazards
No Action	4	- -	- -
Decentralized	4	4.7E-01	3.2E-01
Regionalized-1	3	4.7E-01	3.2E-01
Regionalized-2	3	4.7E-01	3.3E-01
Centralized	1	4.7E-01	3.5E-01

Notes:
- - = The INEL is not considered for storage of vitrified HLW canisters under the No Action Alternative.

Table II-6.4–2. INEL—HLW—Storage: Estimated Number of Cancer Incidences and Genetic Effects

HLW Alternatives	Number of Storage Sites	WM Workers		
		Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	4	--	--	--
Decentralized	4	1.2E+03	1.6E+00	7.1E-02
Regionalized-1	3	1.2E+03	1.6E+00	7.1E-02
Regionalized-2	3	1.2E+03	1.6E+00	7.1E-02
Centralized	1	1.2E+03	1.6E+00	7.1E-02

Notes:
-- The INEL is not considered for storage of vitrified HLW canisters under the No Action Alternative.

Table II-6.4–3. INEL—HLW—Emissions in Tons per Year of Criteria Air Pollutants

HLW Alternatives	Number of Sites S	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	4	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized	4	4 (2/2)	4 (4/0)	0	0	0	0	4 (0/4)	1 (0/1)	0	0	0	0
Regionalized-1	3	4 (2/2)	4 (4/0)	0	0	0	0	4 (0/4)	1 (0/1)	0	0	0	0
Regionalized-2	3	4 (2/2)	4 (4/0)	0	0	0	0	4 (0/4)	1 (0/1)	0	0	0	0
Centralized	1	4 (2/2)	4 (4/0)	0	0	0	0	4 (0/4)	1 (0/1)	0	0	0	0

Notes:
S = Storage
Data is based on repository beginning to accept HLW canisters in 2015.
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)

Table II-6.4-4. INEL—HLW—Percent of Standard/Guideline for Criteria Air Pollutants

HLW Alternatives	Number of Sites S	Construction: Percent of Tons/Year General Conformity Rule (1) CO	NO2	Pb	PM10	SO2	VOC
No Action	4	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--

HLW Alternatives	Number of Sites S	Operations & Maintenance: Percent of Tons/Year Standard or Guideline (2) CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	Percent of NAAQS Concentration (3) CO	NO2	Pb	PM10	SO2
No Action	4	--	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--	--

Notes:
S = Storage
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) INEL is in an attainment area for all criteria pollutants, therfore the GCR does not apply.
(2) Stationary-source emissions from HLW storage facilities are assumed to be negligible.
(3) Stationary-source emissions from HLW storage facilities are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-6.4-5. INEL—HLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HLW Alternatives	Number of Sites	Operations & Maintenance											
	S	Total Radio-nuclides	Other Hazardous and Toxic Air Pollutants	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	4	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 1	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 2	3	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--	--	--

HLW Alternatives	Number of Sites	Operations & Maintenance									
	S	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	4	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--
Regionalized - 1	3	--	--	--	--	--	--	--	--	--	--
Regionalized - 2	3	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--

Notes:
S = Storage
-- = Emissions of hazardous and toxic air pollutants, including radionuclides, from HLW storage facilities are assumed to be negligibl

Table II-6.4-6. INEL—HLW—Impacts on Water Resources Due to Increased Water Use

HLW Alternatives	Number of Sites S	Construction Water Use GPD	Construction % Current Use	Construction % Stream Flow	Operations Water Use GPD	Operations % Current Use	Operations % Stream Flow	Operations Waste Water % Stream Flow
No Action	4	- -	- -	- -	- -	- -	- -	- -
Decentralized	4	23	<0.1	- -	820	<0.1	- -	- -
Regionalized-1	3	23	<0.1	- -	820	<0.1	- -	- -
Regionalized-2	3	23	<0.1	- -	820	<0.1	- -	- -
Centralized	1	23	<0.1	- -	820	<0.1	- -	- -

Notes:
S = Storage
Water supplied by groundwater in the Snake River Plain Aquifer. Current water use = 5,700,000 gallons/day.
Wastewater discharged to onsite evaporation ponds.
Data is based on repository beginning to accept HLW canisters in 2015.
<0.1 indicates that the percentage is less than 0.1%.
- - = The INEL is not considered for storage of vitrified HLW canisters under the No Action Alternative, Stream Flow and Waste Water Stream Flow are not considered for this site.

Table II-6.4-7. INEL—HLW—Socioeconomics Impacts for Storage

HLW Alternatives	Number of Sites	Effect of Implementation of Alternatives					
			Jobs		Income		
	S	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	4	- -	- -	- -	- -	- -	- -
Decentralized	4	33	31	0.03	0.3	0.01	0.07
Regionalized-1	3	33	31	0.03	0.3	0.01	0.07
Regionalized-2	3	33	31	0.03	0.3	0.01	0.07
Centralized	1	33	31	0.03	0.3	0.01	0.07

Notes:
S = Storage
(1) In current 1990 dollars. The economic multiplier analysis only was applied to costs through 2015.
(2) Compared to 1990 baseline.
- - = The INEL is not considered as a storage for vitrified HLW canisters under the No Action Alternative.

Table II-6.4-8. INEL—HLW—Infrastructure Impacts for Storage

HLW Alternatives	Number of Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
	S	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	4	--	--	--	--	--	--	--	--	--	--
Decentralized	4	2	<0.01	820	0.00	820	0.0	0.03	0.06	15	0
Regionalized-1	3	2	<0.01	820	0.00	820	0.0	0.03	0.06	15	0
Regionalized-2	3	2	<0.01	820	0.00	820	0.0	0.03	0.06	15	0
Centralized	1	2	<0.01	820	0.00	820	0.0	0.03	0.06	15	0

Notes:
S = Storage
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
-- = The INEL is not considered for storage of vitrified HLW canisters under the No Action Alternative.

Table II-6.4-9. INEL—HLW—Cost

HLW Alternatives	Number of Sites	Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)		Cost by Functional Area (1)	
	S		Construction (Millions) (2)	Operations & Maintenance (3) (Millions)	Storage (Millions)	Handling (Millions)
No Action	4	--	--	--	--	--
Decentralized	4	368	40	328	60	308
Regionalized-1	3	368	40	328	60	308
Regionalized-2	3	368	40	328	60	308
Centralized	1	368	40	328	60	308
Centralized Delayed Acceptance	1	308	0	308	0	308

Notes:
S = Storage
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In current 1994 Dollars; Total Cost = Sum of Life Cycle Components = Sum of Functional Areas.
(2) Construction costs are for the interim storage facilities.
(3) Operations and maintenance costs include operation and maintenance of the interim storage facilities, and the handling of canisters (unloading/loading of canisters into or out of the interim storage facilities).

II.6.5 INEL HW

Eleven tables immediately following portray the impacts of HW at INEL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	INEL—HW—Treatment: Estimated Number of Fatalities	II-6.5-1	6-58
2.	INEL—HW—Treatment: Estimated Number of Cancer Incidences	II-6.5-2	6-59
5.	INEL—HW—Treatment: MEI Probability of Cancer Incidences	II-6.5-3	6-60
6.	INEL—HW—Treatment: Noncancer Health Risk From Chemical Exposure	II-6.5-4	6-61
7.	INEL—HW—Emissions in Tons per Year of Criteria Air Pollutants	II-6.5-5	6-62
8.	INEL—HW—Percent of Standard/Guideline for Criteria Air Pollutants	II-6.5-6	6-63
9.	INEL—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-6.5-7	6-64
10.	INEL—HW—Impacts on Water Resources Due to Increased Water Use	II-6.5-8	6-65
13.	INEL—HW—Socioeconomic Impacts for Treatment	II-6.5-9	6-66
14.	INEL—HW—Infrastructure Impacts for Treatment	II-6.5-10	6-67
15.	INEL—HW—Cost	II-6.5-11	6-68

Table II-6.5-1. INEL—HW—Treatment: Estimated Number of Fatalities

HW Alternatives	Number of Treatment Sites	WM Workers
		Physical Hazards
No Action	2	2.6E-03
Decentralized	3	- -
Regionalized 1	5	6.8E-03
Regionalized 2	2	3.1E-02

Table II-6.5-2. INEL—HW—Treatment: Estimated Number of Cancer Incidences

HW Alternatives	Number of Treatment Sites	Treatment		
		Offsite Population Chemical Cancer Incidence	Noninvolved Chemical Cancer Incidence	WM Worker Chemical Cancer Incidence
No Action	2	3.4E-05	4.4E-05	1.8E-02
Decentralized	3	- -	- -	- -
Regionalized-1	5	1.0E-04	1.4E-04	7.6E-02
Regionalized-2	2	9.7E-04	1.3E-03	7.4E-01

Notes:
- - = Treatment is not considered for this alternative.

Table II-6.5-3. INEL—HW—Treatment: MEI Probability of Cancer Incidences

HW Alternatives	Number of Treatment Sites	Treatment	
		Offsite MEI Cancer Incidence Probability	Noninvolved Worker MEI Cancer Incidence Probability
No Action	2	4.6E-09	3.7E-08
Decentralized	3	- -	- -
Regionalized-1	5	1.4E-08	1.1E-07
Regionalized-2	2	1.3E-07	1.1E-06

Notes:
MEI = Maximally Exposed Individual
- - = Treatment is not considered for this alternative.

Table II-6.5-4. INEL—HW—Treatment: Noncancer Health Risk From Chemical Exposure

HW Alternatives	Number of Treatment Sites	Treatment		
		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action	2	3.2E-05	2.5E-04	2.1E+00
Decentralized	3	- -	- -	- -
Regionalized-1	5	1.9E-04	1.5E-03	4.8E+00
Regionalized-2	2	1.8E-03	1.4E-02	6.2E+00

Notes:
MEI = Maximally Exposed Individual
- - = Treatment is not considered for this alternative.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-6.5-5. INEL—HW—Emissions in Tons per Year of Criteria Air Pollutants

HW Alternatives	Number of Sites	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--	0	0	0	0	0	0
Decentralized	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	3 (2/1)	4 (4/0)	0	0	0	0	0	0	0	0	0	0
Regionalized-2	2	5 (3/2)	9 (9/0)	0	1 (1/0)	1 (1/0)	1 (1/0)	0	1 (0/0)	0	3 (3/0)	3 (3/0)	0

Notes:
T = Treatment
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)

Table II-6.5-6. INEL—HW—Percent of Standard/Guideline for Criteria Air Pollutants

HW Alternatives	Number of Sites T	Construction: Percent of Tons/Year General Conformity Rule (1) CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--
Regionalized-1	5	--	--	--	--	--	--
Regionalized-2	2	--	--	--	--	--	--

HW Alternatives	Number of Sites T	Operations & Maintenance: Percent of Tons/Year Standard or Guideline (2) CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	Percent of NAAQS Concentration (3) CO	NO2	Pb	PM10	SO2	VOC
No Action	2	0	0	0	2	1	0	0	0	0	0	0	0
Decentralized	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	0	0	0	2	1	0	0	0	0	0	0	0
Regionalized-2	2	0	1	0	17	9	0	0	0	0	0	0	0

Notes:
T = Treatment
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
NAAQS = National Ambient Air Quality Standard.
VOC = volatile organic compounds.
(1) INEL is in an attainment area for all criteria pollutants, therfore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the Decentralized Alternative are assumed to be negligible since no waste is treated at INEL under this alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-6.5-7. INEL—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HW Alternatives	Number of Sites T	Operations & Maintenance											
		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	2	--	--	--	0	--	--	0	0	--	--	--	--
Decentralized	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 1	5	--	--	--	0	--	--	0	0	--	--	--	--
Regionalized - 2	2	--	--	--	0	--	--	0	0	--	--	--	--

HW Alternatives	Number of Sites T	Operations & Maintenance									
		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	Vinyl Chloride
No Action	2	--	0	--	--	0	--	0	0	0	0
Decentralized	3	--	--	--	--	--	--	--	--	--	--
Regionalized - 1	5	--	0	--	--	0	--	0	0	0	0
Regionalized - 2	2	--	0	--	--	0	--	0	0	0	1

Notes:
T = Treatment
Percentages <1% are shown as zeros.
- - = Emissions of certain hazardous or toxic air pollutants, including radionuclides, from HW treatment facilities are assumed to be negligible.

Table II-6.5-8. INEL—HW—Impacts on Water Resources Due to Increased Water Use

HW Alternatives	Number of Sites T	Construction Water Use GPD	Construction % Current Use	Construction % Stream Flow	Operations Water Use GPD	Operations % Current Use	Operations % Stream Flow	Operations Waste Water % Stream Flow
No Action	2	--	--	--	56	<0.1	--	--
Decentralized	3	--	--	--	--	--	--	--
Regionalized-1	5	516	<0.1	--	313	<0.1	--	--
Regionalized-2	2	1823	<0.1	--	1108	<0.1	--	--

Notes:
T = Treatment
GPD = Gallons per day.
Water supplied by groundwater in the Snake River Plain Aquifer. Current water use = 5,700,000 gallons/day.
Wastewater discharged to onsite evaporation ponds.
-- = Not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-6.5-9. INEL—HW—Socioeconomic Impacts for Treatment

HW Alternatives	Number of Sites	Effect of Implementation of Alternatives					
			Jobs		Income		
	T	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	2	6	6	0.01	0.1	0.00	0.00
Decentralized	3	0	0	0.00	0.0	0.00	0.00
Regionalized 1	5	21	23	0.02	0.2	0.01	0.01
Regionalized 2	2	116	128	0.13	1.4	0.05	0.02

Notes:
T = Treatment
(1) In current 1990 dollars.
(2) Compared to 1990 baseline.

Table II-6.5-10. INEL—HW—Infrastructure Impacts for Treatment

HW Alternatives	Number of Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	2	0	0.000	56	0.00	56	0.00	0.30	0.10	0	0
Decentralized	3	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-1	5	1	0.005	516	0.00	313	0.00	0.13	0.30	9	0
Regionalized-2	2	3	0.016	1823	0.01	1108	0.00	0.42	1.00	18	0

Notes:
T = Treatment
GPD = Gallons per Day
MW = Megawatts Electric
- - = Treatment is not considered for this alternative.
(1) Based on 1991 Site Employment.

Table II-6.5-11. INEL—HW—Cost

HW Alternatives	Number of Sites	Total Cost (Millions) (1)	Government Cost by Life-Cycle Component (1)				Cost by Functional Area (1)	
							Treatment & Disposal	
	T		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Government (2) (Millions)	Commercial (Millions)
No Action	2	10	- -	- -	6	0	6	4
Decentralized	3	4	- -	- -	- -	- -	- -	4
Regionalized-1	5	25	2	9	12	1	23	2
Regionalized-2	2	137	10	39	79	3	131	6

Notes:
T = Treatment
- - = Not considered for this site.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In current 1994 Dollars; Total Cost = Sum of the Functional Areas.
(2) Government costs equal to the sum of the life-cycle components.

II.7.0 LANL

LANL currently is custodian of significant volumes of LLMW, LLW, TRUW, and HW. Each of the waste types is treated independently in the following sections:

II.7.1 LANL LLMW

Fifteen tables immediately following portray the impacts of LLMW at LANL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	LANL—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-7.1-1	7-2
2.	LANL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-7.1-2	7-3
3.	LANL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-7.1-3	7-4
4.	LANL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-7.1-4	7-5
5.	LANL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-7.1-5	7-6
6.	LANL—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure	II-7.1-6	7-7
7.	LANL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-7.1-7	7-8
8.	LANL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-7.1-8	7-9
9.	LANL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-7.1-9	7-10
10.	LANL—LLMW—Impacts on Water Resources Due to Increased Water Use	II-7.1-10	7-11
11.	LANL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-7.1-11	7-12
12.	LANL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-7.1-12	7-13
13.	LANL—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-7.1-13	7-14
14.	LANL—LLMW—Infrastructure Impacts for Treatment and Disposal	II-7.1-14	7-15
15.	LANL—LLMW—Cost	II-7.1-15	7-16

Table II-7.1-1. LANL—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Workers		Offsite Population	Noninvolved Workers	WM Workers	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	8.4E-04	1.1E-02	7.5E-05	6.7E-06	- -	- -
Decentralized	37	16	1.6E-03	2.0E-01	5.9E-04	1.2E-05	1.6E-03	1.1E-02
Regionalized-1	11	12	1.8E-03	2.0E-01	6.1E-04	1.2E-05	1.9E-03	1.1E-02
Regionalized-2	7	6	2.3E-03	2.2E-01	8.6E-04	1.7E-05	1.2E-02	1.3E-01
Regionalized-3	7	1	2.3E-03	2.2E-01	8.6E-04	1.7E-05	- -	- -
Regionalized-4	4	6	6.9E-04	4.4E-02	3.8E-05	7.5E-07	- -	- -
Centralized	1	1	6.9E-04	4.4E-02	3.8E-05	7.5E-07	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-7.1-2. LANL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Workers			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	1.5E-01	2.6E-04	3.9E-06	1.5E-05	1.3E-02	2.3E-05	2.0E-06	1.3E-06	2.1E+00	2.9E-03	3.8E-07	1.3E-04
Decentralized	37	16	1.2E+00	2.0E-03	2.6E-07	1.2E-04	2.4E-02	4.0E-05	1.3E-07	2.4E-06	3.9E+00	5.5E-03	4.1E-06	2.3E-04
Regionalized -1	11	12	1.2E+00	2.1E-03	2.6E-07	1.2E-04	2.5E-02	4.2E-05	1.3E-07	2.5E-06	4.5E+00	6.4E-03	4.2E-06	2.7E-04
Regionalized-2	7	6	1.7E+00	2.9E-03	6.9E-06	1.7E-04	3.5E-02	5.9E-05	3.4E-06	3.5E-06	5.9E+00	8.2E-03	6.0E-06	3.5E-04
Regionalized-3	7	1	1.7E+00	2.9E-03	7.0E-07	1.7E-04	3.5E-02	5.9E-05	1.0E-07	3.5E-06	5.9E+00	8.2E-03	6.0E-06	3.5E-04
Regionalized-4	4	6	7.6E-02	1.3E-04	1.4E-06	7.6E-06	1.5E-03	2.6E-06	6.9E-07	1.5E-07	1.7E+00	2.4E-03	3.0E-07	1.0E-04
Centralized	1	1	7.6E-02	1.3E-04	1.6E-08	7.6E-06	1.5E-03	2.6E-06	8.1E-09	1.5E-07	1.7E+00	2.4E-03	3.0E-07	1.0E-04

Notes:
T = Treatment
D = Disposal

Table II-7.1-3. LANL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	3.9E+00	5.5E-03	2.4E-04
Regionalized-1	11	12	4.8E+00	6.7E-03	2.9E-04
Regionalized-2	7	6	2.9E+01	4.0E-02	1.7E-03
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	3.9E+00	5.5E-03	2.4E-04
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-7.1-4. LANL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	8.0E-09	5.1E-09	- -
Decentralized	37	16	6.2E-08	8.7E-09	<9.9E-14
Regionalized-1	11	12	6.4E-08	9.0E-09	<9.9E-14
Regionalized-2	7	6	9.1E-08	1.3E-08	<9.9E-14
Regionalized-3	7	1	9.1E-08	1.3E-08	- -
Regionalized-4	4	6	4.0E-09	5.5E-10	<9.9E-14
Centralized	1	1	4.0E-09	5.5E-10	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-7.1-5. LANL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	1.6E-05	2.7E-08	4.6E-10	1.6E-09	1.0E-05	1.7E-08	1.2E-09	1.0E-09	- -	- -	- -	- -
Decentralized	37	16	1.2E-04	2.1E-07	3.2E-11	1.2E-08	1.7E-05	3.0E-08	8.0E-11	1.7E-09	<9.9E-14	<9.9E-14	7.7E-05	<9.9E-14
Regionalized-1	11	12	1.3E-04	2.2E-07	3.3E-11	1.3E-08	1.8E-05	3.1E-08	8.1E-11	1.8E-09	<9.9E-14	<9.9E-14	7.7E-05	<9.9E-14
Regionalized-2	7	6	1.8E-04	3.1E-07	8.5E-10	1.8E-08	2.6E-05	4.3E-08	2.1E-09	2.6E-09	<9.9E-14	<9.9E-14	4.3E-05	<9.9E-14
Regionalized-3	7	1	1.8E-04	3.1E-07	2.5E-11	1.8E-08	2.6E-05	4.3E-08	6.2E-11	2.6E-09	- -	- -	- -	- -
Regionalized-4	4	6	8.0E-06	1.4E-08	1.7E-10	8.0E-10	1.1E-06	1.9E-09	4.3E-10	1.1E-10	<9.9E-14	<9.9E-14	1.2E-07	<9.9E-14
Centralized	1	1	8.0E-06	1.4E-08	2.0E-12	8.0E-10	1.1E-06	1.9E-09	5.0E-12	1.1E-10	- -	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for this alternative.

Table II-7.1-6. LANL—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	7.7E-07	1.9E-06	5.9E-06	- -
Decentralized	37	16	6.3E-08	1.6E-07	1.4E-05	3.7E-02
Regionalized-1	11	12	6.5E-08	1.6E-07	1.4E-05	3.7E-02
Regionalized-2	7	6	2.6E-07	6.5E-07	5.0E-05	1.8E-02
Regionalized-3	7	1	4.4E-08	1.1E-07	5.0E-05	- -
Regionalized-4	4	6	1.4E-07	3.6E-07	5.8E-06	2.2E-05
Centralized	1	1	3.0E-09	7.5E-09	5.8E-06	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-7.1-7. LANL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	48 (29/19)	80 (76/4)	0	6 (6/0)	7 (7/0)	9 (7/2)	4 (1/3)	3 (2/1)	0	0	0	0
Decentralized	37	16	58 (12/46)	41 (32/9)	0	3 (3/0)	3 (3/0)	9 (3/6)	19 (0/19)	5 (1/4)	0	0	0	2 (0/2)
Regionalized-1	11	12	61 (12/49)	42 (32/10)	0	3 (3/0)	3 (3/0)	9 (3/6)	20 (0/20)	4 (0/4)	0	0	0	2 (0/2)
Regionalized-2	7	6	67 (5/62)	25 (13/12)	0	1 (1/0)	1 (1/0)	8 (1/7)	44 (0/44)	10 (1/9)	0	0	0	5 (0/5)
Regionalized-3	7	1	48 (2/46)	14 (5/9)	0	0	0	7 (1/6)	19 (0/19)	4 (0/4)	0	0	0	2 (0/2)
Regionalized-4	4	6	13 (1/12)	4 (2/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Centralized	1	1	13 (1/12)	4 (2/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-7.1-8. LANL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized-1	11	12	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	1	6	0	3	0	0	--	--	--	--	--	--
Decentralized	37	16	0	2	0	2	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	1	0	1	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	1	0	2	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	1	0	1	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) LANL is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for the No Action, Regionalized-4, and Centralized Alternatives.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-7.1-9. LANL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-7.1-10. LANL—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	69589	1.7	- -	2128	0.1	- -	- -
Decentralized	37	16	21639	0.5	- -	2922	0.1	- -	- -
Regionalized-1	11	12	21320	0.5	- -	2920	0.1	- -	- -
Regionalized-2	7	6	16275	0.4	- -	5078	0.1	- -	- -
Regionalized-3	7	1	10113	0.2	- -	2966	0.1	- -	- -
Regionalized-4	4	6	2149	0.1	- -	597	<0.1	- -	- -
Centralized	1	1	2149	0.1	- -	597	<0.1	- -	- -

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Main Aquifer. Current water use = 4,100,000 gallons/day.
Wastewater discharged to onsite dry stream beds.
- - = Stream Flow and Waste Water Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-7.1-11. LANL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-7.1-12. LANL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	2	0	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	50	0	0	200	0	0	0
Regionalized-1	11	12	50	0	0	200	0	0	0
Regionalized-2	7	6	30	0	0	70	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-7.1-13. LANL—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	156	123	0.01	1.3	0.00	0.09
Decentralized	37	16	427	420	0.03	4.6	0.01	0.12
Regionalized-1	11	12	442	434	0.03	4.7	0.01	0.25
Regionalized-2	7	6	768	755	0.05	8.2	0.01	0.48
Regionalized-3	7	1	407	400	0.03	4.4	0.01	0.25
Regionalized-4	4	6	96	94	0.01	1.0	0.00	0.06
Centralized	1	1	96	94	0.01	1.0	0.00	0.05

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-7.1-14. LANL—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	20.8	0.13	69589	0.70	2128	0.21	10	8.33	144	2
Decentralized	37	16	13.4	0.08	21639	0.22	2922	0.29	1.3	1.08	357	6
Regionalized-1	11	12	13.4	0.08	21320	0.21	2920	0.29	1.28	1.07	376	6
Regionalized-2	7	6	11.1	0.07	16275	0.16	5078	0.51	1.34	1.12	479	8
Regionalized-3	7	1	7.4	0.05	10113	0.10	2966	0.30	0.69	0.58	357	6
Regionalized-4	4	6	4.8	0.03	2149	0.02	597	0.06	0.61	0.51	90	1
Centralized	1	1	4.8	0.02	2149	0.02	597	0.06	0.61	0.51	90	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-7.1-15. LANL—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	176	19	72	79	6	46	131	0
Decentralized	37	16	474	46	179	228	20	395	0	79
Regionalized-1	11	12	500	66	180	235	20	421	0	79
Regionalized-2	7	6	869	94	212	480	84	452	0	417
Regionalized-3	7	1	461	57	178	206	19	461	0	0
Regionalized-4	4	6	343	35	74	187	46	108	0	235
Centralized	1	1	109	12	49	43	5	108	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.7.2 LANL LLW

Thirteen tables immediately following portray the impacts of LLW at LANL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	LANL—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-7.2-1	7-18
2.	LANL—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-7.2-2	7-19
3.	LANL—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-7.2-3	7-20
4.	LANL—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-7.2-4	7-21
5.	LANL—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-7.2-5	7-22
7.	LANL—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-7.2-6	7-23
8.	LANL—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-7.2-7	7-24
9.	LANL—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-7.2-8	7-25
10.	LANL—LLW—Impacts on Water Resources Due to Increased Water Use	II-7.2-9	7-26
11.	LANL—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-7.2-10	7-27
13.	LANL—LLW—Socioeconomic Impacts for Treatment and Disposal	II-7.2-11	7-28
14.	LANL—LLW—Infrastructure Impacts for Treatment and Disposal	II-7.2-12	7-29
15.	LANL—LLW—Cost	II-7.2-13	7-30

Table II-7.2-1. LANL—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	1.8E-01	1.6E-01	1.9E-04	1.3E-05	8.3E-01	3.8E-01
Decentralized		16	1.4E-01	1.4E-01	2.1E-04	1.4E-05	5.6E-01	3.2E-01
Regionalized-1		12	1.4E-01	1.4E-01	2.1E-04	1.4E-05	5.6E-01	3.2E-01
Regionalized-2	11	12	1.9E-01	3.0E-01	7.8E-03	7.0E-04	3.6E-01	1.7E-01
Regionalized-3		6	1.4E-01	1.4E-01	2.1E-04	1.4E-05	7.8E-01	4.1E-01
Regionalized-4	7	6	3.4E-01	5.9E-01	7.8E-03	7.0E-04	3.9E-01	1.8E-01
Regionalized-5	4	6	1.4E-01	1.9E-01	2.1E-04	1.4E-05	3.9E-01	1.8E-01
Regionalized-6		2	1.4E-01	1.9E-01	2.1E-04	1.4E-05	- -	- -
Regionalized-7		2	1.4E-01	1.9E-01	2.1E-04	1.4E-05	- -	- -
Centralized-1		1	1.4E-01	1.9E-01	2.1E-04	1.4E-05	- -	- -
Centralized-2		1	1.4E-01	1.9E-01	2.1E-04	1.4E-05	- -	- -
Centralized-3	7	1	3.4E-01	5.9E-01	7.8E-03	7.0E-04	- -	- -
Centralized-4	7	1	3.4E-01	5.9E-01	7.8E-03	7.0E-04	- -	- -
Centralized-5	1	1	1.4E-01	1.9E-01	2.1E-04	1.4E-05	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-7.2-2. LANL—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Worker			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	3.9E-01	6.6E-04	3.9E-05	2.6E-02	4.5E-05	2.6E-06	4.4E+02	6.2E-01	2.7E-02
Decentralized		16	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02
Regionalized-1		12	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02
Regionalized-2	11	12	1.6E+01	2.7E-02	1.6E-03	1.4E+00	2.4E-03	1.4E-04	4.6E+02	6.5E-01	2.8E-02
Regionalized-3		6	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02
Regionalized-4	7	6	1.6E+01	2.7E-02	1.6E-03	1.4E+00	2.4E-03	1.4E-04	8.6E+02	1.2E+00	5.1E-02
Regionalized-5	4	6	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02
Regionalized-6		2	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02
Regionalized-7		2	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02
Centralized-1		1	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02
Centralized-2		1	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02
Centralized-3	7	1	1.6E+01	2.7E-02	1.6E-03	1.4E+00	2.4E-03	1.4E-04	8.6E+02	1.2E+00	5.1E-02
Centralized-4	7	1	1.6E+01	2.7E-02	1.6E-03	1.4E+00	2.4E-03	1.4E-04	8.6E+02	1.2E+00	5.1E-02
Centralized-5	1	1	4.2E-01	7.1E-04	4.2E-05	2.8E-02	4.8E-05	2.8E-06	3.5E+02	4.9E-01	2.1E-02

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-3. LANL—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	2.1E+03	2.9E+00	1.2E-01
Decentralized		16	1.4E+03	2.0E+00	8.4E-02
Regionalized-1		12	1.4E+03	2.0E+00	8.5E-02
Regionalized-2	11	12	9.1E+02	1.3E+00	5.4E-02
Regionalized-3		6	1.9E+03	2.7E+00	1.2E-01
Regionalized-4	7	6	1.0E+03	1.4E+00	6.0E-02
Regionalized-5	4	6	9.6E+02	1.4E+00	5.8E-02
Regionalized-6		2	--	--	--
Regionalized-7		2	--	--	--
Centralized-1		1	--	--	--
Centralized-2		1	--	--	--
Centralized-3	7	1	--	--	--
Centralized-4	7	1	--	--	--
Centralized-5	1	1	--	--	--

Notes:
T = Treatment
D = Disposal
-- = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-4. LANL—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	2.0E-08	1.0E-08	<9.9E-14
Decentralized		16	2.2E-08	1.1E-08	<9.9E-14
Regionalized-1		12	2.2E-08	1.1E-08	<9.9E-14
Regionalized-2	11	12	8.2E-07	5.3E-07	<9.9E-14
Regionalized-3		6	2.2E-08	1.1E-08	<9.9E-14
Regionalized-4	7	6	8.2E-07	5.3E-07	<9.9E-14
Regionalized-5	4	6	2.2E-08	1.1E-08	<9.9E-14
Regionalized-6		2	2.2E-08	1.1E-08	- -
Regionalized-7		2	2.2E-08	1.1E-08	- -
Centralized-1		1	2.2E-08	1.1E-08	- -
Centralized-2		1	2.2E-08	1.1E-08	- -
Centralized-3	7	1	8.2E-07	5.3E-07	- -
Centralized-4	7	1	8.2E-07	5.3E-07	- -
Centralized-5	1	1	2.2E-08	1.1E-08	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-5. LANL—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	4.1E-05	6.9E-08	4.1E-09	2.0E-05	3.4E-08	2.0E-09	<9.9E-14	<9.9E-14	<9.9E-14
Decentralized		16	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-1		12	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-2	11	12	1.6E-03	2.8E-06	1.6E-07	1.1E-03	1.8E-06	1.1E-07	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-3		6	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-4	7	6	1.6E-03	2.8E-06	1.6E-07	1.1E-03	1.8E-06	1.1E-07	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-5	4	6	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-6		2	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	--	--	--
Regionalized-7		2	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	--	--	--
Centralized-1		1	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	--	--	--
Centralized-2		1	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	--	--	--
Centralized-3	7	1	1.6E-03	2.8E-06	1.6E-07	1.1E-03	1.8E-06	1.1E-07	--	--	--
Centralized-4	7	1	1.6E-03	2.8E-06	1.6E-07	1.1E-03	1.8E-06	1.1E-07	--	--	--
Centralized-5	1	1	4.4E-05	7.5E-08	4.4E-09	2.2E-05	3.7E-08	2.2E-09	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-6. LANL—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	17 (6/11)	15 (13/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	94 (1/93)	20 (1/19)	0	0	0	11 (0/11)
Decentralized		16	28 (10/18)	29 (25/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	68 (0/68)	14 (0/14)	0	0	0	8 (0/8)
Regionalized-1		12	26 (10/16)	29 (26/3)	0	2 (2/0)	2 (2/0)	4 (3/2)	64 (0/64)	13 (0/13)	0	0	0	8 (0/8)
Regionalized-2	11	12	66 (9/57)	34 (23/11)	0	2 (2/0)	2 (2/0)	9 (2/7)	76 (0/76)	18 (3/15)	0	2 (2/0)	0	9 (0/9)
Regionalized-3		6	120 (14/106)	56 (35/21)	0	3 (3/0)	3 (3/0)	16 (3/13)	82 (0/82)	19 (1/18)	0	0	0	10 (0/10)
Regionalized-4	7	6	118 (12/106)	52 (31/21)	0	3 (3/0)	3 (3/0)	16 (3/13)	146 (1/145)	33 (3/30)	0	2 (2/0)	0	18 (0/18)
Regionalized-5	4	6	19 (2/17)	8 (5/3)	0	0	0	2 (0/2)	43 (0/43)	9 (0/9)	0	0	0	5 (0/5)
Regionalized-6		2	19 (2/17)	8 (5/3)	0	0	0	2 (0/2)	14 (0/14)	4 (0/4)	0	0	0	2 (0/2)
Regionalzied-7		2	19 (2/17)	8 (5/3)	0	0	0	2 (0/2)	14 (0/14)	4 (0/4)	0	0	0	2 (0/2)
Centralized-1		1	19 (2/17)	8 (5/3)	0	0	0	2 (0/2)	14 (0/14)	4 (0/4)	0	0	0	2 (0/2)
Centralized-2		1	19 (2/17)	8 (5/3)	0	0	0	2 (0/2)	14 (0/14)	4 (0/4)	0	0	0	2 (0/2)
Centralized-3	7	1	112 (6/106)	37 (16/21)	0	1 (1/0)	2 (2/0)	15 (2/13)	100 (0/100)	25 (3/22)	0	2 (2/0)	0	12 (0/12)
Centralized-4	7	1	112 (6/106)	37 (16/21)	0	1 (1/0)	2 (2/0)	15 (2/13)	100 (0/100)	25 (3/22)	0	2 (2/0)	0	12 (0/12)
Centralized-5	1	1	19 (2/17)	8 (5/3)	0	0	0	2 (0/2)	14 (0/14)	4 (0/4)	0	0	0	2 (0/2)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-7. LANL—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalzied-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	1	3	0	1	0	0	--	--	--	--	--	--
Decentralized		16	0	1	0	1	0	0	--	--	--	--	--	--
Regionalized-1		12	0	1	0	1	0	0	--	--	--	--	--	--
Regionalized-2	11	12	0	8	0	12	0	0	0	0	0	0	0	0
Regionalized-3		6	0	1	0	1	0	0	--	--	--	--	--	--
Regionalized-4	7	6	1	8	0	13	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-6		2	0	0	0	0	0	0	--	--	--	--	--	--
Regionalzied-7		2	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-1		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-2		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	0	8	0	12	0	0	0	0	0	0	0	0
Centralized-4	7	1	0	8	0	12	0	0	0	0	0	0	0	0
Centralized-5	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) LANL is in an attainment area for all criteria pollutants, therefore the GCR do not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all but the Regionalized-2 and -4, and Centralized-3 and -4 Alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-8. LANL—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	2	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	2	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	2	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	2	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-9. LANL—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	3586	0.1	--	9666	0.2	--	--
Decentralized		16	22273	0.5	--	7743	0.2	--	--
Regionalized-1		12	22884	0.6	--	7965	0.2	--	--
Regionalized-2	11	12	25707	0.6	--	11429	0.3	--	--
Regionalized-3		6	30312	0.7	--	10658	0.3	--	--
Regionalized-4	7	6	35601	0.9	--	15828	0.4	--	--
Regionalized-5	4	6	14081	0.3	--	5468	0.1	--	--
Regionalized-6		2	5714	0.1	--	1739	<0.1	--	--
Regionalized-7		2	5714	0.1	--	1739	<0.1	--	--
Centralized-1		1	5714	0.1	--	1739	<0.1	--	--
Centralized-2		1	5714	0.1	--	1739	<0.1	--	--
Centralized-3	7	1	20240	0.5	--	10039	0.2	--	--
Centralized-4	7	1	20240	0.5	--	10039	0.2	--	--
Centralized-5	1	1	5714	0.1	--	1739	<0.1	--	--

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Main Aquifer. Current water use = 4,100,000 gallons/day.
Wastewater discharged to onsite dry stream beds.
** Ten sites use existing facilities for Volume Reduction.
-- = Stream Flow is not considered for this alternative.
<0.1 indicates that the percentage is less than 0.1%.

Table II-7.2-10. LANL—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-7.2-11. LANL—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	1235	971	1.16	10.6	0.42	0.64
Decentralized		16	1072	1053	1.26	11.5	0.45	0.96
Regionalized-1		12	1322	1299	1.56	14.1	0.56	0.62
Regionalized-2	11	12	1249	1228	1.47	13.4	0.53	0.76
Regionalized-3		6	1776	1746	2.09	19.0	0.75	0.77
Regionalized-4	7	6	2007	1972	2.36	21.5	0.85	1.42
Regionalized-5		6	1874	1842	2.21	20.0	0.79	0.41
Regionalized-6		2	254	249	0.30	2.7	0.11	0.14
Regionalized-7		2	254	249	0.30	2.7	0.11	0.14
Centralized-1		1	254	249	0.30	2.7	0.11	0.14
Centralized-2		1	254	249	0.30	2.7	0.11	0.14
Centralized-3	7	1	1207	1187	1.42	12.9	0.51	0.99
Centralized-4	7	1	1207	1187	1.42	12.9	0.51	0.99
Centralized-5	1	1	254	249	0.30	2.7	0.11	0.14

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-12. LANL—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	11.5	0.07	9666	0.10	9666	0.97	1.76	1.46	89	1
Decentralized		16	11.3	0.07	22273	0.22	7743	0.77	2.42	2.01	1478	24
Regionalized-1		12	11.6	0.07	22884	0.23	7965	0.80	2.48	2.07	426	7
Regionalized-2	11	12	13.4	0.08	25707	0.26	11429	1.14	2.81	2.34	621	10
Regionalized-3		6	15.1	0.09	30312	0.30	10658	1.07	3.28	2.73	523	8
Regionalized-4	7	6	18.5	0.11	35601	0.36	15828	1.58	3.89	3.24	1074	17
Regionalized-5	4	6	11.3	0.02	14081	0.14	5468	0.55	1.49	2.08	288	5
Regionalized-6		2	3.3	0.02	5714	0.06	1739	0.17	1.49	2.08	136	2
Regionalized-7		2	3.3	0.02	5714	0.06	1739	0.17	1.49	2.08	136	2
Centralized-1		1	3.3	0.02	5714	0.06	1739	0.17	1.49	2.08	136	2
Centralized-2		1	3.3	0.02	5714	0.06	1739	0.17	1.49	2.08	136	2
Centralized-3	7	1	11.8	0.07	20240	0.20	10039	1.00	2.91	2.42	821	13
Centralized-4	7	1	11.8	0.07	20240	0.20	10039	1.00	2.91	2.42	821	13
Centralized-5	1	1	3.3	0.02	5714	0.06	1739	0.17	1.49	2.08	121	2

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1994 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-7.2-13. LANL—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	1397	15	109	1147	125	292	0	1105
Decentralized		16	1213	95	162	766	190	287	0	925
Regionalized 1		12	1495	121	191	994	190	287	0	1208
Regionalized 2	11	12	1413	140	244	888	141	812	0	602
Regionalized 3		6	2010	127	817	875	191	287	0	1723
Regionalized 4	7	6	2270	199	412	1497	163	1366	0	904
Regionalized 5	4	6	2120	153	657	1126	185	287	0	1833
Regionalized 6		2	287	23	65	176	24	287	0	0
Regionalized 7		2	287	23	65	176	24	287	0	0
Centralized 1		1	287	23	65	176	24	287	0	0
Centralized 2		1	287	23	65	176	24	287	0	0
Centralized 3	7	1	1366	142	318	833	74	1366	0	0
Centralized 4	7	1	1366	142	318	833	74	1366	0	0
Centralized 5	1	1	287	23	65	176	24	287	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.7.3 LANL TRUW

Twelve tables immediately following portray the impacts of TRUW at LANL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	LANL—TRUW—Treatment: Estimated Number of Fatalities	II-7.3-1	7-32
2.	LANL—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-7.3-2	7-33
4.	LANL—TRUW—Treatment: MEI Probability of Cancer Fatality	II-7.3-3	7-34
5.	LANL—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-7.3-4	7-35
6.	LANL—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-7.3-5	7-36
7.	LANL—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-7.3-6	7-37
8.	LANL—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-7.3-7	7-38
9.	LANL—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-7.3-8	7-39
10.	LANL—TRUW—Impacts on Water Resources Due to Increased Water Use	II-7.3-9	7-40
13.	LANL—TRUW—Socioeconomic Impacts for Treatment	II-7.3-10	7-41
14.	LANL—TRUW—Infrastructure Impacts for Treatment	II-7.3-11	7-42
15.	LANL—TRUW—Cost	II-7.2-12	7-43

Table II-7.3-1. LANL—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure
	CH Treat	RH Treat		Radiation Exposure	Physical Hazards		
No Action **	16	5	WIPP WAC	3.5E-04	5.4E-02	4.1E-06	3.8E-07
Decentralized ***	16	5	WIPP WAC	1.4E-01	3.8E-01	5.4E-05	4.9E-06
Regionalized-1	5	2	Reduce Gas	1.4E-01	5.1E-01	6.5E-05	6.0E-06
Regionalized-2	5	2	LDR	1.4E-01	8.4E-01	6.4E-01	5.8E-02
Regionalized-3	3	2	LDR	1.4E-01	2.5E-01	7.1E-05	6.4E-06
Centralized	WIPP	2	LDR	1.4E-01	2.5E-01	7.1E-05	6.4E-06

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-7.3-2. LANL—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	8.3E-03	1.4E-05	2.3E-11	8.3E-07	7.6E-04	1.3E-06	1.1E-11	7.6E-08	8.6E-01	1.2E-03	4.9E-09	5.2E-05
Decentralized***	16	5	WIPP WAC	1.1E-01	1.8E-04	6.8E-10	1.1E-05	9.8E-03	1.7E-05	3.4E-10	9.8E-07	3.6E+02	5.0E-01	3.5E-08	2.1E-02
Regionalized-1	5	2	Reduce Gas	1.3E-01	2.2E-04	9.5E-10	1.3E-05	1.2E-02	2.0E-05	4.7E-10	1.2E-06	3.6E+02	5.0E-01	1.5E-07	2.1E-02
Regionalized-2	5	2	LDR	1.3E+03	2.2E+00	1.1E-09	1.3E-01	1.2E+02	2.0E-01	5.4E-10	1.2E-02	3.4E+02	4.8E-01	3.7E-07	2.0E-02
Regionalized-3	3	2	LDR	1.4E-01	2.4E-04	1.9E-09	1.4E-05	1.3E-02	2.2E-05	9.4E-10	1.3E-06	3.6E+02	5.0E-01	1.7E-07	2.2E-02
Centralized	WIPP	2	LDR	1.4E-01	2.4E-04	1.9E-09	1.4E-05	1.3E-02	2.2E-05	9.4E-10	1.3E-06	3.6E+02	5.0E-01	1.7E-07	2.2E-02

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-7.3-3. LANL—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	4.4E-10	2.8E-10
Decentralized***	16	5	WIPP WAC	5.7E-09	3.7E-09
Regionalized-1	5	2	Reduce Gas	6.9E-09	4.5E-09
Regionalized-2	5	2	LDR	6.7E-05	4.4E-05
Regionalized-3	3	2	LDR	7.4E-09	4.8E-09
Centralized	WIPP	2	LDR	7.4E-09	4.8E-09

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-7.3-4. LANL—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment	Treatment							
				Offsite Population MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat	Treatment Standard	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	8.7E-07	1.5E-09	<9.9E-14	8.7E-11	5.7E-07	9.7E-10	<9.9E-14	5.7E-11
Decentralized ***	16	5	WIPP WAC	1.1E-05	1.9E-08	8.3E-14	1.1E-09	7.4E-06	1.2E-08	2.1E-13	7.4E-10
Regionalized-1	5	2	Reduce Gas	1.4E-05	2.3E-08	1.2E-13	1.4E-09	9.0E-06	1.5E-08	3.0E-13	9.0E-10
Regionalized-2	5	2	LDR	1.3E-01	2.3E-04	1.3E-13	1.3E-05	8.7E-02	1.5E-04	3.3E-13	8.7E-06
Regionalized-3	3	2	LDR	1.5E-05	2.5E-08	2.3E-13	1.5E-09	9.7E-06	1.6E-08	5.7E-13	9.7E-10
Centralized	WIPP	2	LDR	1.5E-05	2.5E-08	2.3E-13	1.5E-09	9.7E-06	1.6E-08	5.7E-13	9.7E-10

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
MEI = Maximally Exposed Individual

Table II-7.3-5. LANL—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment	Treatment		
	CH Treat	RH Treat	Treatment Standard	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	4.2E-12	1.1E-11	6.2E-08
Decentralized***	16	5	WIPP WAC	1.2E-10	3.0E-10	4.7E-07
Regionalized-1	5	2	Reduce Gas	1.7E-10	4.1E-10	4.8E-07
Regionalized-2	5	2	LDR	1.1E-08	2.8E-08	6.7E-05
Regionalized-3	3	2	LDR	3.1E-10	7.8E-10	2.3E-06
Centralized	WIPP	2	LDR	3.1E-10	7.8E-10	2.3E-06

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-7.3-6. LANL—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	4 (0/4)	1 (0/1)	0	0	0	0
Decentralized***	16	5	WIPP WAC	54 (26/28)	74 (68/6)	0	5 (5/0)	6 (6/0)	10 (7/3)	39 (0/39)	8 (0/8)	0	0	0	5 (0/5)
Regionalized-1	5	2	Reduce Gas	67 (21/46)	64 (55/9)	0	4 (4/0)	5 (5/0)	11 (5/6)	42 (0/42)	8 (0/8)	0	0	0	5 (0/5)
Regionalized-2	5	2	LDR	65 (21/44)	63 (54/9)	0	4 (4/0)	5 (5/0)	10 (5/5)	47 (0/47)	10 (1/9)	0	0	0	6 (0/6)
Regionalized-3	3	2	LDR	43 (18/25)	52 (47/5)	0	4 (4/0)	4 (4/0)	8 (5/3)	23 (0/23)	5 (0/5)	0	0	0	3 (0/3)
Centralized	WIPP	2	LDR	43 (18/25)	52 (47/5)	0	4 (4/0)	4 (4/0)	8 (5/3)	23 (0/23)	5 (0/5)	0	0	0	3 (0/3)

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-7.3-7. LANL—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--
Centralized	WIPP	2	LDR	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	0	1	0	0	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	1	0	0	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	2	0	5	2	0	0	0	0	0	0	0
Regionalized-3	3	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) LANL is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for alternatives that do not involve treatment to LDR (incineration) are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-7.3-8. LANL—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance												
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	134	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-7.3-9. LANL—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	1850	<0.1	- -	- -
Decentralized***	16	5	WIPP WAC	33849	0.8	- -	5214	0.1	- -	- -
Regionalized-1	5	2	Reduce Gas	34966	0.9	- -	5922	0.1	- -	- -
Regionalized-2	5	2	LDR	34362	0.8	- -	6974	0.2	- -	- -
Regionalized-3	3	2	LDR	28400	0.7	- -	2019	<0.1	- -	- -
Centralized	WIPP	2	LDR	28400	0.7	- -	2019	<0.1	- -	- -

Notes:
Water supplied by groundwater in the Main Aquifer. Current water use = 4,100,000 gallons/day.
Wastewater discharged to onsite dry stream beds.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Stream Flow and Waste Water Stream Flow are not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-7.3-10. LANL—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	97	76	0.09	0.8	0.03	0.14
Decentralized***	16	5	WIPP WAC	812	798	0.96	8.7	0.34	0.43
Regionalized-1	5	2	Reduce Gas	849	834	1.00	9.1	0.36	0.46
Regionalized-2	5	2	LDR	910	895	1.07	9.7	0.39	0.49
Regionalized-3	3	2	LDR	443	436	0.52	4.7	0.19	0.24
Centralized	WIPP	2	LDR	443	436	0.52	4.7	0.19	0.24

Notes:
(1) In current 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-7.3-11. LANL—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	1850	0.02	1850	0.19	0.25	0.2	0	0.00
Decentralized***	16	5	WIPP WAC	15.4	0.10	33849	0.34	5214	0.52	1.04	0.87	433	7.00
Regionalized-1	5	2	Reduce Gas	15.1	0.09	34966	0.35	5922	0.59	1.28	1.06	475	7.70
Regionalized-2	5	2	LDR	14.9	0.09	34362	0.34	6974	0.70	1.42	1.19	461	7.40
Regionalized-3	3	2	LDR	1.2	0.01	28400	0.28	2019	0.20	1.94	1.62	234	3.80
Centralized	WIPP	2	LDR	1.2	0.01	28400	0.28	2019	0.20	1.94	1.62	234	3.80

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1994 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-7.3-12. LANL—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	110	0	0	87	22	0	90	20
Decentralized***	16	5	WIPP - WAC	919	50	237	397	234	454	438	27
Regionalized-1	5	2	Reduce Gas	961	56	260	405	240	454	468	39
Regionalized-2	5	2	LDR	1030	56	250	480	245	454	539	37
Regionalized-3	3	2	LDR	501	20	139	148	195	454	48	0
Centralized	WIPP	2	LDR	501	20	139	148	195	454	48	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.7.4 LANL HLW

LANL is not one of the sites considered for the management of HLW. Therefore, Section 7.4 has been intentionally left blank.

II.7.5 LANL HW

Eleven tables immediately following portray the impacts of HW at LANL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	LANL—HW—Treatment: Estimated Number of Fatalities	II-7.5-1	7-46
3.	LANL—HW—Treatment: Estimated Number of Cancer Incidences	II-7.5-2	7-47
5.	LANL—HW—Treatment: MEI Probability of Cancer Incidences	II-7.5-3	7-48
6.	LANL—HW—Treatment: Noncancer Health Risk From Chemical Exposure	II-7.5-4	7-49
7.	LANL—HW—Emissions in Tons per Year of Criteria Air Pollutants	II-7.5-5	7-50
8.	LANL—HW—Percent of Standard/Guideline for Criteria Air Pollutants	II-7.5-6	7-51
9.	LANL—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-7.5-7	7-52
10.	LANL—HW—Impacts on Water Resources Due to Increased Water Use	II-7.5-8	7-53
13.	LANL—HW—Socioeconomic Impacts for Treatment	II-7.5-9	7-54
14.	LANL—HW—Infrastructure Impacts for Treatment	II-7.5-10	7-55
15.	LANL—HW—Cost	II-7.5-11	7-56

Table II-7.5-1. LANL—HW—Treatment: Estimated Number of Fatalities

HW Alternatives	Number of Treatment Sites	WM Worker Physical Hazards
No Action	2	- -
Decentralized	3	6.4E-03
Regionalized-1	5	1.7E-02
Regionalized-2	2	- -

Notes:
- - = Treatment is not considered for this alternative

Table II-7.5-2. LANL—HW—Treatment: Estimated Number of Cancer Incidences

HW Alternatives	Number of Treatment Sites	Treatment		
		Offsite Population Chemical Cancer Incidences	Noninvolved Worker Chemical Cancer Incidences	WM Worker Chemical Cancer Incidences
No Action	2	- -	- -	- -
Decentralized	3	4.6E-03	2.3E-03	6.8E-02
Regionalized-1	5	1.9E-02	9.5E-03	3.0E-01
Regionalized-2	2	- -	- -	- -

Notes:
- - = Treatment is not considered for this alternative.

Table II-7.5-3. LANL—HW—Treatment: MEI Probability of Cancer Incidences

HW Alternatives	Number of Treatment Sites	Treatment	
		Offsite MEI Chemical Cancer Incidence Probability	Noninvolved MEI Chemical Cancer Incidence Probability
No Action	2	- -	- -
Decentralized	3	5.7E-07	1.4E-06
Regionalized-1	5	2.4E-06	5.9E-06
Regionalized-2	2	- -	- -

Notes:
MEI = Maximally Exposed Individual
- - = Treatment is not considered for this alternative.

Table II-7.5-4. LANL—HW—Treatment: Noncancer Health Risk From Chemical Exposure

HW Alternatives	Number of Treatment Sites	Treatment		
		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action	2	- -	- -	- -
Decentralized	3	7.6E-03	1.9E-02	4.8E+00
Regionalized-1	5	3.1E-02	7.9E-02	6.1E+00
Regionalized-2	2	- -	- -	- -

Notes:
MEI = Maximally Exposed Individual
- - = Treatment is not considered for this alternative.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-7.5-5. LANL—HW—Emissions in Tons per Year of Criteria Air Pollutants

HW Alternatives	Number of Treatment Sites	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Decentralized	3	3 (2/1)	4 (4/0)	0	0	0	1 (0/0)	0	0	0	0	0	0
Regionalized-1	5	5 (3/2)	9 (9/0)	0	1 (1/0)	1 (1/0)	1 (1/0)	0	0	0	1 (1/0)	2 (2/0)	0
Regionalized-2	2	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)

Table II-7.5-6. LANL—HW—Percent of Standard/Guideline for Criteria Air Pollutants

HW Alternatives	Number of Treatment Sites	Construction					
		Percent of Tons/Year General Conformity Rule (1)					
		CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--
Regionalized-1	5	--	--	--	--	--	--
Regionalized-2	2	--	--	--	--	--	--

HW Alternatives	Number of Treatment Sites	Operations & Maintenance											
		Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	3	0	0	0	2	1	0	0	0	0	0	0	0
Regionalized-1	5	0	1	0	8	4	0	0	0	0	0	0	0
Regionalized-2	2	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) LANL is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the Regionalized-2 Alternative are assumed to be negligible since no waste is treated at LANL under this alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-7.5-7. LANL—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HW Alternatives	Number of Treatment Sites	Operations & Maintenance											
		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	2	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	--	--	0	--	--	0	0	--	--	--	--
Regionalized - 1	5	--	--	--	0	--	--	0	0	--	--	--	--
Regionalized - 2	2	--	--	--	--	--	--	--	--	--	--	--	--

HW Alternatives	Number of Treatment Sites	Operations & Maintenance									
		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	2	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	0	--	--	0	--	0	0	0	37
Regionalized - 1	5	--	0	--	--	0	--	0	0	0	153
Regionalized - 2	2	--	--	--	--	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros.
-- = Emissions of certain hazardous or toxic air pollutants, including radionuclides, from HW treatment facilities are assumed to be negligible.

Table II-7.5-8. LANL—HW—Impacts on Water Resources Due to Increased Water Use

HW Alternatives	Number of Treatment Sites	Construction			Operations			
		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	2	- -	- -	- -	- -	- -	- -	- -
Decentralized	3	775	<0.1	- -	328	<0.1	- -	- -
Regionalized-1	5	1777	<0.1	- -	907	<0.1	- -	- -
Regionalized-2	2	- -	- -	- -	- -	- -	- -	- -

Notes:
Water supplied by groundwater in the Main Aquifer. Current water use = 4,100,000 gallons/day.
Wastewater discharged to onsite dry stream beds.
- - = Not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-7.5-9. LANL—HW—Socioeconomic Impacts for Treatment

HW Alternatives	Number of Treatment Sites	Effect of Implementation of Alternatives					
			Jobs		Income		
		Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	2	- -	- -	- -	- -	- -	- -
Decentralized	3	20	22	0.03	0.2	0.01	0.00
Regionalized 1	5	51	57	0.07	0.6	0.02	0.03
Regionalized 2	2	- -	- -	- -	- -	- -	- -

Notes:
- - = Treatment is not considered for this alternative.
(1) In 1990 dollars.
(2) Compared to 1990 baseline.

Table II-7.5-10. LANL—HW—Infrastructure Impacts for Treatment

HW Alternatives	Number of Treatment Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	2	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Decentralized	3	1	0.00	775	0.01	346	0.03	0.13	0.10	9	0
Regionalized-1	5	1	0.01	1777	0.02	907	0.09	0.26	0.22	19	0
Regionalized-2	2	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

Notes:
FTE = Full-Time Equivalent
GPD = Gallons per Day
MW = Megawatts Electric
- - = Treatment is not considered for this alternative
(1) Based on 1994 Site Employment.

Table II-7.5-11. LANL—HW—Cost

HW Alternatives	Number of Treatment Sites	Total Cost (Millions) (1)	Government Cost by Life-Cycle Component (1)				Cost by Functional Area (1)	
			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment & Disposal	
							Government (2) (Millions)	Commercial (Millions)
No Action	2	3	- -	- -	- -	- -	- -	3
Decentralized	3	26	2	9	12	1	23	3
Regionalized-1	5	66	4	20	33	1	58	8
Regionalized-2	2	- -	- -	- -	- -	- -	- -	- -

Notes:
- - = Not considered for this site.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Functional Areas.
(2) Government costs equal to the sum of the life-cycle components.

II.8.0 LLNL

LLNL currently is custodian of significant volumes of LLMW, LLW, and TRUW. Each of the waste types is treated independently in the following sections.

II.8.1 LLNL LLMW

Fifteen tables immediately following portray the impacts of LLMW at LLNL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	LLNL—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-8.1–1	8–2
2.	LLNL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-8.1–2	8–3
3.	LLNL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-8.1–3	8–4
4.	LLNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-8.1–4	8–5
5.	LLNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-8.1–5	8–6
6.	LLNL—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-8.1–6	8–7
7.	LLNL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-8.1–7	8–8
8.	LLNL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-8.1–8	8–9
9.	LLNL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-8.1–9	8–10
10.	LLNL—LLMW—Impacts on Water Resources Due to Increased Water Use	II-8.1–10	8–11
11.	LLNL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-8.1–11	8–12
12.	LLNL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-8.1–12	8–13
13.	LLNL—LLMW—Socioeconomics Impacts for Treatment and Disposal	II-8.1–13	8–14
14.	LLNL—LLMW—Infrastructure Impacts for Treatment and Disposal	II-8.1–14	8–15
15.	LLNL—LLMW—Cost	II-8.1–15	8–16

Table II-8.1-1. LLNL—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	8.2E-04	1.8E-02	9.5E-04	4.4E-05	- -	- -
Decentralized	37	16	7.8E-03	2.7E-01	1.5E-01	2.1E-03	4.1E-02	2.3E-02
Regionalized-1	11	12	2.3E-02	2.9E-01	1.6E-01	2.2E-03	4.0E-02	2.3E-02
Regionalized-2	7	6	6.2E-04	3.3E-02	4.4E-07	2.0E-08	- -	- -
Regionalized-3	7	1	6.2E-04	3.3E-02	4.4E-07	2.0E-08	- -	- -
Regionalized-4	4	6	6.2E-04	3.3E-02	4.4E-07	2.0E-08	- -	- -
Centralized	1	1	6.2E-04	3.3E-02	4.4E-07	2.0E-08	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-8.1-2. LLNL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	1.9E+00	3.2E-03	9.1E-05	1.9E-04	8.8E-02	1.5E-04	2.2E-05	8.8E-06	2.1E+00	2.9E-03	4.2E-06	1.2E-04
Decentralized	37	16	3.1E+02	5.2E-01	8.0E-06	3.1E-02	4.2E+00	7.2E-03	1.9E-06	4.2E-04	2.0E+01	2.7E-02	9.5E-05	1.2E-03
Regionalized-1	11	12	3.1E+02	5.3E-01	8.4E-06	3.1E-02	4.3E+00	7.3E-03	2.0E-06	4.3E-04	5.8E+01	8.1E-02	1.0E-04	3.5E-03
Regionalized-2	7	6	8.8E-04	1.5E-06	4.5E-07	8.8E-08	4.1E-05	6.9E-08	1.1E-07	4.1E-09	1.5E+00	2.2E-03	2.9E-06	9.2E-05
Regionalized-3	7	1	8.8E-04	1.5E-06	4.5E-07	8.8E-08	4.1E-05	6.9E-08	1.1E-07	4.1E-09	1.5E+00	2.2E-03	2.9E-06	9.2E-05
Regionalized-4	4	6	8.8E-04	1.5E-06	4.5E-07	8.8E-08	4.1E-05	6.9E-08	1.1E-07	4.1E-09	1.5E+00	2.2E-03	2.9E-06	9.2E-05
Centralized	1	1	8.8E-04	1.5E-06	4.5E-07	8.8E-08	4.1E-05	6.9E-08	1.1E-07	4.1E-09	1.5E+00	2.2E-03	2.9E-06	9.2E-05

Notes:
T = Treatment
D = Disposal

Table II-8.1-3. LLNL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	1.0E+02	1.4E-01	6.1E-03
Regionalized-1	11	12	1.0E+02	1.4E-01	6.1E-03
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-8.1-4. LLNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.6E-08	1.5E-08	- -
Decentralized	37	16	2.5E-06	7.3E-07	3.3E-07
Regionalized-1	11	12	2.6E-06	7.4E-07	3.3E-07
Regionalized-2	7	6	7.2E-12	6.9E-12	- -
Regionalized-3	7	1	7.2E-12	6.9E-12	- -
Regionalized-4	4	6	7.2E-12	6.9E-12	- -
Centralized	1	1	7.2E-12	6.9E-12	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-8.1-5. LLNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	3.1E-05	5.3E-08	2.0E-09	3.1E-09	3.0E-05	5.1E-08	6.4E-09	3.0E-09	--	--	--	--
Decentralized	37	16	5.0E-03	8.5E-06	1.8E-10	5.0E-07	1.5E-03	2.5E-06	5.6E-10	1.5E-07	6.5E-04	1.1E-06	8.4E-07	6.5E-08
Regionalized-1	11	12	5.1E-03	8.7E-06	1.9E-10	5.1E-07	1.5E-03	2.5E-06	6.0E-10	1.5E-07	6.5E-04	1.1E-06	8.4E-07	6.5E-08
Regionalized-2	7	6	1.4E-08	2.4E-11	1.0E-11	1.4E-12	1.4E-08	2.3E-11	3.2E-11	1.4E-12	--	--	--	--
Regionalized-3	7	1	1.4E-08	2.4E-11	1.0E-11	1.4E-12	1.4E-08	2.3E-11	3.2E-11	1.4E-12	--	--	--	--
Regionalized-4	4	6	1.4E-08	2.4E-11	1.0E-11	1.4E-12	1.4E-08	2.3E-11	3.2E-11	1.4E-12	--	--	--	--
Centralized	1	1	1.4E-08	2.4E-11	1.0E-11	1.4E-12	1.4E-08	2.3E-11	3.2E-11	1.4E-12	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered for this alternative.

Table II-8.1-6. LLNL—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	1.2E-06	3.8E-06	8.5E-06	- -
Decentralized	37	16	2.0E-07	6.6E-07	3.4E-04	5.5E-04
Regionalized-1	11	12	2.1E-07	6.7E-07	3.5E-04	5.5E-04
Regionalized-2	7	6	2.5E-09	7.9E-09	8.5E-06	- -
Regionalized-3	7	1	2.5E-09	7.9E-09	8.5E-06	- -
Regionalized-4	4	6	2.5E-09	7.9E-09	8.5E-06	- -
Centralized	1	1	2.5E-09	7.9E-09	8.5E-06	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-8.1-7. LLNL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	52 (29/23)	81 (76/5)	0	6 (6/0)	7 (7/0)	10 (7/3)	6 (1/5)	4 (3/1)	0	1 (1/0)	0	1 (0/1)
Decentralized	37	16	39 (7/32)	34 (18/16)	0	1 (1/0)	2 (2/0)	6 (2/4)	14 (0/14)	4 (1/3)	0	0	0	2 (0/2)
Regionalized-1	11	12	79 (7/72)	33 (19/14)	0	1 (1/0)	2 (2/0)	11 (2/9)	33 (0/33)	8 (1/7)	0	0	0	4 (0/4)
Regionalized-2	7	6	5 (0/5)	2 (1/1)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-3	7	1	5 (0/5)	2 (1/1)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-4	4	6	5 (0/5)	2 (1/1)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)
Centralized	1	1	5 (0/5)	2 (1/1)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-8.1-8. LLNL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized-1	11	12	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	1	8	0	3	0	1	--	--	--	--	--	--
Decentralized	37	16	0	3	0	5	0	0	0	0	0	1	3	0
Regionalized-1	11	12	0	4	0	5	0	0	0	0	0	1	3	0
Regionalized-2	7	6	0	1	0	0	0	0	--	--	--	--	--	--
Regionalized-3	7	1	0	1	0	0	0	0	--	--	--	--	--	--
Regionalized-4	4	6	0	1	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	1	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) LLNL is in an attainment area for all criteria pollutants; therefore, the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized and Regionalized-1 Alternatives.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-8.1-9. LLNL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	5	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	5	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-8.1-10. LLNL—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	70507	81.0	--	2905	3.3	--	--
Decentralized	37	16	17574	20.2	--	6791	7.8	--	--
Regionalized-1	11	12	19103	22.0	--	7769	8.9	--	--
Regionalized-2	7	6	1277	1.5	--	652	0.7	--	--
Regionalized-3	7	1	1277	1.5	--	652	0.7	--	--
Regionalized-4	4	6	1277	1.5	--	652	0.7	--	--
Centralized	1	1	1277	1.5	--	652	0.7	--	--

Notes:
T = Treatment
D = Disposal
Water supplied by deep groundwater. Current water use = 87,000 gallons/day.
Wastewater discharged to onsite evaporation ponds and dry stream beds.
-- = Stream Flow and Waste Water Stream Flow is not considered for this site.

Table II-8.1-11. LLNL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-8.1-12. LLNL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	1	0	0	0	0
Regionalized-1	11	12	0	0	0	1	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	1	0	0	1	0	0	0
Regionalized-1	11	12	1	0	0	1	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-8.1-13. LLNL—LLMW—Socioeconomics Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	237	223	0.02	2.5	0.01	0.01
Decentralized	37	16	296	358	0.03	3.8	0.01	0.01
Regionalized-1	11	12	749	880	0.08	9.7	0.02	0.02
Regionalized-2	7	6	68	80	0.01	0.9	0.00	0.00
Regionalized-3	7	1	68	80	0.01	0.9	0.00	0.00
Regionalized-4	4	6	68	80	0.01	0.9	0.00	0.00
Centralized	1	1	68	80	0.01	0.9	0.00	0.00

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-8.1-14. LLNL—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	21.7	0.28	70507	2.80	2905	0.17	10.1	10.10	175	2
Decentralized	37	16	12.6	0.16	17574	0.70	6761	0.40	1.19	1.19	247	3
Regionalized-1	11	12	13.9	0.18	19103	0.76	7769	0.46	1.32	1.32	557	6
Regionalized-2	7	6	1.1	0.01	1277	0.05	652	0.04	0.71	0.71	38	0.4
Regionalized-3	7	1	1.1	0.01	1277	0.05	652	0.04	0.71	0.71	38	0.4
Regionalized-4	4	6	1.1	0.01	1277	0.05	652	0.04	0.71	0.71	38	0.4
Centralized	1	1	1.1	0.01	1277	0.05	652	0.04	0.71	0.71	38	0.4

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-8.1-15. LLNL—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	269	25	87	128	28	90	179	0
Decentralized	37	16	334	40	125	151	19	334	0	0
Regionalized-1	11	12	846	99	262	443	43	700	0	146
Regionalized-2	7	6	77	4	21	38	13	77	0	0
Regionalized-3	7	1	77	4	21	38	13	77	0	0
Regionalized-4	4	6	77	4	21	38	13	77	0	0
Centralized	1	1	77	4	21	38	13	77	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.8.2 LLNL LLW

Thirteen tables immediately following portray the impacts of LLW at LLNL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	LLNL—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-8.2-1	8-18
2.	LLNL—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-8.2-2	8-19
3.	LLNL—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-8.2-3	8-20
4.	LLNL—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-8.2-4	8-21
5.	LLNL—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-8.2-5	8-22
7.	LLNL—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-8.2-6	8-23
8.	LLNL—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-8.2-7	8-24
9.	LLNL—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-8.2-8	8-25
10.	LLNL—LLW—Impacts on Water Resources Due to Increased Water Use	II-8.2-9	8-26
11.	LLNL—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-8.2-10	8-27
13.	LLNL—LLW—Socioeconomic Impacts for Treatment and Disposal	II-8.2-11	8-28
14.	LLNL—LLW—Infrastructure Impacts for Treatment and Disposal	II-8.2-12	8-29
15.	LLNL—LLW—Cost	II-8.2-13	8-30

Table II-8.2-1. LLNL—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	1.2E-03	6.9E-02	3.5E-07	1.6E-08	- -	- -
Decentralized		16	2.5E-03	4.7E-02	1.0E-02	1.4E-04	1.6E-01	7.0E-02
Regionalized-1		12	2.5E-03	5.7E-02	1.0E-02	1.4E-04	1.6E-01	7.0E-02
Regionalized-2	11	12	5.0E-02	9.9E-02	3.9E-01	5.3E-03	1.3E-01	5.4E-02
Regionalized-3		6	2.5E-03	5.7E-02	1.0E-02	1.4E-04	- -	- -
Regionalized-4	7	6	2.5E-03	5.7E-02	4.4E-03	6.0E-05	- -	- -
Regionalized-5	4	6	2.5E-03	5.7E-02	4.4E-03	6.0E-05	- -	- -
Regionalized-6		2	2.5E-03	5.7E-02	1.0E-02	1.4E-04	- -	- -
Regionalized-7		2	2.5E-03	5.7E-02	1.0E-02	1.4E-04	- -	- -
Centralized-1		1	2.5E-03	5.7E-02	1.0E-02	1.4E-04	- -	- -
Centralized-2		1	2.5E-03	5.7E-02	1.0E-02	1.4E-04	- -	- -
Centralized-3	7	1	2.5E-03	5.7E-02	4.4E-03	6.0E-05	- -	- -
Centralized-4	7	1	2.5E-03	5.7E-02	4.4E-03	6.0E-05	- -	- -
Centralized-5	1	1	2.5E-03	5.7E-02	4.4E-03	6.0E-05	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-8.2-2. LLNL—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Worker			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	7.1E-04	1.2E-06	7.1E-08	3.2E-05	5.5E-08	3.2E-09	2.9E+00	4.1E-03	1.8E-04
Decentralized		16	2.0E+01	3.4E-02	2.0E-03	2.8E-01	4.7E-04	2.8E-05	6.3E+00	8.9E-03	3.8E-04
Regionalized-1		12	2.0E+01	3.4E-02	2.0E-03	2.8E-01	4.7E-04	2.8E-05	6.3E+00	8.9E-03	3.8E-04
Regionalized-2	11	12	7.7E+02	1.3E+00	7.7E-02	1.1E+01	1.8E-02	1.1E-03	1.2E+02	1.7E-01	7.5E-03
Regionalized-3		6	2.0E+01	3.4E-02	2.0E-03	2.8E-01	4.7E-04	2.8E-05	6.3E+00	8.9E-03	3.8E-04
Regionalized-4	7	6	8.7E+00	1.5E-02	8.7E-02	1.2E-01	2.1E-04	1.2E-05	6.3E+00	8.9E-03	3.8E-04
Regionalized-5	4	6	8.7E+00	1.5E-02	8.7E-02	1.2E-01	2.0E-04	1.2E-05	6.3E+00	8.9E-03	3.8E-04
Regionalized-6		2	2.0E+01	3.4E-02	2.0E-03	2.8E-01	4.7E-04	2.8E-05	6.3E+00	8.9E-03	3.8E-04
Regionalized-7		2	2.0E+01	3.4E-02	2.0E-03	2.8E-01	4.7E-04	2.8E-05	6.3E+00	8.9E-03	3.8E-04
Centralized-1		1	2.0E+01	3.4E-02	2.0E-03	2.8E-01	4.7E-04	2.8E-05	6.3E+00	8.9E-03	3.8E-04
Centralized-2		1	2.0E+01	3.4E-02	2.0E-03	2.8E-01	4.7E-04	2.8E-05	6.3E+00	8.9E-03	3.8E-04
Centralized-3	7	1	8.7E+00	1.5E-02	8.7E-04	1.2E-01	2.0E-04	1.2E-05	6.3E+00	8.9E-03	3.8E-04
Centralized-4	7	1	8.7E+00	1.5E-02	8.7E-04	1.2E-01	2.0E-04	1.2E-05	6.3E+00	8.9E-03	3.8E-04
Centralized-5	1	1	8.7E+00	1.5E-02	8.7E-04	1.2E-01	2.0E-04	1.2E-05	6.3E+00	8.9E-03	3.8E-04

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-8.2-3. LLNL—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	4.0E+02	5.6E-01	2.4E-02
Regionalized-1		12	4.0E+02	5.6E-01	2.4E-02
Regionalized-2	11	12	3.3E+02	4.7E-01	2.0E-02
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-8.2-4. LLNL—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	6.0E-12	5.5E-12	- -
Decentralized		16	1.6E-07	4.7E-08	1.1E-06
Regionalized-1		12	1.6E-07	4.7E-08	1.1E-06
Regionalized-2	11	12	6.3E-06	1.8E-06	1.1E-06
Regionalized-3		6	1.6E-07	4.7E-08	- -
Regionalized-4	7	6	7.1E-08	2.1E-08	- -
Regionalized-5	4	6	7.1E-08	2.1E-08	- -
Regionalized-6		2	1.6E-07	4.7E-08	- -
Regionalized-7		2	1.6E-07	4.7E-08	- -
Centralized-1		1	1.6E-07	4.7E-08	- -
Centralized-2		1	1.6E-07	4.7E-08	- -
Centralized-3	7	1	7.1E-08	2.1E-08	- -
Centralized-4	7	1	7.1E-08	2.1E-08	- -
Centralized-5	1	1	7.1E-08	2.1E-08	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-8.2-5. LLNL—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	1.2E-08	2.0E-11	1.2E-12	1.1E-08	1.9E-11	1.1E-12	--	--	--
Decentralized		16	3.3E-04	5.5E-07	3.3E-08	9.4E-05	1.6E-07	9.4E-09	8.8E-03	1.5E-05	8.8E-07
Regionalized-1		12	3.3E-04	5.5E-07	3.3E-08	9.4E-05	1.6E-07	9.4E-09	8.8E-03	1.5E-05	8.8E-07
Regionalized-2	11	12	1.3E-02	2.1E-05	1.3E-06	3.6E-03	6.2E-06	3.6E-07	8.8E-03	1.5E-05	8.8E-07
Regionalized-3		6	3.3E-04	5.5E-07	3.3E-08	9.4E-05	1.6E-07	9.4E-09	--	--	--
Regionalized-4	7	6	1.4E-04	2.4E-07	1.4E-08	4.1E-05	7.0E-08	4.1E-09	--	--	--
Regionalized-5	4	6	1.4E-04	2.4E-07	1.4E-08	4.1E-05	7.0E-08	4.1E-09	--	--	--
Regionalized-6		2	3.3E-04	5.5E-07	3.3E-08	9.4E-05	1.6E-07	9.4E-09	--	--	--
Regionalized-7		2	3.3E-04	5.5E-07	3.3E-08	9.4E-05	1.6E-07	9.4E-09	--	--	--
Centralized-1		1	3.3E-04	5.5E-07	3.3E-08	9.4E-05	1.6E-07	9.4E-09	--	--	--
Centralized-2		1	3.3E-04	5.5E-07	3.3E-08	9.4E-05	1.6E-07	9.4E-09	--	--	--
Centralized-3	7	1	1.4E-04	2.4E-07	1.4E-08	4.1E-05	7.0E-08	4.1E-09	--	--	--
Centralized-4	7	1	1.4E-04	2.4E-07	1.4E-08	4.1E-05	7.0E-08	4.1E-09	--	--	--
Centralized-5	1	1	1.4E-04	2.4E-07	1.4E-08	4.1E-05	7.0E-08	4.1E-09	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-8.2-6. LLNL—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	9 (2/7)	6 (5/1)	0	0	0	1 (0/1)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Decentralized		16	15 (3/12)	9 (7/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	24 (0/24)	5 (0/5)	0	0	0	3 (0/3)
Regionalized-1		12	15 (3/12)	9 (7/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	24 (0/24)	5 (0/5)	0	0	0	3 (0/3)
Regionalized-2	11	12	26 (7/19)	22 (18/4)	0	1 (1/0)	2 (2/0)	4 (2/2)	29 (0/29)	6 (0/6)	0	0	0	3 (0/3)
Regionalized-3		6	16 (1/15)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-4	7	6	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	10 (0/10)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-5	4	6	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	10 (0/10)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-6		2	16 (1/15)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Regionalzied-7		2	16 (1/15)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Centralized-1		1	16 (1/15)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Centralized-2		1	16 (1/15)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Centralized-3	7	1	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	10 (0/10)	2 (0/2)	0	0	0	1 (0/1)
Centralized-4	7	1	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	10 (0/10)	2 (0/2)	0	0	0	1 (0/1)
Centralized-5	1	1	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	10 (0/10)	2 (0/2)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-8.2-7. LLNL—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
	T	D	Percent of Tons/Year General Conformity Rule (1)					
			CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalzied-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
			CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1		12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	11	12	0	1	0	1	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	7	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-5	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-6		2	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-7		2	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-1		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-2		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-4	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-5	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) LLNL is in an attainment area for all criteria pollutants; therefore, the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-8.2-8. LLNL—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	13	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-8.2-9. LLNL—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	1224	1.4	- -	683	0.8	- -	- -
Decentralized		16	7036	8.1	- -	2958	3.4	- -	- -
Regionalized-1		12	7036	8.1	- -	2958	3.4	- -	- -
Regionalized-2	11	12	19972	23.0	- -	4025	4.6	- -	- -
Regionalized-3		6	4156	4.8	- -	1592	1.8	- -	- -
Regionalized-4	7	6	4156	4.8	- -	1592	1.8	- -	- -
Regionalized-5	4	6	4156	4.8	- -	1592	1.8	- -	- -
Regionalized-6		2	4156	4.8	- -	1592	1.8	- -	- -
Regionalized-7		2	4156	4.8	- -	1592	1.8	- -	- -
Centralized-1		1	4156	4.8	- -	1592	1.8	- -	- -
Centralized-2		1	4156	4.8	- -	1592	1.8	- -	- -
Centralized-3	7	1	4156	4.8	- -	1592	1.8	- -	- -
Centralized-4	7	1	4156	4.8	- -	1592	1.8	- -	- -
Centralized-5	1	1	4156	4.8	- -	1592	1.8	- -	- -

Notes:
T = Treatment
D = Disposal
Water supplied by deep groundwater. Current water use = 87,000 gallons/day.
Wastewater discharged to onsite evaporation ponds and dry stream beds.
** Ten sites use existing facilities for Volume Reduction.
- - = Stream Flow is not considered for this alternative.
See text for description of impacts if water is supplied by the Hetch Hetchy Aqueduct.

Table II-8.2-10. LLNL—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-8.2-11. LLNL—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	202	190	0.01	2.1	0.01	0.00
Decentralized		16	360	423	0.03	4.7	0.01	0.01
Regionalized-1		12	360	423	0.03	4.7	0.01	0.01
Regionalized-2	11	12	524	616	0.04	6.8	0.01	0.02
Regionalized-3		6	189	222	0.01	2.5	0.00	0.01
Regionalized-4	7	6	189	222	0.01	2.5	0.00	0.01
Regionalized-5		6	189	222	0.01	2.5	0.00	0.01
Regionalized-6		2	189	222	0.01	2.5	0.00	0.01
Regionalized-7		2	189	222	0.01	2.5	0.00	0.01
Centralized-1		1	189	222	0.01	2.5	0.00	0.01
Centralized-2		1	189	222	0.01	2.5	0.00	0.01
Centralized-3	7	1	189	222	0.01	2.5	0.00	0.01
Centralized-4	7	1	189	222	0.01	2.5	0.00	0.01
Centralized-5	1	1	189	222	0.01	2.5	0.00	0.01

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline
** Ten sites use existing facilities for Volume Reduction.

Table II-8.2-12. LLNL—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	1.0	0.01	1224	0.05	683	0.04	0.12	0.12	53	1
Decentralized		16	5.3	0.07	7036	0.28	2958	0.18	0.75	0.79	168	2
Regionalized-1		12	5.3	0.07	7036	0.28	2958	0.18	0.75	0.79	168	2
Regionalized-2	11	12	10.0	0.13	19972	0.80	4025	0.24	1.05	1.05	340	4
Regionalized-3		6	3.6	0.05	4156	0.16	1592	0.09	0.42	0.45	114	1
Regionalized-4	7	6	3.6	0.04	4156	0.15	1592	0.09	0.42	0.45	114	1
Regionalized-5	4	6	3.6	0.04	4156	0.15	1592	0.09	0.42	0.45	114	1
Regionalized-6		2	3.6	0.04	4156	0.16	1592	0.09	0.42	0.45	114	1
Regionalized-7		2	3.6	0.04	4156	0.16	1592	0.09	0.42	0.45	114	1
Centralized-1		1	3.6	0.04	4156	0.16	1592	0.09	0.42	0.45	114	1
Centralized-2		1	3.6	0.04	4156	0.16	1592	0.09	0.42	0.45	114	1
Centralized-3	7	1	3.6	0.04	4156	0.15	1592	0.09	0.42	0.45	114	1
Centralized-4	7	1	3.6	0.04	4156	0.15	1592	0.09	0.42	0.45	114	1
Centralized-5	1	1	3.6	0.04	4156	0.15	1592	0.09	0.42	0.45	114	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1994 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-8.2-13. LLNL—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	229	8	27	181	13	229	0	0
Decentralized		16	408	36	68	224	80	183	0	225
Regionalized-1		12	408	36	68	224	80	183	0	225
Regionalized-2	11	12	593	56	162	332	42	282	0	311
Regionalized-3		6	214	17	58	117	22	214	0	0
Regionalized-4	7	6	214	17	58	117	22	214	0	0
Regionalized-5	4	6	214	17	58	117	22	214	0	0
Regionalized-6		2	214	17	58	117	22	214	0	0
Regionalized-7		2	214	17	58	117	22	214	0	0
Centralized-1		1	214	17	58	117	22	214	0	0
Centralized-2		1	214	17	58	117	22	214	0	0
Centralized-3	7	1	214	17	58	117	22	214	0	0
Centralized-4	7	1	214	17	58	117	22	214	0	0
Centralized-5	1	1	214	17	58	117	22	214	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.8.3 LLNL TRUW

Twelve tables immediately following portray the impacts of TRUW at LLNL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	LLNL—TRUW—Treatment: Estimated Number of Fatalities	II-8.3-1	8-32
2.	LLNL—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-8.3-2	8-33
4.	LLNL—TRUW—Treatment: MEI Probability of Cancer Fatality	II-8.3-3	8-34
5.	LLNL—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-8.3-4	8-35
6.	LLNL—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-8.3-5	8-36
7.	LLNL—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-8.3-6	8-37
8.	LLNL—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-8.3-7	8-38
9.	LLNL—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-8.3-8	8-39
10.	LLNL—TRUW—Impacts on Water Resources Due to Increased Water Use	II-8.3-9	8-40
13.	LLNL—TRUW—Socioeconomic Impacts for Treatment	II-8.3-10	8-41
14.	LLNL—TRUW—Infrastructure Impacts for Treatment	II-8.3-11	8-42
15.	LLNL—TRUW—Cost	II-8.3-12	8-43

Table II-8.3-1. LLNL—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure
	CH Treat	RH Treat		Radiation Exposure	Physical Hazards		
No Action **	16	5	WIPP WAC	7.1E-06	3.0E-02	1.1E-06	5.3E-08
Decentralized ***	16	5	WIPP WAC	5.6E-04	1.1E-01	3.5E-06	1.7E-07
Regionalized-1	5	2	Reduce Gas	5.7E-04	5.6E-02	3.6E-06	1.8E-07
Regionalized-2	5	2	LDR	5.7E-04	5.6E-02	3.6E-06	1.8E-07
Regionalized-3	3	2	LDR	5.7E-04	5.6E-02	3.6E-06	1.8E-07
Centralized	WIPP	2	LDR	5.7E-04	5.6E-02	3.6E-06	1.8E-07

Notes:

** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-8.3-2. LLNL—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	2.2E-03	3.7E-06	1.4E-08	2.2E-07	1.1E-04	1.8E-07	3.4E-09	1.1E-08	1.8E-02	2.5E-05	2.6E-07	1.1E-06
Decentralized***	16	5	WIPP WAC	6.9E-03	1.2E-05	1.3E-07	6.9E-07	3.4E-04	5.8E-07	3.0E-08	3.4E-08	1.4E+00	1.9E-03	8.8E-07	8.4E-05
Regionalized-1	5	2	Reduce Gas	7.3E-03	1.2E-05	2.2E-07	7.3E-07	3.6E-04	6.1E-07	5.2E-08	3.6E-08	1.4E+00	2.0E-03	1.9E-06	8.6E-05
Regionalized-2	5	2	LDR	7.3E-03	1.2E-05	2.2E-07	7.3E-07	3.6E-04	6.1E-07	5.2E-08	3.6E-08	1.4E+00	2.0E-03	1.9E-06	8.6E-05
Regionalized-3	3	2	LDR	7.3E-03	1.2E-05	2.2E-07	7.3E-07	3.6E-04	6.1E-07	5.2E-08	3.6E-08	1.4E+00	2.0E-03	1.9E-06	8.6E-05
Centralized	WIPP	2	LDR	7.3E-03	1.2E-05	2.2E-07	7.3E-07	3.6E-04	6.1E-07	5.2E-08	3.6E-08	1.4E+00	2.0E-03	1.9E-06	8.6E-05

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-8.3-3. LLNL—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	1.8E-11	1.8E-11
Decentralized***	16	5	WIPP WAC	5.7E-11	5.7E-11
Regionalized-1	5	2	Reduce Gas	5.9E-11	6.0E-11
Regionalized-2	5	2	LDR	5.9E-11	6.0E-11
Regionalized-3	3	2	LDR	5.9E-11	6.0E-11
Centralized	WIPP	2	LDR	5.9E-11	6.0E-11

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-8.3-4. LLNL—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treat STD	Treatment							
				Offsite Population MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	3.6E-08	6.0E-11	3.1E-13	3.6E-12	3.6E-08	6.1E-11	9.9E-13	3.6E-12
Decentralized ***	16	5	WIPP WAC	1.1E-07	1.9E-10	2.8E-12	1.1E-11	1.2E-07	2.0E-10	8.9E-12	1.2E-11
Regionalized-1	5	2	Reduce Gas	1.2E-07	2.0E-10	4.8E-12	1.2E-11	1.2E-07	2.0E-10	1.5E-11	1.2E-11
Regionalized-2	5	2	LDR	1.2E-07	2.0E-10	4.8E-12	1.2E-11	1.2E-07	2.0E-10	1.5E-11	1.2E-11
Regionalized-3	3	2	LDR	1.2E-07	2.0E-10	4.8E-12	1.2E-11	1.2E-07	2.0E-10	1.5E-11	1.2E-11
Centralized	WIPP	2	LDR	1.2E-07	2.0E-10	4.8E-12	1.2E-11	1.2E-07	2.0E-10	1.5E-11	1.2E-11

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
MEI = Maximally Exposed Individual

Table II-8.3-5. LLNL—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment	Treatment		
	CH Treat	RH Treat	Treatment Standard	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	2.6E-11	8.2E-11	2.6E-06
Decentralized***	16	5	WIPP WAC	1.5E-10	4.8E-10	5.8E-06
Regionalized-1	5	2	Reduce Gas	2.2E-10	6.9E-10	2.1E-05
Regionalized-2	5	2	LDR	2.2E-10	6.9E-10	2.1E-05
Regionalized-3	3	2	LDR	2.2E-10	6.9E-10	2.1E-05
Centralized	WIPP	2	LDR	2.2E-10	6.9E-10	2.1E-05

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-8.3-6. LLNL—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treat STD	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -	3 (0/3)	1 (0/1)	0	0	0	0
Decentralized**	16	5	WIPP WAC	13 (2/11)	7 (5/2)	0	0	0	1 (0/1)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-1	5	2	Reduce Gas	9 (0/9)	3 (1/2)	0	0	0	1 (0/1)	6 (0/6)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	5	2	LDR	20 (2/18)	10 (6/4)	0	0	1 (1/0)	3 (1/2)	6 (0/6)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-3	3	2	LDR	20 (2/18)	10 (6/4)	0	0	1 (1/0)	3 (1/2)	6 (0/6)	2 (0/2)	0	0	0	1 (0/1)
Centralized	WIPP	2	LDR	20 (2/18)	10 (6/4)	0	0	1 (1/0)	3 (1/2)	6 (0/6)	2 (0/2)	0	0	0	1 (0/1)

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(3) Values = total emissions (stationary-source emissions / mobile-source emission)
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-8.3-7. LLNL—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--
Centralized	WIPP	2	LDR	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--

Notes:

Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.

CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.

VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.

(1) LLNL is in an attainment area for all criteria pollutants, therefore the GCR does not apply.

(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.

(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives assumed to be negligible.

(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP

Table II-8.3-8. LLNL—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-8.3-9. LLNL—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	898	1.0	- -	- -
Decentralized***	16	5	WIPP WAC	2455	2.8	- -	1345	1.5	- -	- -
Regionalized-1	5	2	Reduce Gas	2455	2.8	- -	809	0.9	- -	- -
Regionalized-2	5	2	LDR	2455	2.8	- -	809	0.9	- -	- -
Regionalized-3	3	2	LDR	2455	2.8	- -	809	0.9	- -	- -
Centralized	WIPP	2	LDR	2455	2.8	- -	809	0.9	- -	- -

Notes:
Water supplied by deep groundwater. Current water use = 87,000 gallons/day.
Wastewater discharged to onsite evaporation ponds and dry stream beds.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Sream Flow and Waste Water Stream Flow are not considered for this site.

Table II-8.3-10. LLNL—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	77	72	0.09	0.8	0.03	0.00
Decentralized***	16	5	WIPP WAC	207	244	0.29	2.7	0.11	0.01
Regionalized-1	5	2	Reduce Gas	167	196	0.23	2.2	0.09	0.00
Regionalized-2	5	2	LDR	257	303	0.36	3.3	0.13	0.01
Regionalized-3	3	2	LDR	257	303	0.36	3.3	0.13	0.01
Centralized	WIPP	2	LDR	257	303	0.36	3.3	0.13	0.01

Notes:
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-8.3-11. LLNL—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	898	0.04	898	0.05	0.1	0.10	0	0.00
Decentralized***	16	5	WIPP WAC	1.6	0.02	2455	0.10	1345	0.08	0.21	0.21	123	1.40
Regionalized-1	5	2	Reduce Gas	1.6	0.02	2455	0.10	809	0.05	0.21	0.21	106	1.20
Regionalized-2	5	2	LDR	1.6	0.02	2455	0.10	809	0.05	0.21	0.21	199	2.30
Regionalized-3	3	2	LDR	1.6	0.02	2455	0.10	809	0.05	0.21	0.21	199	2.30
Centralized	WIPP	2	LDR	1.6	0.02	2455	0.10	809	0.05	0.21	0.21	199	2.30

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-8.3-12. LLNL—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	16	5	WIPP - WAC	87	0	0	73	14	0	74	12
Decentralized***	16	5	WIPP - WAC	234	17	63	132	21	0	221	14
Regionalized-1	5	2	Reduce Gas	188	15	54	109	10	0	188	0
Regionalized-2	5	2	LDR	291	27	107	145	13	0	291	0
Regionalized-3	3	2	LDR	291	27	107	145	13	0	291	0
Centralized	WIPP	2	LDR	291	27	107	145	13	0	291	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.9.0 NTS

NTS currently is custodian of significant volumes of LLMW, LLW, and TRUW. Each of the waste types is treated independently in the following sections.

II.9.1 NTS LLMW

Fifteen tables immediately following portray the impacts of LLMW at NTS. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	NTS—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-9.1-1	9-2
2.	NTS—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-9.1-2	9-3
3.	NTS—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-9.1-3	9-4
4.	NTS—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-9.1-4	9-5
5.	NTS—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-9.1-5	9-6
6.	NTS—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-9.1-6	9-7
7.	NTS—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-9.1-7	9-8
8.	NTS—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-9.1-8	9-9
9.	NTS—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-9.1-9	9-10
10.	NTS—LLMW—Impacts on Water Resources Due to Increased Water Use	II-9.1-10	9-11
11.	NTS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-9.1-11	9-12
12.	NTS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-9.1-12	9-13
13.	NTS—LLMW—Socioeconomics Impacts for Treatment and Disposal	II-9.1-13	9-14
14.	NTS—LLMW—Infrastructure Impacts for Treatment and Disposal	II-9.1-14	9-15
15.	NTS—LLMW—Cost	II-9.1-15	9-16

Table II-9.1-1. NTS—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	1.2E-02	2.7E-02	5.8E-06	1.5E-05	- -	- -
Decentralized	37	16	1.4E-02	9.9E-02	7.9E-07	2.1E-06	1.3E-02	1.4E-02
Regionalized-1	11	12	2.9E-03	4.6E-02	6.4E-09	8.7E-09	7.8E-06	2.4E-04
Regionalized-2	7	6	2.9E-03	4.6E-02	6.4E-09	8.7E-09	- -	- -
Regionalized-3	7	1	2.9E-03	4.6E-02	6.4E-09	8.7E-09	3.9E-01	8.4E-02
Regionalized-4	4	6	2.9E-03	4.6E-02	6.4E-09	8.7E-09	- -	- -
Centralized	1	1	2.9E-03	4.6E-02	6.4E-09	8.7E-09	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Treatment and/or disposal is not considered for this Alternative.

Table II-9.1-2. NTS—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	1.2E-02	2.0E-05	4.7E-08	1.2E-06	3.1E-02	5.2E-05	6.2E-07	3.1E-06	3.0E+01	4.2E-02	4.5E-07	1.8E-03
Decentralized	37	16	1.6E-03	2.7E-06	2.1E-09	1.6E-07	4.1E-03	7.0E-06	2.8E-08	4.1E-07	3.4E+01	4.8E-02	5.4E-05	2.1E-03
Regionalized -1	11	12	1.3E-05	2.2E-08	1.5E-11	1.3E-09	1.7E-05	3.0E-08	2.1E-10	1.7E-09	7.2E+00	1.0E-02	2.0E-07	4.4E-04
Regionalized-2	7	6	1.3E-05	2.2E-08	1.5E-11	1.3E-09	1.7E-05	3.0E-08	2.1E-10	1.7E-09	7.2E+00	1.0E-02	2.0E-07	4.4E-04
Regionalized-3	7	1	1.3E-05	2.2E-08	1.5E-11	1.3E-09	1.7E-05	3.0E-08	2.1E-10	1.7E-09	7.2E+00	1.0E-02	2.0E-07	4.4E-04
Regionalized-4	4	6	1.3E-05	2.2E-08	1.5E-11	1.3E-09	1.7E-05	3.0E-08	2.1E-10	1.7E-09	7.2E+00	1.0E-02	2.0E-07	4.4E-04
Centralized	1	1	1.3E-05	2.2E-08	1.5E-11	1.3E-09	1.7E-05	3.0E-08	2.1E-10	1.7E-09	7.2E+00	1.0E-02	2.0E-07	4.4E-04

Notes:
T = Treatment
D = Disposal

Table II-9.1-3. NTS—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	3.2E+01	4.5E-02	1.9E-03
Regionalized-1	11	12	2.0E-02	2.7E-05	1.2E-06
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	9.8E+02	1.4E+00	5.9E-02
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-9.1-4. NTS—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.5E-09	7.1E-08	- -
Decentralized	37	16	2.0E-10	9.6E-09	<9.9E-14
Regionalized-1	11	12	1.6E-12	4.0E-11	<9.9E-14
Regionalized-2	7	6	1.6E-12	4.0E-11	- -
Regionalized-3	7	1	1.6E-12	4.0E-11	<9.9E-14
Regionalized-4	4	6	1.6E-12	4.0E-11	- -
Centralized	1	1	1.6E-12	4.0E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Treatment and/or disposal is not considered under the Alternative

Table II-9.1-5. NTS—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI*			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	3.0E-06	5.1E-09	1.2E-11	3.0E-10	1.4E-04	2.4E-07	2.6E-09	1.4E-08	--	--	--	--
Decentralized	37	16	4.1E-07	6.9E-10	5.3E-13	4.1E-11	1.9E-05	3.3E-08	1.2E-10	1.9E-09	<9.9E-14	<9.9E-14	2.0E-06	<9.9E-14
Regionalized-1	11	12	3.2E-09	5.4E-12	<9.9E-14	3.2E-13	8.0E-08	1.4E-10	8.6E-13	8.0E-12	<9.9E-14	<9.9E-14	2.0E-06	<9.9E-14
Regionalized-2	7	6	3.2E-09	5.4E-12	<9.9E-14	3.2E-13	8.0E-08	1.4E-10	8.6E-13	8.0E-12	--	--	--	--
Regionalized-3	7	1	3.2E-09	5.4E-12	<9.9E-14	3.2E-13	8.0E-08	1.4E-10	8.6E-13	8.0E-12	<9.9E-14	<9.9E-14	2.0E-06	<9.9E-14
Regionalized-4	4	6	3.2E-09	5.4E-12	<9.9E-14	3.2E-13	8.0E-08	1.4E-10	8.6E-13	8.0E-12	--	--	--	--
Centralized	1	1	3.2E-09	5.4E-12	<9.9E-14	3.2E-13	8.0E-08	1.4E-10	8.6E-13	8.0E-12	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Treatment and/or disposal is not considered for this alternative.
* The values for NTS overestimate potential risks because the travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be more than 2 million years.

Table II-9.1-6. NTS—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	2.4E-09	5.2E-07	1.2E-06	- -
Decentralized	37	16	3.0E-10	6.6E-08	2.0E-04	2.3E-02
Regionalized-1	11	12	1.1E-12	2.3E-10	8.6E-07	1.0E-03
Regionalized-2	7	6	1.1E-12	2.3E-10	8.6E-07	- -
Regionalized-3	7	1	1.1E-12	2.3E-10	8.6E-07	8.1E-01
Regionalized-4	4	6	1.1E-12	2.3E-10	8.6E-07	- -
Centralized	1	1	1.1E-12	2.3E-10	8.6E-07	- -

Notes:
T = Treatment
D = Disposal
- - = Treatment and/or Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-9.1-7. NTS—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	T	D	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
			CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	25(18/7)	48 (47/1)	0	4 (4/0)	4 (4/0)	6 (5/1)	3 (0/3)	2 (1/1)	0	0	0	0
Decentralized	37	16	94 (64/30)	172 (166/6)	0	13 (13/0)	16 (16/0)	20 (16/4)	21 (1/20)	8 (4/4)	0	1 (1/0)	0	2 (0/2)
Regionalized-1	11	12	26 (12/14)	33 (30/3)	0	2 (2/0)	3 (3/0)	5 (3/2)	9 (0/9)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-2	7	6	25 (12/13)	33 (30/3)	0	2 (2/0)	3 (3/0)	5 (3/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-3	7	1	73 (41/32)	112 (106/6)	0	8 (8/0)	10 (10/0)	14 (10/4)	39 (0/39)	8 (0/8)	0	0	0	5 (0/5)
Regionalized-4	4	6	25 (12/13)	33 (30/3)	0	2 (2/0)	3 (3/0)	5 (3/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Centralized	1	1	25 (12/13)	33 (30/3)	0	2 (2/0)	3 (3/0)	5 (3/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-9.1-8. NTS—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	25 (18/7)	--	--	4 (4/0)	--	--
Decentralized	37	16	94 (64/30)	--	--	13 (13/0)	--	--
Regionalized-1	11	12	26 (12/14)	--	--	2 (2/0)	--	--
Regionalized-2	7	6	25 (12/13)	--	--	2 (2/0)	--	--
Regionalized-3	7	1	73 (41/32)	--	--	8 (8/0)	--	--
Regionalized-4	4	6	25 (12/13)	--	--	2 (2/0)	--	--
Centralized	1	1	25 (12/13)	--	--	2 (2/0)	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (5)	NO2 (4)	Pb (4)	PM10 (5)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	3 (3/0)	2	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	21 (1/20)	10	0	1 (1/0)	0	1 (1/0)	0	0	0	0	0	0
Regionalized-1	11	12	9 (0/9)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	7	6	8 (0/8)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	7	1	39 (0/39)	1	0	0	0	0	--	--	--	--	--	--
Regionalized-4	4	6	8 (0/8)	0	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	8 (0/8)	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions)

Table II-9.1-9. NTS—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-9.1-10. NTS—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	17,781	1.3	--	775	0.1	--	--
Decentralized	37	16	52,726	3.9	--	18,706	1.4	--	--
Regionalized-1	11	12	6,690	0.5	--	939	0.1	--	--
Regionalized-2	7	6	6,593	0.5	--	936	0.1	--	--
Regionalized-3	7	1	32,155	2.4	--	8,685	0.6	--	--
Regionalized-4	4	6	6,593	0.5	--	936	0.1	--	--
Centralized	1	1	6,593	0.5	--	936	0.1	--	--

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater. Current water use = 1,367,000 gallons/day.
Wastewater discharged to onsite evaporation ponds.
- - = Treatment and/or Disposal is not considered for this alternative, but where treatment and/or disposal is considered stream flow and waste water stream flow are not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-9.1-11. NTS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-9.1-12. NTS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)[a]

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	50	0	0	0	0
Regionalized-1	11	12	0	0	0	1	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	3000	0	1	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	10	0	0	40	0	0	0
Regionalized-1	11	12	10	0	0	40	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0
Regionalized-3	7	1	1000	0	0	4000	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.
a The values for NTS overestimate potential risks since the travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

Table II-9.1-13. NTS—LLMW—Socioeconomics Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income	% ROI Population Increase (2)
No Action	3	-	67	80	0.02	0.8	<0.01	0.01
Decentralized	37	16	417	407	0.09	4.6	0.03	0.04
Regionalized-1	11	12	172	168	0.04	1.9	0.01	0.02
Regionalized-2	7	6	161	156	0.03	1.8	0.01	0.02
Regionalized-3	7	1	620	605	0.13	6.8	0.05	0.07
Regionalized-4	4	6	161	156	0.03	1.8	0.01	0.02
Centralized	1	1	161	156	0.03	1.8	0.01	0.02

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-9.1-14. NTS—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	7.1	0.001	17,781	0.64	775	0.23	2.57	8.55	210	3
Decentralized	37	16	25.2	0.003	52,725	1.90	9,352	2.77	6.52	14.30	235	3
Regionalized-1	11	12	5.8	0.0009	6,593	0.24	939	0.28	0.46	1.54	102	1
Regionalized-2	7	6	20.5	0.0009	6,593	0.24	936	0.28	0.46	1.54	102	1
Regionalized-3	7	1	20.5	0.0032	32,155	1.16	8,685	2.57	2.34	7.80	249	4
Regionalized-4	4	6	5.7	0.0009	6,593	0.24	936	0.28	0.46	1.54	102	1
Centralized	1	1	5.7	0.0009	6,593	0.24	936	0.28	0.46	1.54	102	1

Notes:
(1) T is defined as Treatment, D is defined as Disposal

Table II-9.1-15. NTS—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	120	10	35	72	3	64	56	0
Decentralized	37	16	472	45	150	252	25	419	0	55
Regionalized-1	11	12	194	17	68	99	10	182	0	12
Regionalized-2	7	6	182	17	62	94	9	182	0	0
Regionalized-3	7	1	702	60	122	439	81	182	0	520
Regionalized-4	4	6	182	17	62	94	9	182	0	0
Centralized	1	1	182	17	62	94	9	182	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.9.2 NTS LLW

Thirteen tables immediately following portray the impacts of LLW at NTS. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	NTS—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-9.2-1	9-18
2.	NTS—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-9.2-2	9-19
3.	NTS—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-9.2-3	9-20
4.	NTS—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-9.2-4	9-21
5.	NTS—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-9.2-5	9-22
7.	NTS—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-9.2-6	9-23
8.	NTS—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-9.2-7	9-24
9.	NTS—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-9.2-8	9-25
10.	NTS—LLW—Impacts on Water Resources Due to Increased Water Use	II-9.2-9	9-26
11.	NTS—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-9.2-10	9-27
13.	NTS—LLW—Socioeconomic Impacts for Treatment and Disposal	II-9.2-11	9-28
14.	NTS—LLW—Infrastructure Impacts for Treatment and Disposal	II-9.2-12	9-29
15.	NTS—LLW—Cost	II-9.2-13	9-30

Table II-9.2-1. NTS—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	3.6E-04	5.1E-03	1.3E-12	3.0E-12	1.6E-02	1.9E-01
Decentralized		16	3.0E-04	6.2E-03	1.4E-12	3.2E-12	4.4E-04	1.4E-02
Regionalized-1		12	3.0E-04	6.2E-03	1.4E-12	3.2E-12	4.4E-04	1.4E-02
Regionalized-2	11	12	3.0E-04	1.3E-02	1.6E-12	3.6E-12	1.2E-04	3.7E-03
Regionalized-3		6	3.0E-04	6.2E-03	1.4E-12	3.2E-12	3.6E-02	4.4E-02
Regionalized-4	7	6	3.0E-04	1.3E-02	1.6E-12	3.6E-12	7.6E-03	1.5E-02
Regionalized-5	4	6	3.0E-04	1.3E-02	1.6E-12	3.6E-12	7.6E-03	1.5E-02
Regionalized-6		2	3.0E-04	1.3E-02	1.6E-12	3.6E-12	- -	- -
Regionalized-7		2	3.0E-04	6.2E-03	1.4E-12	3.2E-12	8.1E-01	2.4E-01
Centralized-1		1	3.0E-04	1.3E-02	1.6E-12	3.6E-12	- -	- -
Centralized-2		1	3.0E-04	6.2E-03	1.4E-12	3.2E-12	2.2E+00	6.1E-01
Centralized-3	7	1	3.0E-04	1.3E-02	1.6E-12	3.6E-12	- -	- -
Centralized-4	7	1	3.0E-04	1.3E-02	1.6E-12	3.6E-12	1.6E+00	4.0E-01
Centralized-5	1	1	3.0E-04	1.3E-02	1.6E-12	3.6E-12	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Treatment and/or disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-9.2-2. NTS—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Worker			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	2.6E-09	4.5E-12	2.6E-13	6.0E-09	1.0E-11	6.0E-13	9.0E-01	1.3E-03	5.4E-05
Decentralized		16	2.9E-09	4.9E-12	2.9E-13	6.4E-09	1.1E-11	6.4E-13	7.4E-01	1.0E-03	4.4E-05
Regionalized-1		12	2.9E-09	4.9E-12	2.9E-13	6.4E-09	1.1E-11	6.4E-13	7.4E-01	1.0E-03	4.4E-05
Regionalized-2	11	12	3.2E-09	5.5E-12	3.2E-13	7.2E-09	1.2E-11	7.2E-13	7.4E-01	1.0E-03	4.4E-05
Regionalized-3		6	2.9E-09	4.9E-12	2.9E-13	6.4E-09	1.1E-11	6.4E-13	7.4E-01	1.0E-03	4.4E-05
Regionalized-4	7	6	3.2E-09	5.5E-12	3.2E-13	7.2E-09	1.2E-11	7.2E-13	7.4E-01	1.0E-03	4.4E-05
Regionalized-5	4	6	3.2E-09	5.5E-12	3.2E-13	7.2E-09	1.2E-11	7.2E-13	7.4E-01	1.0E-03	4.4E-05
Regionalized-6		2	3.2E-09	5.5E-12	3.2E-13	7.2E-09	1.2E-11	7.2E-13	7.4E-01	1.0E-03	4.4E-05
Regionalized-7		2	2.9E-09	4.9E-12	2.9E-13	6.4E-09	1.1E-11	6.4E-13	7.4E-01	1.0E-03	4.4E-05
Centralized-1		1	3.2E-09	5.5E-12	3.2E-13	7.2E-09	1.2E-11	7.2E-13	7.4E-01	1.0E-03	4.4E-05
Centralized-2		1	2.9E-09	4.9E-12	2.9E-13	6.4E-09	1.1E-11	6.4E-13	7.4E-01	1.0E-03	4.4E-05
Centralized-3	7	1	3.2E-09	5.5E-12	3.2E-13	7.2E-09	1.2E-11	7.2E-13	7.4E-01	1.0E-03	4.4E-05
Centralized-4	7	1	3.2E-09	5.5E-12	3.2E-13	7.2E-09	1.2E-11	7.2E-13	7.4E-01	1.0E-03	4.4E-05
Centralized-5	1	1	3.2E-09	5.5E-12	3.2E-13	7.2E-09	1.2E-11	7.2E-13	7.4E-01	1.0E-03	4.4E-05

Notes:
T = Treatment
D = Disposal
- - = Treatment and/or disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-9.2-3. NTS—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	4.0E+01	5.7E-02	2.4E-03
Decentralized		16	1.1E+00	1.5E-03	6.6E-05
Regionalized-1		12	1.1E+00	1.5E-03	6.6E-05
Regionalized-2	11	12	2.9E-01	4.0E-04	1.7E-05
Regionalized-3		6	9.0E+02	1.3E-01	5.4E-03
Regionalized-4	7	6	1.9E+01	2.7E-02	1.1E-03
Regionalized-5	4	6	1.9E+01	2.7E-02	1.1E-03
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	2.0E+03	2.8E+00	1.2E-01
Centralized-1		1	- -	- -	- -
Centralized-2		1	5.5E+03	7.7E+00	3.3E-01
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	3.9E+03	5.5E+00	2.3E-01
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-9.2-4. NTS—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	<9.9E-14	1.4E-14	<9.9E-14
Decentralized		16	<9.9E-14	1.5E-14	<9.9E-14
Regionalized-1		12	<9.9E-14	1.5E-14	<9.9E-14
Regionalized-2	11	12	<9.9E-14	1.7E-14	<9.9E-14
Regionalized-3		6	<9.9E-14	1.5E-14	<9.9E-14
Regionalized-4	7	6	<9.9E-14	1.7E-14	<9.9E-14
Regionalized-5	4	6	<9.9E-14	1.7E-14	<9.9E-14
Regionalized-6		2	<9.9E-14	1.7E-14	- -
Regionalized-7		2	<9.9E-14	1.5E-14	<9.9E-14
Centralized-1		1	<9.9E-14	1.7E-14	- -
Centralized-2		1	<9.9E-14	1.5E-14	<9.9E-14
Centralized-3	7	1	<9.9E-14	1.7E-14	- -
Centralized-4	7	1	<9.9E-14	1.7E-14	<9.9E-14
Centralized-5	1	1	<9.9E-14	1.7E-14	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Treatment and/or disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-9.2-5. NTS—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	6.7E-13	<9.9E-14	<9.9E-14	2.8E-11	4.7E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Decentralized		16	7.2E-13	<9.9E-14	<9.9E-14	3.0E-11	5.1E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-1		12	7.2E-13	<9.9E-14	<9.9E-14	3.0E-11	5.1E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-2	11	12	8.1E-13	<9.9E-14	<9.9E-14	3.4E-11	5.7E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-3		6	7.2E-13	<9.9E-14	<9.9E-14	3.0E-11	5.1E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-4	7	6	8.1E-13	<9.9E-14	<9.9E-14	3.4E-11	5.7E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-5	4	6	8.1E-13	<9.9E-14	<9.9E-14	3.4E-11	5.7E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-6		2	8.1E-13	<9.9E-14	<9.9E-14	3.4E-11	5.7E-14	<9.9E-14	- -	- -	- -
Regionalized-7		2	7.2E-13	<9.9E-14	<9.9E-14	3.0E-11	5.1E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Centralized-1		1	8.1E-13	<9.9E-14	<9.9E-14	3.4E-11	5.7E-14	<9.9E-14	- -	- -	- -
Centralized-2		1	7.2E-13	<9.9E-14	<9.9E-14	3.0E-11	5.1E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Centralized-3	7	1	8.1E-13	<9.9E-14	<9.9E-14	3.4E-11	5.7E-14	<9.9E-14	- -	- -	- -
Centralized-4	7	1	8.1E-13	<9.9E-14	<9.9E-14	3.4E-11	5.7E-14	<9.9E-14	<9.9E-14	<9.9E-14	<9.9E-14
Centralized-5	1	1	8.1E-13	<9.9E-14	<9.9E-14	3.4E-11	5.7E-14	<9.9E-14	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Treatment and Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-9.2-6. NTS—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	0	0	0	0	0	67 (0/67)	16 (0/16)	0	0	0	8 (0/8)
Decentralized		16	6 (2/4)	6 (5/1)	0	0	0	0	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-1		12	6 (2/4)	6 (5/1)	0	0	0	0	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	11	12	6 (2/4)	6 (5/1)	0	0	0	1 (1/0)	3 (3/0)	1 (0/1)	0	0	0	0
Regionalized-3		6	12 (5/7)	14 (13/1)	0	1 (1/0)	1 (1/0)	2 (1/1)	11 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-4	7	6	9 (3/6)	8 (7/1)	0	1 (1/0)	1 (1/0)	2 (1/1)	6 (0/6)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-5	4	6	9 (3/6)	8 (7/1)	0	1 (1/0)	1 (1/0)	2 (1/1)	6 (0/6)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-6		2	5 (1/4)	0	0	0	0	0	2 (0/2)	0	0	0	0	0
Regionalzied-7		2	64 (20/44)	61 (52/9)	0	4 (4/0)	5 (5/0)	10 (5/5)	67 (0/67)	17 (0/17)	0	0	0	8 (0/8)
Centralized-1		1	5 (1/4)	0	0	0	0	0	2 (0/2)	0	0	0	0	0
Centralized-2		1	189 (79/110)	228 (206/22)	0	16 (16/0)	20 (20/0)	33 (20/13)	183 (0/183)	55 (1/54)	0	1 (0/1)	0	23 (0/23)
Centralized-3	7	1	5 (1/4)	0	0	0	0	0	2 (0/2)	0	0	0	0	0
Centralized-4	7	1	128 (49/79)	144 (128/16)	0	10 (10/0)	12 (12/0)	21 (12/9)	118 (0/118)	25 (1/24)	0	0	0	14 (0/14)
Centralized-5	1	1	5 (1/4)	0	0	0	0	0	2 (0/2)	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-9.2-7. NTS—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	T	D	Construction					
			Percent of Tons/Year General Conformity Rule (1)					
			CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	--	--	0	--	--
Decentralized		16	6 (2/4)	--	--	0	--	--
Regionalized-1		12	6 (2/4)	--	--	0	--	--
Regionalized-2	11	12	6 (2/4)	--	--	0	--	--
Regionalized-3		6	12 (5/7)	--	--	1 (1/0)	--	--
Regionalized-4	7	6	9 (3/6)	--	--	1 (1/0)	--	--
Regionalized-5	4	6	9 (3/6)	--	--	1 (1/0)	--	--
Regionalized-6		2	5 (1/4)	--	--	0	--	--
Regionalzied-7		2	64 (20/44)	--	--	4 (4/0)	--	--
Centralized-1		1	5 (1/4)	--	--	0	--	--
Centralized-2		1	189 (79/110)	--	--	16 (16/0)	--	--
Centralized-3	7	1	5 (1/4)	--	--	0	--	--
Centralized-4	7	1	128 (49/79)	--	--	10 (10/0)	--	--
Centralized-5	1	1	5 (1/4)	--	--	0	--	--

LLW Alternatives	T	D	Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
			CO (5)	NO2 (4)	Pb (4)	PM10 (5)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	67 (0/67)	0	0	0	0	0	--	--	--	--	--	--
Decentralized		16	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1		12	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	11	12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3		6	11 (0/11)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	7	6	6 (0/6)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-5	4	6	13 (0/13)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-6		2	2 (0/2)	0	0	0	0	0	--	--	--	--	--	--
Regionalzied-7		2	67 (0/67)	1	0	0	0	0	--	--	--	--	--	--
Centralized-1		2	2 (0/2)	0	0	0	0	0	--	--	--	--	--	--
Centralized-2		1	183 (0/183)	2	0	1	0	0	--	--	--	--	--	--
Centralized-3		2	2 (0/2)	0	0	0	0	0	--	--	--	--	--	--
Centralized-4	7	1	118 (0/118)	1	0	0	0	0	--	--	--	--	--	--
Centralized-5		2	2 (0/2)	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions)
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / '% of mobile-source emissions).
** Ten sites use existing facilities for Volume Reduction.

Table II-9.2-8. NTS—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-9.2-9. NTS—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	0	0.0	- -	1426	0.1	- -	- -
Decentralized		16	1416	0.1	- -	480	0.0	- -	- -
Regionalized-1		12	1416	0.1	- -	480	0.0	- -	- -
Regionalized-2	11	12	1183	0.1	- -	324	0.0	- -	- -
Regionalized-3		6	3833	0.3	- -	1500	0.1	- -	- -
Regionalized-4	7	6	7605	0.6	- -	642	0.0	- -	- -
Regionalized-5	4	6	7605	0.6	- -	642	0.0	- -	- -
Regionalized-6		2	554	0.0	- -	252	0.0	- -	- -
Regionalized-7		2	13851	1.0	- -	5428	0.4	- -	- -
Centralized-1		1	554	0.0	- -	252	0.0	- -	- -
Centralized-2		1	54787	4.0	- -	22197	1.6	- -	- -
Centralized-3	7	1	554	0.0	- -	252	0.0	- -	- -
Centralized-4	7	1	33976	2.5	- -	13648	1.0	- -	- -
Centralized-5	1	1	554	0.0	- -	252	0.0	- -	- -

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater. Current water use = 1,367,000 gallons/day.
Wastewater discharged to onsite evaporation ponds
** Ten sites use existing facilities for Volume Reduction.
- - = NTS is not considered under the alternative; for alternatives that disposal is considered at NTS, percent stream flow and waste water percent stream flow are not considered.

Table II-9.2-10. NTS—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-9.2-11. NTS—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income	% ROI Population Increase (2)
No Action	10**	6	1196	932	0.21	10.5	0.07	0.19
Decentralized		16	234	228	0.05	2.6	0.02	0.01
Regionalized-1		12	234	228	0.05	2.6	0.02	0.01
Regionalized-2	11	12	66	65	0.01	0.7	<0.01	<0.01
Regionalized-3		6	161	157	0.03	1.8	0.02	0.02
Regionalized-4	7	6	101	98	0.02	1.1	0.01	0.01
Regionalized-5	4	6	101	98	0.02	1.1	0.01	0.01
Regionalized-6		2	48	47	0.01	0.05	<0.01	<0.01
Regionalized-7		2	1004	979	0.22	11.0	0.07	0.11
Centralized-1		1	48	47	0.01	0.5	<0.01	<0.01
Centralized-2		1	2639	2573	0.57	29.0	0.20	0.25
Centralized-3	7	1	48	47	0.01	0.05	<0.01	<0.01
Centralized-4	7	1	1661	1619	0.35	18.2	0.13	0.21
Centralized-5	1	1	48	47	0.01	0.05	<0.01	<0.01

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction

Table II-9.2-12. NTS—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	1.5	0.0002	1426	0.05	1426	0.43	0.21	0.46	0	0
Decentralized		16	1.0	0.0002	1416	0.05	480	0.14	0.16	0.36	29	0.40
Regionalized-1		12	1.0	0.0002	1416	0.05	480	0.14	0.16	0.36	29	0.40
Regionalized-2	11	12	1	0.0002	1182	0.04	324	0.10	0.11	0.25	32	0.45
Regionalized-3		6	2.6	0.0004	3833	0.14	1500	0.44	0.46	1.02	58	0.82
Regionalized-4	7	6	1.4	0.0002	7605	0.27	641	0.19	0.21	0.46	45	0.64
Regionalized-5	4	6	1.4	0.0002	7605	0.27	641	0.19	0.21	0.46	45	0.64
Regionalized-6		2	0.5	0.0001	553	0.02	251	0.07	0.17	0.37	28	0.40
Regionalized-7		2	6.4	0.001	13850	0.50	5427	0.61	1.40	3.11	338	4.77
Centralized-1		1	0.5	0.0001	553	0.02	251	0.07	0.17	0.37	28	0.40
Centralized-2		1	2.4	0.004	54787	1.97	22196	0.80	5.53	12.30	85	1.20
Centralized-3	7	1	0.5	0.0001	553	0.02	251	0.07	0.17	0.37	28	0.40
Centralized-4	7	1	15.2	0.0024	33976	1.22	13647	4.04	3.43	7.61	609	8.59
Centralized-5	1	1	0.5	0.0001	553	0.02	251	0.07	0.17	0.37	28	0.40

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** Ten sites use existing facilities for Volume Reduction.
- - = Treatment and Disposal is not considered under this alternative.

Table II-9.2-13. NTS—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	1353	0	0	1186	167	0	0	1353
Decentralized		16	265	18	62	168	17	25	0	240
Regionalized 1		12	265	18	62	168	17	25	0	240
Regionalized 2	11	12	75	7	18	44	6	55	0	20
Regionalized 3		6	182	15	28	120	19	36	0	146
Regionalized 4	7	6	114	9	25	71	9	55	0	59
Regionalized 5	4	6	114	9	25	71	9	55	0	59
Regionalized 6		2	55	5	17	31	2	55	0	0
Regionalized 7		2	1136	85	148	729	174	36	0	1100
Centralized 1		1	55	5	17	31	2	55	0	0
Centralized 2		1	2986	220	379	1934	453	36	0	2950
Centralized 3	7	1	55	5	17	31	2	55	0	0
Centralized 4	7	1	1879	157	235	1172	315	55	0	1824
Centralized 5	1	1	55	5	17	31	2	55	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.9.3 NTS TRUW

Twelve tables immediately following portray the impacts of TRUW at NTS. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	NTS—TRUW—Treatment: Estimated Number of Fatalities	II-9.3-1	9-32
2.	NTS—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-9.3-2	9-33
4.	NTS—TRUW—Treatment: MEI Probability of Cancer Fatality	II-9.3-3	9-34
5.	NTS—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-9.3-4	9-35
6.	NTS—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-9.3-5	9-36
7.	NTS—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-9.3-6	9-37
8.	NTS—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-9.3-7	9-38
9.	NTS—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-9.3-8	9-39
10.	NTS—TRUW—Impacts on Water Resources Due to Increased Water Use	II-9.3-9	9-40
13.	NTS—TRUW—Socioeconomic Impacts for Treatment	II-9.3-10	9-41
14.	NTS—TRUW—Infrastructure Impacts for Treatment	II-9.3-11	9-42
15.	NTS—TRUW—Cost	II-9.3-12	9-43

Table II-9.3-1. NTS—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure
	CH Treat	RH Treat		Radiation Exposure	Physical Hazards		
No Action **	16	5	WIPP WAC	--	--	--	--
Decentralized ***	16	5	WIPP WAC	2.1E-04	6.8E-02	1.1E-10	3.2E-10
Regionalized-1	5	2	Reduce Gas	2.0E-04	4.2E-02	1.5E-10	4.2E-10
Regionalized-2	5	2	LDR	2.0E-04	4.2E-02	1.5E-10	4.2E-10
Regionalized-3	3	2	LDR	2.0E-04	4.2E-02	1.5E-10	4.2E-10
Centralized	WIPP	2	LDR	2.0E-04	4.2E-02	1.5E-10	4.2E-10

Notes:
-- = Treatment is not considered for this alternative.
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-9.3-2. NTS—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	2.3E-07	3.9E-10	3.8E-13	2.3E-11	6.4E-07	1.1E-09	5.1E-12	6.4E-11	5.2E-01	7.3E-04	8.8E-10	3.1E-05
Regionalized-1	5	2	Reduce Gas	3.0E-07	5.1E-10	1.1E-12	3.0E-11	8.4E-07	1.4E-09	1.5E-11	8.4E-11	5.0E-01	7.0E-04	4.4E-09	3.0E-05
Regionalized-2	5	2	LDR	3.0E-07	5.1E-10	1.1E-12	3.0E-11	8.4E-07	1.4E-09	1.5E-11	8.4E-11	5.0E-01	7.0E-04	4.4E-09	3.0E-05
Regionalized-3	3	2	LDR	3.0E-07	5.1E-10	1.1E-12	3.0E-11	8.4E-07	1.4E-09	1.5E-11	8.4E-11	5.0E-01	7.0E-04	4.4E-09	3.0E-05
Centralized	WIPP	2	LDR	3.0E-07	5.1E-10	1.1E-12	3.0E-11	8.4E-07	1.4E-09	1.5E-11	8.4E-11	5.0E-01	7.0E-04	4.4E-09	3.0E-05

Notes:
-- = Treatment is not considered for this alternative.
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-9.3-3. NTS—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	- -	- -
Decentralized***	16	5	WIPP WAC	3.0E-14	1.5E-12
Regionalized-1	5	2	Reduce Gas	3.9E-14	1.9E-12
Regionalized-2	5	2	LDR	3.9E-14	1.9E-12
Regionalized-3	3	2	LDR	3.9E-14	1.9E-12
Centralized	WIPP	2	LDR	3.9E-14	1.9E-12

Notes:
- - = Treatment is not considered for this alternative.
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-9.3-4. NTS—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite Population MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	--	--	--	--	--	--	--	--
Decentralized ***	16	5	WIPP WAC	5.9E-11	1.0E-13	<9.9E-14	<9.9E-14	2.9E-09	5.0E-12	2.1E-14	2.9E-13
Regionalized-1	5	2	Reduce Gas	7.8E-11	1.3E-13	<9.9E-14	<9.9E-14	3.9E-09	6.6E-12	6.2E-14	3.9E-13
Regionalized-2	5	2	LDR	7.8E-11	1.3E-13	<9.9E-14	<9.9E-14	3.9E-09	6.6E-12	6.2E-14	3.9E-13
Regionalized-3	3	2	LDR	7.8E-11	1.3E-13	<9.9E-14	<9.9E-14	3.9E-09	6.6E-12	6.2E-14	3.9E-13
Centralized	WIPP	2	LDR	7.8E-11	1.3E-13	<9.9E-14	<9.9E-14	3.9E-09	6.6E-12	6.2E-14	3.9E-13

Notes:
-- = Treatment is not considered for this alternative.
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
MEI = Maximally Exposed Individual

Table II-9.3-5. NTS—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment	Treatment		
	CH Treat	RH Treat	Treatment Standard	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	- -	- -	- -
Decentralized***	16	5	WIPP WAC	1.4E-13	3.0E-11	3.2E-08
Regionalized-1	5	2	Reduce Gas	3.8E-13	8.2E-11	1.8E-07
Regionalized-2	5	2	LDR	3.8E-13	8.2E-11	1.8E-07
Regionalized-3	3	2	LDR	3.8E-13	8.2E-11	1.8E-07
Centralized	WIPP	2	LDR	3.8E-13	8.2E-11	1.8E-07

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Treatment is not considered under this alternative.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold

Table II-9.3-6. NTS—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -	2 (0/2)	0	0	0	0	0
Decentralized***	16	5	WIPP WAC	6 (1/5)	3 (2/1)	0	0	0	01 (0/1)	3 (0/3)	1 (0/1)	0	0	0	0
Regionalized-1	5	2	Reduce Gas	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	5	2	LDR	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	3	2	LDR	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	WIPP	2	LDR	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-9.3-7. NTS—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat	Standard	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	6 (1/5)	--	--	0	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	0	--	--
Regionalized-2	5	2	LDR	0	--	--	0	--	--
Regionalized-3	3	2	LDR	0	--	--	0	--	--
Centralized	WIPP	2	LDR	0	--	--	0	--	--

TRUW Alternatives	Number of Sites		Treat	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat	STD	CO (5)	NO2 (4)	Pb (4)	PM10 (5)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	2 (0/2)	0	0	0	0	0	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	3 (0/3)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) NTS is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-9.3-8. NTS—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-9.3-9. NTS—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	514	<0.1	- -	- -
Decentralized***	16	5	WIPP WAC	1465	0.1	- -	609	<0.1	- -	- -
Regionalized-1	5	2	Reduce Gas	- -	- -	- -	38	<0.1	- -	- -
Regionalized-2	5	2	LDR	- -	- -	- -	38	<0.1	- -	- -
Regionalized-3	3	2	LDR	- -	- -	- -	38	<0.1	- -	- -
Centralized	WIPP	2	LDR	- -	- -	- -	38	<0.1	- -	- -

Notes:
Water supplied by groundwater. Current water use = 1,367,000 gallons/day.
Wastewater discharged to onsite evaporation ponds.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Construction is not considered for the alternative, and Stream Flow and Waste Water Stream Flow are not consideed for this site.

Table II-9.3-10. NTS—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	43	34	0.01	0.4	0.00	0.01
Decentralized***	16	5	WIPP WAC	85	83	0.02	0.9	0.01	0.01
Regionalized-1	5	2	Reduce Gas	6	6	0.00	0.1	0.00	0.00
Regionalized-2	5	2	LDR	6	6	0.00	0.1	0.00	0.00
Regionalized-3	3	2	LDR	6	6	0.00	0.1	0.00	0.00
Centralized	WIPP	2	LDR	6	6	0.00	0.1	0.00	0.00

Notes:
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-9.3-11. NTS—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	514	0.02	514	0.15	0.02	0.04	0	0.00
Decentralized***	16	5	WIPP WAC	1.2	0.00	1465	0.05	609	0.18	0.12	0.26	51	0.70
Regionalized-1	5	2	Reduce Gas	0	0.00	38	0.00	38	0.01	0.02	0.04	0	0.00
Regionalized-2	5	2	LDR	0	0.00	38	0.00	38	0.01	0.02	0.04	0	0.00
Regionalized-3	3	2	LDR	0	0.00	38	0.00	38	0.01	0.02	0.04	0	0.00
Centralized	WIPP	2	LDR	0	0.00	38	0.00	38	0.01	0.02	0.04	0	0.00

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-9.3-12. NTS—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	49	0	0	35	14	0	38	11
Decentralized***	16	5	WIPP - WAC	96	6	27	46	17	0	84	12
Regionalized-1	5	2	Reduce Gas	7	0	0	7	0	0	7	0
Regionalized-2	5	2	LDR	7	0	0	7	0	0	7	0
Regionalized-3	3	2	LDR	7	0	0	7	0	0	7	0
Centralized	WIPP	2	LDR	7	0	0	7	0	0	7	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.10.0 ORR

ORR currently is custodian of significant volumes of LLMW, LLW, and TRUW. Each of the waste types is treated independently in the following sections.

II.10.1 ORR LLMW

1. Seventeen tables immediately following portray the impacts of LLMW at ORR. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	ORR—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-10.1-1	10-3
2.	ORR—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-10.1-2	10-4
3.	ORR—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-10.1-3	10-5
4.	ORR—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-10.1-4	10-6
5.	ORR—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-10.1-5	10-7
6.	ORR—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-10.1-6	10-8
7.	ORR—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-10.1-7	10-9
8.	ORR—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-10.1-8	10-10
9.	ORR—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-10.1-9	10-11
10.	ORR—LLMW—Impacts on Water Resources Due to Increased Water Use	II-10.1-10	10-12
11.	ORR—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-10.1-11	10-13
11.	ORR—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Remote-Handled)	II-10.1-12	10-14
12.	ORR—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-10.1-13	10-15
12.	ORR—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Remote-Handled)	II-10.1-14	10-16

13.	ORR—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-10.1-15	10-17
14.	ORR—LLMW—Infrastructure Impacts for Treatment and Disposal	II-10.1-16	10-18
15.	ORR—LLMW—Cost	II-10.1-17	10-19

Table II-10.1-1. ORR—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	2.0E-01	1.6E-01	1.1E-01	4.8E-03	- -	- -
Decentralized	37	16	1.7E-01	6.0E-01	1.1E-03	4.4E-05	7.9E-02	4.8E-02
Regionalized-1	11	12	1.1E-01	4.8E-01	9.3E-04	3.8E-05	7.1E-02	4.8E-02
Regionalized-2	7	6	1.2E-01	4.8E-01	1.2E-03	5.0E-05	9.3E-04	5.6E-02
Regionalized-3	7	1	1.2E-01	4.8E-01	1.2E-03	5.0E-05	- -	- -
Regionalized-4	4	6	2.4E-01	7.1E-01	1.6E-03	6.6E-05	9.4E-02	5.5E-02
Centralized	1	1	2.4E-02	1.4E-01	6.8E-06	2.3E-07	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-10.1-2. ORR—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	2.3E+02	3.9E-01	4.1E-05	2.3E-02	9.6E+00	1.6E-02	1.4E-05	9.6E-04	5.0E+02	7.0E-01	7.1E-03	3.0E-02
Decentralized	37	16	2.2E+00	3.7E-03	2.2E-05	2.2E-04	8.9E-02	1.5E-04	7.5E-06	8.9E-06	4.4E+02	6.1E-01	5.8E-03	2.6E-02
Regionalized -1	11	12	1.9E+00	3.2E-03	1.9E-05	1.9E-04	7.6E-02	1.3E-04	6.5E-06	7.6E-06	2.8E+02	3.9E-01	5.1E-03	1.7E-02
Regionalized-2	7	6	2.4E+00	4.1E-03	1.9E-05	2.4E-04	1.0E-01	1.7E-04	6.5E-06	1.0E-05	3.0E+02	4.2E-01	5.2E-03	1.8E-02
Regionalized-3	7	1	2.4E+00	4.1E-03	1.9E-05	2.4E-04	1.0E-01	1.7E-04	6.5E-06	1.0E-05	3.0E+02	4.2E-01	5.2E-03	1.8E-02
Regionalized-4	4	6	3.3E+00	5.6E-03	2.9E-05	3.3E-04	1.3E-01	2.2E-04	9.7E-06	1.3E-05	6.0E+02	8.4E-01	8.6E-03	3.6E-02
Centralized	1	1	1.4E-02	2.3E-05	1.1E-06	1.4E-06	4.5E-04	7.7E-07	3.7E-07	4.5E-08	6.0E+01	8.4E-02	1.5E-04	3.6E-03

Notes:
T = Treatment
D = Disposal

Table II-10.1-3. ORR—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	2.0E+02	2.8E-01	1.2E-02
Regionalized-1	11	12	1.8E+02	2.5E-01	1.1E-02
Regionalized-2	7	6	2.3E+02	3.3E-01	1.4E-02
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	2.4E+02	3.3E-01	1.4E-02
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-10.1-4. ORR—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	3.5E-06	4.3E-06	- -
Decentralized	37	16	3.3E-08	4.0E-08	9.5E-07
Regionalized-1	11	12	2.9E-08	3.5E-08	7.6E-07
Regionalized-2	7	6	3.6E-08	4.5E-08	8.9E-07
Regionalized-3	7	1	3.6E-08	4.5E-08	- -
Regionalized-4	4	6	5.0E-08	5.9E-08	1.1E-06
Centralized	1	1	2.1E-10	2.1E-10	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-10.1-5. ORR—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	7.0E-03	1.2E-05	2.1E-09	7.0E-07	8.7E-03	1.5E-05	1.3E-08	8.7E-07	--	--	--	--
Decentralized	37	16	6.7E-05	1.1E-07	1.2E-09	6.7E-09	8.1E-05	1.4E-07	7.1E-09	8.1E-09	1.9E-03	3.2E-06	1.6E-03	1.9E-07
Regionalized-1	11	12	5.7E-05	9.7E-08	1.0E-09	5.7E-09	6.9E-05	1.2E-07	6.2E-09	6.9E-09	1.5E-03	2.6E-06	1.6E-03	1.5E-01
Regionalized-2	7	6	7.3E-05	1.2E-07	1.0E-09	7.3E-09	1.0E-01	1.7E-04	6.5E-06	1.0E-05	1.8E-03	3.0E-06	2.9E-03	1.8E-07
Regionalized-3	7	1	7.3E-05	1.2E-07	1.0E-09	7.3E-09	1.0E-01	1.7E-04	6.5E-06	1.0E-05	--	--	--	--
Regionalized-4	4	6	1.0E-04	1.7E-07	1.5E-09	1.0E-08	1.2E-04	2.0E-07	9.3E-09	1.2E-08	2.2E-03	3.7E-06	2.9E-03	2.2E-07
Centralized	1	1	4.2E-07	7.1E-10	5.8E-11	4.2E-11	4.1E-07	7.0E-10	3.6E-10	4.1E-11	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered for this alternative.

Table II-10.1-6. ORR—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	1.7E-06	1.1E-05	1.2E-02	- -
Decentralized	37	16	1.4E-06	8.8E-06	1.2E-02	7.8E-01
Regionalized-1	11	12	1.4E-06	8.7E-06	1.2E-02	7.7E-01
Regionalized-2	7	6	1.4E-06	8.8E-06	1.3E-02	1.1E+00
Regionalized-3	7	1	1.4E-06	8.8E-06	1.3E-02	- -
Regionalized-4	4	6	2.0E-06	1.3E-05	1.6E-02	1.1E+00
Centralized	1	1	9.5E-09	3.7E-07	2.9E-04	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-10.1-7. ORR—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	180 (4/176)	45 (10/35)	0	1(1/0)	1(1/0)	22 (1/21)	68 (2/66)	17 (4/13)	0	4 (4/0)	0	8 (0/8)
Decentralized	37	16	134 (6/128)	42 (16/26)	0	1 (1/0)	2 (2/0)	17 (2/15)	92 (2/90)	31 (13/18)	0	7 (7/0)	1 (1/0)	11 (0/11)
Regionalized-1	11	12	134 (6/128)	42 (16/26)	0	1 (1/0)	2 (2/0)	17 (2/15)	92 (2/90)	31 (13/18)	0	7 (7/0)	1 (1/0)	11 (0/11)
Regionalized-2	7	6	134 (6/128)	42 (16/26)	0	1 (1/0)	2 (2/0)	17 (2/15)	92 (2/90)	31 (13/18)	0	7 (7/0)	1 (1/0)	11 (0/11)
Regionalized-3	7	1	192 (5/187)	49 (12/37)	0	1 (1/0)	1 (1/0)	23 (1/22)	98 (1/97)	22 (2/20)	0	7 (7/0)	1 (1/0)	12 (0/12)
Regionalized-4	4	6	235 (10/225)	70 (25/45)	0	2 (2/0)	2 (2/0)	29 (2/27)	144 (3/141)	36 (8/28)	0	12 (12/0)	1 (1/0)	17 (0/17)
Centralized	1	1	153 (3/150)	36 (6/30)	0	0	0	18 (0/18)	64 (0/64)	13 (0/13)	0	0	0	8 (0/8)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-10.1-8. ORR—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized - 1	11	12	--	--	--	--	--	--
Regionalized - 2	7	6	--	--	--	--	--	--
Regionalized - 3	7	1	--	--	--	--	--	--
Regionalized - 4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	2	19	0	26	1	1	0	0	0	3	2	0
Decentralized	37	16	2	33	0	50	2	1	0	0	0	6	3	0
Regionalized - 1	11	12	2	33	0	50	2	1	0	0	0	6	3	0
Regionalized - 2	7	6	2	33	0	50	2	1	0	0	0	6	3	0
Regionalized - 3	7	1	1	26	0	46	1	0	0	0	0	6	3	0
Regionalized - 4	4	6	3	51	0	77	2	1	0	0	0	9	5	0
Centralized	1	1	0	1	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) ORR is in an attainment area for all criteria pollutants, therefore the GCR doe not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the Centralized Alternative are assumed to be negligible since ther is no incineration at ORR under this alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-10.1-9. ORR—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	7	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-10.1-10. ORR—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	9920	0.1	<0.1	11491	0.1	<0.1	<0.1
Decentralized	37	16	24085	0.1	<0.1	14992	0.1	<0.1	<0.1
Regionalized-1	11	12	24085	0.1	<0.1	14992	0.1	<0.1	<0.1
Regionalized-2	7	6	24085	0.1	<0.1	14992	0.1	<0.1	<0.1
Regionalized-3	7	1	16203	0.1	<0.1	10579	0.1	<0.1	<0.1
Regionalized-4	4	6	32846	0.2	<0.1	20085	0.1	<0.1	<0.1
Centralized	1	1	7888	<0.1	<0.1	4686	<0.1	<0.1	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by surface water in the Clinch River. Current water use = 18,300,000 gallons/day.
Wastewater discharged to the Clinch River.
Average flow rate of the Clinch River = 3,003,000,000 gallons/day.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-10.1-11. ORR—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																				
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	50	30	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	40	20	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	40	30	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	50	30	0
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	7	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	5	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	10	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	10	0	0
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal of CH-LLMW at this site for this alternative.

Table II-10.1-12. ORR—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Remote-Handled)

LLMW Alternatives	T	D *	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1000	600	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1000	600	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1000	600	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1000	600	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1000	600	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1000	600	0

LLMW Alternatives	T	D *	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	900	0	0	0	0	0	0	0	1	0	0	100	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	900	0	0	0	0	0	0	0	1	0	0	100	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	900	0	0	0	0	0	0	0	1	0	0	100	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	900	0	0	0	0	0	0	0	1	0	0	100	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	900	0	0	0	0	0	0	0	1	0	0	100	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	900	0	0	0	0	0	0	0	1	0	0	100	0	0

Notes:

T = Treatment

D = Disposal

* = In addition to the CH-LLMW disposal sites indicated below, disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR and SRS) for all alternatives except No Action.

- - = No disposal at this site for this alternative.

Table II-10.1-13. ORR—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	50	0	0	0	0
Regionalized-1	11	12	0	0	0	50	0	0	0	0
Regionalized-2	7	6	0	0	0	70	0	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	70	0	0	0	0
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	1000	0	0	1000	0	0	0
Regionalized-1	11	12	1000	0	0	1000	0	0	0
Regionalized-2	7	6	2000	0	0	3000	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	2000	0	0	3000	0	0	0
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-10.1-14. ORR—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Remote-Handled)

LLMW Alternatives	T	D *	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0

LLMW Alternatives	T	D *	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	1	0	0	2	0	0	0
Regionalized-1	11	12	1	0	0	2	0	0	0
Regionalized-2	7	6	1	0	0	2	0	0	0
Regionalized-3	7	1	1	0	0	2	0	0	0
Regionalized-4	4	6	1	0	0	2	0	0	0
Centralized	1	1	1	0	0	2	0	0	0

Notes:
T = Treatment
D = Disposal
* = In addition to the CH-LLMW disposal sites indicated below, disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR and SRS) for all alternatives except No Action.
"--" = No disposal at this site for this alternative.

Table II-10.1-15. ORR—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	825	733	0.25	8.3	0.10	0.16
Decentralized	37	16	1566	1739	0.60	19.7	0.24	0.30
Regionalized-1	11	12	1566	1739	0.60	19.7	0.24	0.30
Regionalized-2	7	6	1566	1739	0.60	19.7	0.24	0.29
Regionalized-3	7	1	1367	1519	0.53	17.2	0.21	0.25
Regionalized-4	4	6	1973	2192	0.76	24.8	0.31	0.38
Centralized	1	1	872	969	0.34	11.0	0.13	0.15

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-10.1-16. ORR—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	5.83	0.10	11491	0.03	11491	0.28	2.62	0.4	324	2
Decentralized	37	16	12.38	0.22	24085	0.06	14992	0.37	3.7	0.56	995	5
Regionalized-1	11	12	12.38	0.22	24085	0.06	14992	0.37	3.7	0.56	995	5
Regionalized-2	7	6	12.62	0.22	24085	0.06	14992	0.37	4.6	0.7	995	5
Regionalized-3	7	1	10.52	0.19	16203	0.04	10579	0.26	2.45	0.37	933	4
Regionalized-4	4	6	19.05	0.34	32846	0.08	20085	0.49	6.65	1.01	1225	6
Centralized	1	1	5.31	0.09	7888	0.02	4686	0.11	0.74	0.11	644	3

Notes:
T is defined as Treatment, D is defined as Disposal
(1) Based on 1991 site employment

Table II-10.1-17. ORR—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	934	38	170	667	59	509	424	0
Decentralized	37	16	1772	143	528	1005	95	1456	0	316
Regionalized-1	11	12	1772	143	528	1005	95	1456	0	316
Regionalized-2	7	6	1772	143	528	1005	95	1456	0	316
Regionalized-3	7	1	1547	128	494	855	70	1456	0	92
Regionalized-4	4	6	2233	184	635	1292	120	1867	0	366
Centralized	1	1	987	80	360	502	45	895	0	92

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.10.2 ORR LLW

Thirteen tables immediately following portray the impacts of LLW at ORR. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	ORR—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-10.2-1	10-21
2.	ORR—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-10.2-2	10-22
3.	ORR—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-10.2-3	10-23
4.	ORR—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-10.2-4	10-24
5.	ORR—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-10.2-5	10-25
7.	ORR—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-10.2-6	10-26
8.	ORR—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-10.2-7	10-27
9.	ORR—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-10.2-8	10-28
10.	ORR—LLW—Impacts on Water Resources Due to Increased Water Use	II-10.2-9	10-29
11.	ORR—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-10.2-10	10-30
13.	ORR—LLW—Socioeconomic Impacts for Treatment and Disposal	II-10.2-11	10-31
14.	ORR—LLW—Infrastructure Impacts for Treatment and Disposal	II-10.2-12	10-32
15.	ORR—LLW—Cost	II-10.2-13	10-33

Table II-10.2-1. ORR—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	1.1E-01	8.3E-02	4.6E-06	1.5E-07	3.4E-01	1.5E-01
Decentralized		16	6.1E-02	4.8E-02	5.0E-06	1.7E-07	3.0E-01	2.4E-01
Regionalized-1		12	6.1E-02	4.8E-02	5.0E-06	1.7E-07	3.0E-01	2.4E-01
Regionalized-2	11	12	3.1E-01	3.8E-01	8.2E-05	3.4E-06	2.1E-01	1.3E-01
Regionalized-3		6	6.1E-02	2.8E-02	5.0E-06	1.7E-07	5.5E-01	4.0E-01
Regionalized-4	7	6	3.1E-01	3.6E-01	8.2E-05	3.4E-06	4.7E-01	3.0E-01
Regionalized-5	4	6	4.2E-01	4.3E-01	3.0E-01	4.3E-03	4.7E-01	3.0E-01
Regionalized-6		2	7.0E-02	5.2E-02	1.2E-05	3.9E-07	- -	- -
Regionalized-7		2	7.0E-02	5.2E-02	1.2E-05	3.9E-07	- -	- -
Centralized-1		1	7.0E-02	5.2E-02	1.2E-05	3.9E-07	- -	- -
Centralized-2		1	7.0E-02	5.2E-02	1.2E-05	3.9E-07	- -	- -
Centralized-3	7	1	3.2E-01	3.9E-01	8.9E-05	3.6E-06	- -	- -
Centralized-4	7	1	3.2E-01	3.9E-01	8.9E-05	3.6E-06	- -	- -
Centralized-5	1	1	7.0E-02	5.2E-02	1.2E-05	3.9E-07	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-10.2-2. ORR—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Worker			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	9.2E-03	1.6E-05	9.2E-07	3.1E-04	5.2E-07	3.1E-08	2.8E+02	3.9E-01	1.7E-02
Decentralized		16	1.0E-02	1.7E-05	1.0E-06	3.3E-04	5.7E-07	3.3E-08	1.5E+02	2.1E-01	9.1E-03
Regionalized-1		12	1.0E-02	1.7E-05	1.0E-06	3.3E-04	5.7E-07	3.3E-08	1.5E+02	2.1E-01	9.1E-03
Regionalized-2	11	12	1.7E-01	2.8E-04	1.7E-05	6.7E-03	1.1E-05	6.7E-07	7.8E+02	1.1E+00	4.7E-02
Regionalized-3		6	1.0E-02	1.7E-05	1.0E-06	3.3E-04	5.7E-07	3.3E-08	1.5E+02	2.1E-01	9.1E-03
Regionalized-4	7	6	1.7E-01	2.8E-04	1.7E-05	6.7E-03	1.1E-05	6.7E-07	7.7E+02	1.1E+00	4.7E-02
Regionalized-5	4	6	6.0E+02	1.0E+00	6.0E-02	8.7E+00	1.5E-02	8.7E-04	1.1E+03	1.5E+00	6.3E-02
Regionalized-6		2	2.3E-02	3.9E-05	2.3E-06	7.8E-04	1.3E-06	7.8E-08	1.8E+02	2.5E-01	1.1E-02
Regionalized-7		2	2.3E-02	3.9E-05	2.3E-06	7.8E-04	1.3E-06	7.8E-08	1.8E+02	2.5E-01	1.1E-02
Centralized-1		1	2.3E-02	3.9E-05	2.3E-06	7.8E-04	1.3E-06	7.8E-08	1.8E+02	2.5E-01	1.1E-02
Centralized-2		1	2.3E-02	3.9E-05	2.3E-06	7.8E-04	1.3E-06	7.8E-08	1.8E+02	2.5E-01	1.1E-02
Centralized-3	7	1	1.8E-01	3.0E-04	1.8E-05	7.1E-03	1.2E-05	7.1E-07	8.0E+02	1.1E+00	4.8E-02
Centralized-4	7	1	1.8E-01	3.0E-04	1.8E-05	7.1E-03	1.2E-05	7.1E-07	8.0E+02	1.1E+00	4.8E-02
Centralized-5	1	1	2.3E-02	3.9E-05	2.3E-06	7.8E-04	1.3E-06	7.8E-08	1.8E+02	2.5E-01	1.1E-02

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-3. ORR—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	8.5E+02	1.2E+00	5.1E-02
Decentralized		16	7.6E+02	1.1E+00	4.6E-02
Regionalized-1		12	7.6E+02	1.1E+00	4.6E-02
Regionalized-2	11	12	5.3E+02	7.4E-01	3.2E-02
Regionalized-3		6	1.4E+03	1.9E+00	8.3E-02
Regionalized-4	7	6	1.2E+03	1.7E+00	7.1E-02
Regionalized-5	4	6	1.2E+03	1.7E+00	7.1E-02
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-4. ORR—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	1.4E-10	1.4E-10	2.2E-07
Decentralized		16	1.6E-10	1.5E-10	1.8E-07
Regionalized-1		12	1.6E-10	1.5E-10	1.8E-07
Regionalized-2	11	12	2.5E-09	3.0E-09	3.9E-07
Regionalized-3		6	1.6E-10	1.5E-10	1.3E-07
Regionalized-4	7	6	2.5E-09	3.0E-09	1.8E-07
Regionalized-5	4	6	9.3E-06	3.9E-06	1.8E-07
Regionalized-6		2	3.5E-10	3.5E-10	- -
Regionalized-7		2	3.5E-10	3.5E-10	- -
Centralized 1		1	3.5E-10	3.5E-10	- -
Centralized 2		1	3.5E-10	3.5E-10	- -
Centralized 3	7	1	2.7E-09	3.2E-09	- -
Centralized 4	7	1	2.7E-09	3.2E-09	- -
Centralized 5	1	1	3.5E-10	3.5E-10	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-5. ORR—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	2.9E-07	4.9E-10	2.9E-11	2.8E-07	4.7E-10	2.8E-11	4.5E-04	7.6E-07	4.5E-08
Decentralized		16	3.1E-07	5.3E-10	3.1E-11	3.0E-07	5.1E-10	3.0E-11	3.7E-04	6.2E-07	3.7E-08
Regionalized-1		12	3.1E-07	5.3E-10	3.1E-11	3.0E-07	5.1E-10	3.0E-11	3.7E-04	6.2E-07	3.7E-08
Regionalized-2	11	12	5.0E-06	8.5E-09	5.0E-10	6.1E-06	1.0E-08	6.1E-10	7.8E-04	1.3E-06	7.8E-08
Regionalized-3		6	3.1E-07	5.3E-10	3.1E-11	3.0E-07	5.1E-10	3.0E-11	2.5E-04	4.3E-07	2.5E-08
Regionalized-4	7	6	5.0E-06	8.5E-09	5.0E-10	6.1E-06	1.0E-08	6.1E-10	3.7E-04	6.3E-07	3.7E-08
Regionalized-5	4	6	1.9E-02	3.2E-05	1.9E-06	7.8E-03	1.3E-05	7.8E-07	3.7E-04	6.3E-07	3.7E-08
Regionalized-6		2	7.1E-07	1.2E-09	7.1E-11	7.0E-07	1.2E-09	7.0E-11	--	--	--
Regionalized-7		2	7.1E-07	1.2E-09	7.1E-11	7.0E-07	1.2E-09	7.0E-11	--	--	--
Centralized-1		1	7.1E-07	1.2E-09	7.1E-11	7.0E-07	1.2E-09	7.0E-11	--	--	--
Centralized-2		1	7.1E-07	1.2E-09	7.1E-11	7.0E-07	1.2E-09	7.0E-11	--	--	--
Centralized-3	7	1	5.4E-06	9.2E-09	5.4E-10	6.5E-06	1.1E-08	6.5E-10	--	--	--
Centralized-4	7	1	5.4E-06	9.2E-09	5.4E-10	6.5E-06	1.1E-08	6.5E-10	--	--	--
Centralized-5	1	1	7.1E-07	1.2E-09	7.1E-11	7.0E-07	1.2E-09	7.0E-11	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-6. ORR—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	49 (18/31)	54 (48/6)	0	4 (4/0)	5 (5/0)	9 (5/4)	213 (2/211)	46 (4/42)	0	1 (1/0)	0	25 (0/25)
Decentralized		16	153 (106/47)	287 (277/9)	0	22 (22/0)	26 (26/0)	33 (27/6)	112 (4/108)	31 (9/22)	0	2 (1/0)	0	14 (1/13)
Regionalized-1		12	153 (106/47)	287 (277/9)	0	22 (22/0)	26 (26/0)	33 (27/6)	112 (4/108)	31 (9/22)	0	2 (1/0)	0	14 (1/13)
Regionalized-2	11	12	241 (46/195)	159 (120/39)	0	10 (10/0)	11 (11/0)	35 (12/23)	185 (2/183)	41 (4/37)	0	1 (1/0)	0	22 (0/22)
Regionalized-3		6	281 (234/47)	619 (610/9)	0	49 (49/0)	58 (58/0)	65 (59/6)	135 (9/126)	49 (19/30)	0	3 (3/0)	0	16 (1/15)
Regionalized-4	7	6	313 (110/203)	326 (286/40)	0	23 (23/0)	27 (27/0)	52 (28/24)	290 (4/286)	70 (9/61)	0	3 (2/1)	0	36 (1/35)
Regionalized-5	4	6	351 (114/237)	344 (297/47)	0	24 (24/0)	28 (28/0)	57 (29/28)	332 (4/328)	81 (11/70)	0	4 (3/1)	0	41 (1/40)
Regionalized-6		2	75 (8/67)	33 (20/13)	0	2 (2/0)	2 (2/0)	10 (2/8)	54 (0/54)	16 (1/15)	0	0	0	7 (0/7)
Regionalzied-7		2	75 (8/67)	33 (20/13)	0	2 (2/0)	2 (2/0)	10 (2/8)	54 (0/54)	16 (1/15)	0	0	0	7 (0/7)
Centralized-1		1	75 (8/67)	33 (20/13)	0	2 (2/0)	2 (2/0)	10 (2/8)	54 (0/54)	16 (1/15)	0	0	0	7 (0/7)
Centralized-2		1	75 (8/67)	33 (20/13)	0	2 (2/0)	2 (2/0)	10 (2/8)	54 (0/54)	16 (1/15)	0	0	0	7 (0/7)
Centralized-3	7	1	220 (17/203)	84 (44/40)	0	3 (3/0)	4 (4/0)	29 (4/24)	240 (1/239)	54 (2/52)	0	1 (0/1)	0	29 (0/29)
Centralized-4	7	1	220 (17/203)	84 (44/40)	0	3 (3/0)	4 (4/0)	29 (4/24)	240 (1/239)	54 (2/52)	0	1 (0/1)	0	29 (0/29)
Centralized-5	1	1	203 (8/195)	59 (20/39)	0	2 (2/0)	2 (2/0)	25 (2/23)	54 (0/54)	16 (1/15)	0	0	0	7 (0/7)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-7. ORR—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	T	D	Construction					
			Percent of Tons/Year General Conformity Rule (1)					
			CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalzied-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	T	D	Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
			CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	2	9	0	4	0	1	--	--	--	--	--	--
Decentralized		16	4	21	0	10	0	2	--	--	--	--	--	--
Regionalized-1		12	4	21	0	10	0	2	--	--	--	--	--	--
Regionalized-2	11	12	2	9	0	4	0	1	0	0	0	0	0	0
Regionalized-3		6	9	47	0	21	0	3	--	--	--	--	--	--
Regionalized-4	7	6	4	22	0	12	0	2	0	0	0	0	0	0
Regionalized-5	4	6	4	27	0	18	0	2	0	0	0	0	0	0
Regionalized-6		2	0	2	0	1	0	0	--	--	--	--	--	--
Regionalzied-7		2	0	2	0	1	0	0	--	--	--	--	--	--
Centralized-1		1	0	2	0	1	0	0	--	--	--	--	--	--
Centralized-2		1	0	2	0	1	0	0	--	--	--	--	--	--
Centralized-3	7	1	1	4	0	3	0	0	0	0	0	0	0	0
Centralized-4	7	1	1	4	0	3	0	0	0	0	0	0	0	0
Centralized-5	1	1	0	2	0	1	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide. VOC = volatile organic compounds.
NAAQS = National Ambient Air Quality Standard.
(1) ORR is in an attainment area for all criteria pollutants, therefore the GCR do not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the minimum treatment (no incineration) alternatives, and the Centralized-5 Alternatives, are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-8. ORR—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-9. ORR—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	13202	0.1	<0.1	13701	0.1	<0.1	<0.1
Decentralized		16	247613	1.4	<0.1	12392	0.1	<0.1	<0.1
Regionalized-1		12	247613	1.4	<0.1	12392	0.1	<0.1	<0.1
Regionalized-2	11	12	123499	0.7	<0.1	36399	0.2	<0.1	<0.1
Regionalized-3		6	539756	2.9	<0.1	20858	0.1	<0.1	<0.1
Regionalized-4	7	6	269232	1.5	<0.1	40283	0.2	<0.1	<0.1
Regionalized-5	4	6	282328	1.5	<0.1	47608	0.3	<0.1	<0.1
Regionalized-6		2	23982	0.1	<0.1	7328	<0.1	<0.1	<0.1
Regionalized-7		2	23982	0.1	<0.1	7328	<0.1	<0.1	<0.1
Centralized-1		1	23982	0.1	<0.1	7328	<0.1	<0.1	<0.1
Centralized-2		1	23982	0.1	<0.1	7328	<0.1	<0.1	<0.1
Centralized-3	7	1	56373	0.3	<0.1	33909	0.2	<0.1	<0.1
Centralized-4	7	1	56373	0.3	<0.1	33909	0.2	<0.1	<0.1
Centralized-5	1	1	23982	0.1	<0.1	7328	<0.1	<0.1	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by surface water in the Clinch River. Current water use = 18,300,000 gallons/day.
Wastewater discharged to the Clinch River. Average flow rate of the Clinch River = 3,003,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
<0.1 indicates that the percentage is less than 0.1%.

Table II-10.2-10. ORR—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Decentralized		16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
- - = Disposal is not considered for this Alternative.

Table II-10.2-11. ORR—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	3721	3307	1.15	37.4	0.46	0.36
Decentralized		16	1349	1500	0.52	16.9	0.21	0.26
Regionalized-1		12	1349	1500	0.52	16.9	0.21	0.26
Regionalized-2	11	12	3631	4033	1.40	45.6	0.56	0.57
Regionalized-3		6	2533	2814	0.98	31.8	0.39	0.37
Regionalized-4	7	6	4112	4568	1.59	51.7	0.64	0.84
Regionalized-5	4	6	4712	5234	1.82	59.2	0.73	0.96
Regionalized-6		2	885	983	0.34	11.1	0.14	0.16
Regionalized-7		2	885	983	0.34	11.1	0.14	0.16
Centralized-1		1	885	983	0.34	11.1	0.14	0.16
Centralized-2		1	885	983	0.34	11.1	0.14	0.16
Centralized-3	7	1	3403	3780	1.31	42.7	0.53	0.69
Centralized-4	7	1	3403	3780	1.31	42.7	0.53	0.69
Centralized-5	1	1	885	983	0.34	11.1	0.14	0.16

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-12. ORR—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	83.2	1.48	13701	0.03	13701	0.34	8.10	1.23	237	1
Decentralized		16	65.6	1.16	247613	0.62	12392	0.30	36.66	5.55	2076	10
Regionalized-1		12	65.6	1.16	247613	0.62	12392	0.30	36.66	5.55	2076	10
Regionalized-2	11	12	45.7	0.81	123499	0.31	36399	0.89	15.90	2.41	1658	8
Regionalized-3		6	137.6	2.44	539756	1.34	20858	0.51	80.69	12.23	1012	5
Regionalized-4	7	6	80.1	1.42	269232	0.67	40283	0.98	37.86	5.74	1968	9
Regionalized-5	4	6	86.2	1.53	282328	0.70	47608	1.16	39.29	5.95	2233	10
Regionalized-6		2	11.6	0.21	23982	0.06	7328	0.18	2.86	0.43	518	2
Regionalized-7		2	11.6	0.21	23982	0.06	7328	0.18	2.86	0.43	518	2
Centralized-1		1	11.6	0.21	23982	0.06	7328	0.18	2.86	0.43	518	2
Centralized-2		1	11.6	0.21	23982	0.06	7328	0.18	2.86	0.43	518	2
Centralized-3	7	1	27.5	0.49	56373	0.14	33909	0.83	37.86	1.38	1571	7
Centralized-4	7	1	27.5	0.49	56373	0.14	33909	0.83	37.86	1.38	1571	7
Centralized-5	1	1	11.6	0.21	23982	0.06	7328	0.18	2.86	0.43	518	2

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-10.2-13. ORR—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	4210	36	1024	2949	200	979	0	3231
Decentralized		16	1526	118	401	946	61	548	0	978
Regionalized-1		12	1526	118	401	946	61	548	0	978
Regionalized-2	11	12	4108	278	716	3020	93	3773	0	334
Regionalized-3		6	2866	187	1132	1344	203	711	0	2155
Regionalized-4	7	6	4653	332	854	3346	122	3850	0	803
Regionalized-5	4	6	5331	367	974	3848	141	4528	0	803
Regionalized-6		2	1001	78	250	630	44	1001	0	0
Regionalized-7		2	1001	78	250	630	44	1001	0	0
Centralized-1		1	1001	78	250	630	44	1001	0	0
Centralized-2		1	1001	78	250	630	44	1001	0	0
Centralized-3	7	1	3850	273	663	2860	55	3850	0	0
Centralized-4	7	1	3850	273	663	2860	55	3850	0	0
Centralized-5	1	1	1001	78	250	630	44	1001	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.10.3 ORR TRUW

Twelve tables immediately following portray the impacts of TRUW at ORR. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	ORR—TRUW—Treatment: Estimated Number of Fatalities	II-10.3-1	10-35
2.	ORR—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-10.3-2	10-36
4.	ORR—TRUW—Treatment: MEI Probability of Cancer Fatality	II-10.3-3	10-37
5.	ORR—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-10.3-4	10-38
6.	ORR—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-10.3-5	10-39
7.	ORR—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-10.3-6	10-40
8.	ORR—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-10.3-7	10-41
9.	ORR—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-10.3-8	10-42
10.	ORR—TRUW—Impacts on Water Resources Due to Increased Water Use	II-10.3-9	10-43
13.	ORR—TRUW—Socioeconomic Impacts for Treatment	II-10.3-10	10-44
14.	ORR—TRUW—Infrastructure Impacts for Treatment	II-10.3-11	10-45
15.	ORR—TRUW—Cost	II-10.3-12	10-46

Table II-10.3-1. ORR—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure
	CH Treat	RH Treat		Radiation Exposure	Physical Hazards		
No Action **	16	5	WIPP WAC	3.6E-07	8.4E-03	6.6E-08	2.3E-09
Decentralized ***	16	5	WIPP WAC	2.7E-03	9.1E-02	8.0E-07	2.7E-08
Regionalized-1	5	2	Reduce Gas	2.8E-03	1.0E-01	8.3E-07	2.9E-08
Regionalized-2	5	2	LDR	9.0E-02	2.1E-01	4.6E-02	1.6E-03
Regionalized-3	3	2	LDR	9.0E-02	2.1E-01	4.6E-02	1.6E-03
Centralized	WIPP	2	LDR	9.0E-02	2.1E-01	4.6E-02	1.6E-03

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-10.3-2. ORR—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	1.3E-04	2.2E-07	7.8E-09	1.3E-08	4.6E-06	7.8E-09	2.6E-09	4.6E-10	9.0E-04	1.3E-06	8.4E-08	5.4E-08
Decentralized***	16	5	WIPP WAC	1.6E-03	2.7E-06	1.6E-07	1.6E-07	5.4E-05	9.2E-08	5.2E-08	5.4E-09	6.8E+00	9.5E-03	3.0E-06	4.1E-04
Regionalized-1	5	2	Reduce Gas	1.7E-03	2.8E-06	1.6E-07	1.7E-07	5.7E-05	9.7E-08	5.2E-08	5.7E-09	6.9E+00	9.6E-03	3.4E-06	4.1E-04
Regionalized-2	5	2	LDR	9.2E+01	1.6E-01	1.1E-07	9.2E-03	3.1E+00	5.3E-03	3.7E-08	3.1E-04	2.3E+02	3.2E-01	5.1E-06	1.4E-02
Regionalized-3	3	2	LDR	9.2E+01	1.6E-01	1.1E-07	9.2E-03	3.1E+00	5.3E-03	3.7E-08	3.1E-04	2.3E+02	3.2E-01	5.1E-06	1.4E-02
Centralized	WIPP	2	LDR	9.2E+01	1.6E-01	1.1E-07	9.2E-03	3.1E+00	5.3E-03	3.7E-08	3.1E-04	2.3E+02	3.2E-01	5.1E-06	1.4E-02

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-10.3-3. ORR—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	2.1E-12	2.1E-12
Decentralized***	16	5	WIPP WAC	2.5E-11	2.5E-11
Regionalized-1	5	2	Reduce Gas	2.6E-11	2.6E-11
Regionalized-2	5	2	LDR	1.4E-06	1.4E-06
Regionalized-3	3	2	LDR	1.4E-06	1.4E-06
Centralized	WIPP	2	LDR	1.4E-06	1.4E-06

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-10.3-4. ORR—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite Population MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	4.1E-09	7.0E-12	4.0E-13	4.1E-13	4.1E-09	7.0E-12	2.5E-12	4.1E-13
Decentralized ***	16	5	WIPP WAC	4.9E-08	8.4E-11	8.1E-12	4.9E-12	4.9E-08	8.3E-11	5.0E-11	4.9E-12
Regionalized-1	5	2	Reduce Gas	5.1E-08	8.7E-11	8.1E-12	5.1E-12	5.2E-08	8.8E-11	5.0E-11	5.2E-12
Regionalized-2	5	2	LDR	2.8E-03	4.8E-06	5.7E-12	2.8E-07	2.8E-03	4.8E-06	3.5E-11	2.8E-07
Regionalized-3	3	2	LDR	2.8E-03	4.8E-06	5.7E-12	2.8E-07	2.8E-03	4.8E-06	3.5E-11	2.8E-07
Centralized	WIPP	2	LDR	2.8E-03	4.8E-06	5.7E-12	2.8E-07	2.8E-03	4.8E-06	3.5E-11	2.8E-07

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
MEI = Maximally Exposed Individual

Table II-10.3-5. ORR—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment		
	CH Treat	RH Treat		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	3.3E-12	2.0E-11	3.0E-06
Decentralized***	16	5	WIPP WAC	1.3E-10	8.0E-10	3.0E-05
Regionalized-1	5	2	Reduce Gas	1.3E-10	8.1E-10	3.0E-05
Regionalized-2	5	2	LDR	1.9E-09	1.2E-08	3.0E-05
Regionalized-3	3	2	LDR	1.9E-09	1.2E-08	3.0E-05
Centralized	WIPP	2	LDR	1.9E-09	1.2E-08	3.0E-05

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-10.3-6. ORR—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites CH Treat	Number of Sites RH Treat	Treatment Standard	Construction Emissions in Tons/Year (1) CO	NO2	Pb	PM10	SO2	VOC	Operations & Maintenance Emissions in Tons/Year (2) CO	NO2	Pb	PM10	SO2
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -	15 (0/15)	3 (0/3)	0	0	0
Decentralized***	16	5	WIPP WAC	34 (7/27)	24 (19/5)	0	1 (1/0)	2 (2/0)	5 (2/3)	23 (0/23)	5 (0/5)	0	0	0
Regionalized-1	5	2	Reduce Gas	27 (6/21)	20 (16/4)	0	1 (1/0)	2 (2/0)	5 (2/3)	19 (19/0)	4 (0/4)	0	0	0
Regionalized-2	5	2	LDR	43 (7/36)	26 (19/7)	0	1 (1/0)	2 (2/0)	6 (2/4)	24 (0/24)	5 (0/5)	0	0	0
Regionalized-3	3	2	LDR	43 (7/36)	26 (19/7)	0	1 (1/0)	2 (2/0)	6 (2/4)	24 (0/24)	5 (0/5)	0	0	0
Centralized	WIPP	2	LDR	43 (7/36)	26 (19/7)	0	1 (1/0)	2 (2/0)	6 (2/4)	24 (0/24)	5 (0/5)	0	0	0

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-10.3-7. ORR—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--
Centralized	WIPP	2	LDR	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	0	1	0	0	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	1	0	2	1	0	0	0	0	0	0	0
Regionalized-3	3	2	LDR	0	1	0	2	1	0	0	0	0	0	0	0
Centralized	WIPP	2	LDR	0	1	0	2	1	0	0	0	0	0	0	0

Notes:

Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.

CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.

VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.

(1) ORR is in an attainment area for all criteria pollutants, therfore the GCR does not apply.

(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.

(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives are assumed to be negligible.

(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-10.3-8. ORR—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	3	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	3	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	3	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-10.3-9. ORR—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	--	--	--	1425	<0.1	<0.1	<0.1
Decentralized***	16	5	WIPP WAC	12954	0.1	<0.1	3929	<0.1	<0.1	<0.1
Regionalized-1	5	2	Reduce Gas	11065	0.1	<0.1	3228	<0.1	<0.1	<0.1
Regionalized-2	5	2	LDR	14448	0.1	<0.1	3787	<0.1	<0.1	<0.1
Regionalized-3	3	2	LDR	14448	0.1	<0.1	3787	<0.1	<0.1	<0.1
Centralized	WIPP	2	LDR	14448	0.1	<0.1	3787	<0.1	<0.1	<0.1

Notes:
Water supplied by surface water in the Clinch River. Current water use = 18,300,000 gallons/day.
Wastewater discharged to the Clinch River. Average flow rate of the Clinch River = 3,003,000,000 gallons/day.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
<0.1 indicates that the precentage are less than 0.1%.

Table II-10.3-10. ORR—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	215	191	0.07	2.2	0.03	0.05
Decentralized***	16	5	WIPP WAC	487	541	0.19	6.1	0.08	0.08
Regionalized-1	5	2	Reduce Gas	424	471	0.16	5.3	0.07	0.09
Regionalized-2	5	2	LDR	598	664	0.23	7.5	0.09	0.09
Regionalized-3	3	2	LDR	598	664	0.23	7.5	0.09	0.09
Centralized	WIPP	2	LDR	598	664	0.23	7.5	0.09	0.09

Notes:
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-10.3-11. ORR—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	1425	0.00	1425	0.03	0.14	0.02	0	0.00
Decentralized***	16	5	WIPP WAC	6.6	0.12	12954	0.03	3929	0.10	0.69	0.10	276	1.30
Regionalized-1	5	2	Reduce Gas	5.9	0.11	11065	0.03	3228	0.08	0.65	0.10	258	1.20
Regionalized-2	5	2	LDR	6.3	0.11	14448	0.04	3787	0.09	0.57	0.09	412	1.90
Regionalized-3	3	2	LDR	6.3	0.11	14448	0.04	3787	0.09	0.57	0.09	412	1.90
Centralized	WIPP	2	LDR	6.3	0.11	14448	0.04	3787	0.09	0.57	0.09	412	1.90

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-10.3-12. ORR—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	243	0	0	207	37	0	217	27
Decentralized***	16	5	WIPP - WAC	551	33	151	286	81	109	415	28
Regionalized-1	5	2	Reduce Gas	480	45	120	247	68	109	353	19
Regionalized-2	5	2	LDR	677	64	207	335	72	109	554	14
Regionalized-3	3	2	LDR	677	64	207	335	72	109	554	14
Centralized	WIPP	2	LDR	677	64	207	335	72	109	554	14

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.10.4 ORR HLW

ORR is not one of the sites considered for management of HLW. Therefore, Section 10.4 has been intentionally left blank.

II.10.5 ORR HW

Eleven tables immediately following portray the impacts of HW at ORR. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	ORR—HW—Treatment: Estimated Number of Fatalities	II-10.5-1	10-49
3.	ORR—HW—Treatment: Estimated Number of Cancer Incidences	II-10.5-2	10-50
5.	ORR—HW—Treatment: MEI Probability of Cancer Incidences	II-10.5-3	10-51
6.	ORR—HW—Treatment: Noncancer Health Risk From Chemical Exposure	II-10.5-4	10-52
7.	ORR—HW—Emissions in Tons per Year of Criteria Air Pollutants	II-10.5-5	10-53
8.	ORR—HW—Percent of Standard/Guideline for Criteria Air Pollutants	II-10.5-6	10-54
9.	ORR—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-10.5-7	10-55
10.	ORR—HW—Impacts on Water Resources Due to Increased Water Use	II-10.5-8	10-56
13.	ORR—HW—Socioeconomics Impacts for Treatment	II-10.5-9	10-57
14.	ORR—HW—Infrastructure Impacts for Treatment	II-10.5-10	10-58
15.	ORR—HW—Cost	II-10.5-11	10-59

Table II-10.5-1. ORR—HW—Treatment: Estimated Number of Fatalities

HW Alternatives	Number of Treatment Sites	WM Worker Physical Hazards
No Action	2	5.6E-03
Decentralized	3	8.4E-03
Regionalized-1	5	2.0E-02
Regionalized-2	2	4.1E-02

Table II-10.5-2. ORR—HW—Treatment: Estimated Number of Cancer Incidences

HW Alternatives	Number of Treatment Sites	Treatment		
		Offsite Population Chemical Cancer Incidence	Noninvolved Worker Chemical Cancer Incidence	WM Worker Chemical Cancer Incidence
No Action	2	7.4E-03	2.5E-03	7.6E-02
Decentralized	3	1.0E-02	3.5E-03	1.0E-01
Regionalized-1	5	3.6E-02	1.1E-02	4.2E-01
Regionalized-2	2	9.5E-02	3.2E-02	1.1E+00

Table II-10.5-3. ORR—HW—Treatment: MEI Probability of Cancer Incidences

HW Alternatives	Number of Treatment Sites	Treatment	
		Offsite MEI Cancer Incidence Probability	Noninvolved MEI Cancer Incidence Probability
No Action	2	3.9E-07	2.4E-06
Decentralized	3	5.4E-07	3.3E-06
Regionalized-1	5	1.8E-06	1.1E-05
Regionalized-2	2	5.0E-06	3.1E-05
Notes: MEI = Maximally Exposed Individual			

Table II-10.5–4. ORR—HW—Treatment: Noncancer Health Risk From Chemical Exposure

HW Alternatives	Number of Treatment Sites	Treatment		
		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action	2	2.6E-03	1.6E-02	4.3E+00
Decentralized	3	7.2E-03	4.4E-02	5.3E+00
Regionalized-1	5	2.5E-02	1.5E-01	6.1E+00
Regionalized-2	2	6.6E-02	4.1E-01	6.2E+00

Notes:
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-10.5-5. ORR—HW—Emissions in Tons per Year of Criteria Air Pollutants

HW Alternatives	Number of Sites T	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--	0	0	0	0	1 (1/0)	0
Decentralized	3	3 (2/1)	5 (5/0)	0	0	0	1 (0/0)	0	0	0	0	1 (1/0)	0
Regionalized - 1	5	6 (4/2)	10 (10/0)	0	1 (1/0)	1 (1/0)	1 (1/0)	0	1 (0/0)	0	2 (2/0)	2 (2/0)	0
Regionalized - 2	2	8 (5/3)	13 (12/1)	0	1 (1/0)	1 (1/0)	1 (1/0)	0	1 (0/0)	0	2 (2/0)	2 (2/0)	0

Notes:
T = Treatment
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)

Table II-10.5-6. ORR—HW—Percent of Standard/Guideline for Criteria Air Pollutants

HW Alternatives	Number of Sites T	Construction: Percent of Tons/Year General Conformity Rule (1) CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--
Regionalized-1	5	--	--	--	--	--	--
Regionalized-2	2	--	--	--	--	--	--

HW Alternatives	Number of Sites T	Operations & Maintenance: Percent of Tons/Year Standard or Guideline (2) CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	Percent of NAAQS Concentration (3) CO	NO2	Pb	PM10	SO2	VOC
No Action	2	0	0	0	3	1	0	0	0	0	0	0	0
Decentralized	3	0	0	0	3	1	0	0	0	0	0	0	0
Regionalized-1	5	0	1	0	10	5	0	0	0	0	0	0	0
Regionalized-2	2	0	2	0	13	6	0	0	0	0	0	0	0

Notes:
T = Treatment
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) ORR is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions only.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-10.5-7. ORR—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HW Alternatives	Number of Sites T	Operations & Maintenance: Total Radionuclides	Acetone	Benzene	Bromodichloromethane	Butyl Alcohol	Carbon Tetrachloride	Chloroform	Chloromethane	Chromium VI	Cyanide	1,2-Dichloroethane	Lead
No Action	2	--	--	--	0	--	--	0	0	--	--	--	--
Decentralized	3	--	--	--	0	--	--	0	0	--	--	--	--
Regionalized - 1	5	--	--	--	0	--	--	0	0	--	--	--	--
Regionalized - 2	2	--	--	--	0	--	--	0	0	--	--	--	--

HW Alternatives	Number of Sites T	Operations & Maintenance: Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloroethane	1,2,2-Trichloro, 1,1-Trifluoroethane	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichlorofluoromethane	Vinyl Chloride
No Action	2	--	0	--	--	0	--	0	0	0	14
Decentralized	3	--	0	--	--	0	--	0	0	0	35
Regionalized - 1	5	--	0	--	--	0	--	0	0	0	120
Regionalized - 2	2	--	0	--	--	0	--	0	0	0	322

Notes:
T = Treatment
Percentages <1% are shown as zeros.
-- = Emissions of certain hazardous or toxic air pollutants, including radionuclides, from HW treatment facilities are assumed to be negligible.

Table II-10.5-8. ORR—HW—Impacts on Water Resources Due to Increased Water Use

HW Alternatives	Number of Sites T	Construction Water Use GPD	Construction % Current Use	Construction % Stream Flow	Operations Water Use GPD	Operations % Current Use	Operations % Stream Flow	Operations Waste Water % Stream Flow
No Action	2	- -	- -	- -	168	<0.1	<0.1	<0.1
Decentralized	3	516	<0.1	<0.1	367	<0.1	<0.1	<0.1
Regionalized-1	5	1373	<0.1	<0.1	1088	<0.1	<0.1	<0.1
Regionalized-2	2	2438	<0.1	<0.1	2101	<0.1	<0.1	<0.1

Notes:
T = Treatment
Water supplied by surface water in the Clinch River. Current water use = 18,300,000 gallons/day.
Wastewater discharged to the Clinch River. Average flow rate of the Clinch River = 3,003,000,000 gallons/day.
- - = Under No Action construction is not considered.
<0.1 indicates that the percentage is less than 0.1%.

Table II-10.5-9. ORR—HW—Socioeconomics Impacts for Treatment

HW Alternatives	Number of Sites	Effect of Implementation of Alternatives					
			Jobs		Income		
	T	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	2	12	15	0.01	0.2	0.00	0.00
Decentralized	3	24	31	0.01	0.4	0.00	0.00
Regionalized 1	5	60	76	0.03	0.9	0.01	0.01
Regionalized 2	2	99	126	0.04	1.4	0.02	0.01

Notes:
T = Treatment
(1) In 1990 dollars.
(2) Compared to 1990 baseline.

Table II-10.5-10. ORR—HW—Infrastructure Impacts for Treatment

HW Alternatives	Number of Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	2	0	0.00	168	0.00	168	0.00	0.13	0.02	0	0
Decentralized	3	1	0.01	516	0.00	367	0.01	0.15	0.02	9	0
Regionalized-1	5	1	0.23	1373	0.01	1088	0.03	0.31	0.05	23	0
Regionalized-2	2	2	0.04	2438	0.01	2101	0.05	0.58	0.09	10	0

Notes:
T = Treatment
GPD = Gallons per Day
MW = Megawatts Electric
(1) Based on 1991 Site Employment.

Table II-10.5-11. ORR—HW—Cost

HW Alternatives	Number of Sites	Total Cost (Millions) (1)	Government Cost by Life-Cycle Component (1)				Cost by Functional Area (1)	
							Treatment & Disposal	
	T		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Government (2) (Millions)	Commercial (Millions)
No Action	2	18	0	0	13	0	13	4
Decentralized	3	31	2	10	15	1	28	3
Regionalized-1	5	97	5	23	38	2	68	29
Regionalized-2	2	135	8	35	66	3	112	22

Notes:
T = Treatment
- - = Not considered for this site.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Functional Areas.
(2) Government costs equal to the sum of the life-cycle components.

II.11.0 PGDP

PGDP currently is custodian of significant volumes of LLMW, LLW, and TRUW. Each of the waste types is treated independently in the following sections.

II.11.1 PGDP LLMW

Fifteen tables immediately following portray the impacts of LLMW at PGDP. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	PGDP—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-11.1-1	11-2
2.	PGDP—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-11.1-2	11-3
3.	PGDP—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-11.1-3	11-4
4.	PGDP—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-11.1-4	11-5
5.	PGDP—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-11.1-5	11-6
6.	PGDP—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-11.1-6	11-7
7.	PGDP—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-11.1-7	11-8
8.	PGDP—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-11.1-8	11-9
9.	PGDP—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-11.1-9	11-10
10.	PGDP—LLMW—Impacts on Water Resources Due to Increased Water Use	II-11.1-10	11-11
11.	PGDP—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-11.1-11	11-12
12.	PGDP—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-11.1-12	11-13
13.	PGDP—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-11.1-13	11-14
14.	PGDP—LLMW—Infrastructure Impacts for Treatment and Disposal	II-11.1-14	11-15
15.	PGDP—LLMW—Cost	II-11.1-15	11-16

Table II-11.1-1. PGDP—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	1.7E-04	4.6E-03	1.8E-03	1.4E-04	- -	- -
Decentralized	37	16	2.4E-04	4.7E-02	1.2E-04	9.5E-06	1.4E-04	2.9E-03
Regionalized-1	11	12	3.9E-04	4.7E-02	1.2E-04	9.5E-06	1.4E-04	2.9E-03
Regionalized-2	7	6	1.5E-04	1.3E-02	8.1E-07	6.4E-08	- -	- -
Regionalized-3	7	1	1.5E-04	1.3E-02	8.1E-07	6.4E-08	- -	- -
Regionalized-4	4	6	1.5E-04	1.3E-02	8.1E-07	6.4E-08	- -	- -
Centralized	1	1	1.5E-04	1.3E-02	8.1E-07	6.4E-08	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-11.1-2. PGDP—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	3.6E+00	6.1E-03	1.1E-06	3.6E-04	2.8E-01	4.8E-04	5.9E-07	2.8E-06	4.4E-01	6.1E-04	6.2E-07	2.6E-05
Decentralized	37	16	2.4E-01	4.1E-04	6.5E-08	2.4E-05	1.9E-02	3.2E-05	3.4E-08	1.9E-06	6.0E-01	8.4E-04	6.2E-06	3.6E-05
Regionalized-1	11	12	2.4E-01	4.1E-04	6.5E-08	2.4E-05	1.9E-02	3.2E-05	3.4E-08	1.9E-06	9.8E-01	1.4E-03	6.2E-06	5.9E-05
Regionalized-2	7	6	1.6E-03	2.7E-06	9.7E-09	1.6E-07	1.3E-04	2.2E-07	5.1E-09	1.3E-08	3.7E-01	5.2E-04	4.9E-07	2.2E-05
Regionalized-3	7	1	1.6E-03	2.7E-06	9.7E-09	1.6E-07	1.3E-04	2.2E-07	5.1E-09	1.3E-08	3.7E-01	5.2E-04	4.9E-07	2.2E-05
Regionalized-4	4	6	1.6E-03	2.7E-06	9.7E-09	1.6E-07	1.3E-04	2.2E-07	5.1E-09	1.3E-08	3.7E-01	5.2E-04	4.9E-07	2.2E-05
Centralized	1	1	1.6E-03	2.7E-06	9.7E-09	1.6E-07	1.3E-04	2.2E-07	5.1E-09	1.3E-08	3.7E-01	5.2E-04	4.9E-07	2.2E-05

Notes:
T = Treatment
D = Disposal

Table II-11.1-3. PGDP—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	3.4E-01	4.8E-04	2.1E-05
Regionalized-1	11	12	3.4E-01	4.8E-04	2.1E-05
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-11.1-4. PGDP—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	2.0E-07	1.7E-07	- -
Decentralized	37	16	1.3E-08	1.2E-08	1.9E-06
Regionalized-1	11	12	1.3E-08	1.2E-08	1.9E-06
Regionalized-2	7	6	9.0E-11	7.9E-11	- -
Regionalized-3	7	1	9.0E-11	7.9E-11	- -
Regionalized-4	4	6	9.0E-11	7.9E-11	- -
Centralized	1	1	9.0E-11	7.9E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-11.1-5. PGDP—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	4.0E-04	6.8E-07	1.5E-10	4.0E-08	3.5E-04	6.0E-07	8.9E-10	3.5E-08	--	--	--	--
Decentralized	37	16	2.7E-05	4.5E-08	9.0E-12	2.7E-09	2.3E-05	3.9E-08	5.2E-11	2.3E-09	3.9E-03	6.6E-06	2.7E-07	3.9E-07
Regionalized-1	11	12	2.7E-05	4.5E-08	9.0E-12	2.7E-09	2.3E-05	3.9E-08	5.2E-11	2.3E-09	3.9E-03	6.6E-06	2.7E-07	3.9E-07
Regionalized-2	7	6	1.8E-07	3.1E-10	1.3E-12	1.8E-11	1.6E-07	2.7E-10	7.8E-12	1.6E-11	--	--	--	--
Regionalized-3	7	1	1.8E-07	3.1E-10	1.3E-12	1.8E-11	1.6E-07	2.7E-10	7.8E-12	1.6E-11	--	--	--	--
Regionalized-4	4	6	1.8E-07	3.1E-10	1.3E-12	1.8E-11	1.6E-07	2.7E-10	7.8E-12	1.6E-11	--	--	--	--
Centralized	1	1	1.8E-07	3.1E-10	1.3E-12	1.8E-11	1.6E-07	2.7E-10	7.8E-12	1.6E-11	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for this site

Table II-11.1-6. PGDP—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	5.5E-08	3.2E-07	5.1E-06	- -
Decentralized	37	16	4.1E-09	2.4E-08	2.9E-04	5.5E-03
Regionalized-1	11	12	4.1E-09	2.4E-08	2.9E-04	5.5E-03
Regionalized-2	7	6	5.0E-11	2.9E-10	5.1E-06	- -
Regionalized-3	7	1	5.0E-11	2.9E-10	5.1E-06	- -
Regionalized-4	4	6	5.0E-11	2.9E-10	5.1E-06	- -
Centralized	1	1	5.0E-11	2.9E-10	5.1E-06	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupationale threshold limits.

Table II-11.1-7. PGDP—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	2 (0/2)	1 (1/0)	0	0	0	0	1 (0/1)	0	0	0	0	0
Decentralized	37	16	25 (1/24)	7 (2/5)	0	0	0	3 (0/3)	7 (0/7)	1 (0/1)	0	0	0	1(0/1)
Regionalized-1	11	12	19 (1/18)	6 (2/4)	0	0	0	2 (0/2)	6 (0/6)	1 (0/1)	0	0	0	1(0/1)
Regionalized-2	7	6	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Regionalized-3	7	1	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Regionalized-4	4	6	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Centralized	1	1	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-11.1-8. PGDP—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	1 (1/0)	--	--	--	0
Decentralized	37	16	--	7 (2/5)	--	--	--	6 (0/6)
Regionalized-1	11	12	--	6 (2/4)	--	--	--	4 (0/4)
Regionalized-2	7	6	--	1 (0/1)	--	--	--	1 (0/1)
Regionalized-3	7	1	--	1 (0/1)	--	--	--	1 (0/1)
Regionalized-4	4	6	--	1 (0/1)	--	--	--	1 (0/1)
Centralized	1	1	--	1 (0/1)	--	--	--	1 (0/1)

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (4)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	0	1 (0/1)	0	1	0	2 (0/2)	0	0	0	0	0	0
Regionalized-1	11	12	0	1 (0/1)	0	1	0	1 (0/1)	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized and Regionalized -1 Alternatives.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).

Table II-11.1-9. PGDP—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-11.1-10. PGDP—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	711	<0.1	<0.1	298	<0.1	<0.1	<0.1
Decentralized	37	16	2963	<0.1	<0.1	1541	<0.1	<0.1	<0.1
Regionalized-1	11	12	2963	<0.1	<0.1	1541	<0.1	<0.1	<0.1
Regionalized-2	7	6	116	<0.1	<0.1	176	<0.1	<0.1	<0.1
Regionalized-3	7	1	116	<0.1	<0.1	176	<0.1	<0.1	<0.1
Regionalized-4	4	6	116	<0.1	<0.1	176	<0.1	<0.1	<0.1
Centralized	1	1	116	<0.1	<0.1	176	<0.1	<0.1	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by surface water in the Ohio River. Current water use = 15,000,000 gallons/day.
Wastewater discharged to the Ohio River.
Average flow rate of the Ohio River = 174,521,000,000 gallons/day.
<0.1 indicates that the percentage is less than 0.1%.

Table II-11.1-11. PGDP—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-11.1-12. PGDP—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-11.1-13. PGDP—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	37	29	0.04	0.3	0.01	0.02
Decentralized	37	16	195	194	0.24	2.1	0.09	0.11
Regionalized-1	11	12	195	194	0.24	2.1	0.09	0.11
Regionalized-2	7	6	48	48	0.06	0.5	0.02	0.02
Regionalized-3	7	1	48	48	0.06	0.5	0.02	0.02
Regionalized-4	4	6	48	48	0.06	0.5	0.02	0.02
Centralized	1	1	48	48	0.06	0.5	0.02	0.02

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-11.1-14. PGDP—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	0.66	0.025	711	0	298	0.02	0.27	0.01	14	1
Decentralized	37	16	2.33	0.087	2963	0.01	1541	0.09	0.45	0.01	185	11
Regionalized-1	11	12	2.33	0.087	2963	0.01	1541	0.09	0.45	0.01	137	8
Regionalized-2	7	6	0.27	0.01	116	0	176	0.01	0.25	0.01	39	2
Regionalized-3	7	1	0.27	0.01	116	0	176	0.01	0.25	0.01	39	2
Regionalized-4	4	6	0.27	0.01	116	0	176	0.01	0.25	0.01	39	2
Centralized	1	1	0.27	0.01	116	0	176	0.01	0.25	0.01	39	2

Notes:
T is defined as Treatment, D is defined as Disposal
(1) Based on 1991 site employment

Table II-11.1-15. PGDP—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	41	3	7	21	11	19	23	0
Decentralized	37	16	221	32	90	76	22	179	0	42
Regionalized-1	11	12	221	32	90	76	22	179	0	42
Regionalized-2	7	6	55	8	18	20	10	55	0	0
Regionalized-3	7	1	55	8	18	20	10	55	0	0
Regionalized-4	4	6	55	8	18	20	10	55	0	0
Centralized	1	1	55	8	18	20	10	55	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.11.2 PGDP LLW

Thirteen tables immediately following portray the impacts of LLW at PGDP. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	PGDP—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-11.2-1	11-18
2.	PGDP—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-11.2-2	11-19
3.	PGDP—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-11.2-3	11-20
4.	PGDP—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-11.2-4	11-21
5.	PGDP—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-11.2-5	11-22
7.	PGDP—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-11.2-6	11-23
8.	PGDP—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-11.2-7	11-24
9.	PGDP—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-11.2-8	11-25
10.	PGDP—LLW—Impacts on Water Resources Due to Increased Water Use	II-11.2-9	11-26
11.	PGDP—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-11.2-10	11-27
13.	PGDP—LLW—Socioeconomic Impacts for Treatment and Disposal	II-11.2-11	11-28
14.	PGDP—LLW—Infrastructure Impacts for Treatment and Disposal	II-11.2-12	11-29
15.	PGDP—LLW—Cost	II-11.2-13	11-30

Table II-11.2-1. PGDP—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	2.2E-03	1.1E-01	2.0E-08	1.6E-09	- -	- -
Decentralized		16	1.5E-03	1.1E-01	3.2E-07	2.5E-08	3.1E-03	1.5E-01
Regionalized-1		12	1.5E-03	1.1E-01	3.2E-07	2.5E-08	3.0E-03	1.5E-01
Regionalized-2	11	12	1.7E-03	1.8E-01	1.9E-06	1.5E-07	2.8E-03	1.3E-01
Regionalized-3		6	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Regionalized-4	7	6	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Regionalized-5	4	6	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Regionalized-6		2	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Regionalized-7		2	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Centralized-1		1	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Centralized-2		1	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Centralized-3	7	1	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Centralized-4	7	1	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -
Centralized-5	1	1	1.5E-03	1.1E-01	2.1E-08	1.7E-09	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-11.2-2. PGDP—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

Noninvolved Worke	Number of Sites		Offsite Population			Noninvolved Workers			WM Workers		
LLW Alternatives	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	4.0E-05	6.9E-08	4.0E-09	3.2E-06	5.4E-09	3.2E-10	5.6E+00	7.8E-03	3.3E-04
Decentralized		16	6.4E-04	1.1E-06	6.4E-08	5.1E-05	8.6E-08	5.8E-09	3.7E+00	5.2E-03	2.2E-04
Regionalized-1		12	6.4E-04	1.1E-06	6.4E-08	5.1E-05	8.6E-08	5.8E-09	3.7E+00	5.2E-03	2.2E-04
Regionalized-2	11	12	3.8E-03	6.4E-06	3.8E-07	3.0E-04	5.1E-07	3.0E-08	4.1E+00	5.8E-03	2.5E-04
Regionalized-3		6	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Regionalized-4	7	6	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Regionalized-5	4	6	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Regionalized-6		2	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Regionalized-7		2	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Centralized-1		1	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Centralized-2		1	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Centralized-3	7	1	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Centralized-4	7	1	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04
Centralized-5	1	1	4.2E-05	7.2E-08	4.2E-09	3.3E-06	5.7E-09	3.3E-10	3.7E+00	5.2E-03	2.2E-04

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-3. PGDP—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	7.6E+00	1.1E-02	4.6E-04
Regionalized-1		12	7.6E+00	1.1E-02	4.6E-04
Regionalized-2	11	12	6.9E+00	9.7E-03	4.2E-04
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-4. PGDP—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	2.3E-12	2.0E-12	- -
Decentralized		16	3.6E-11	3.1E-11	9.3E-05
Regionalized-1		12	3.6E-11	3.1E-11	9.3E-05
Regionalized-2	11	12	2.1E-10	1.8E-10	1.2E-04
Regionalized-3		6	2.3E-12	2.0E-12	- -
Regionalized-4	7	6	2.4E-12	2.0E-12	- -
Regionalized-5	4	6	2.4E-12	2.0E-12	- -
Regionalized-6		2	2.3E-12	2.0E-12	- -
Regionalized-7		2	2.3E-12	2.0E-12	- -
Centralized-1		1	2.3E-12	2.0E-12	- -
Centralized-2		1	2.3E-12	2.0E-12	- -
Centralized-3	7	1	2.4E-12	2.1E-12	- -
Centralized-4	7	1	2.4E-12	2.1E-12	- -
Centralized-5	1	1	2.4E-12	2.1E-12	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-5. PGDP—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	4.5E-09	7.6E-12	4.5E-13	3.9E-09	6.6E-12	3.9E-13	--	--	--
Decentralized		16	7.2E-08	1.2E-10	7.2E-12	6.2E-08	1.1E-10	6.2E-12	1.9E-01	6.8E-05	1.9E-05
Regionalized-1		12	7.2E-08	1.2E-10	7.2E-12	6.2E-08	1.1E-10	6.2E-12	1.9E-01	6.8E-05	1.9E-05
Regionalized-2	11	12	4.2E-07	7.1E-10	4.2E-11	3.6E-07	6.2E-10	3.6E-11	2.5E-01	4.2E-04	2.5E-05
Regionalized-3		6	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Regionalized-4	7	6	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Regionalized-5	4	6	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Regionalized-6		2	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Regionalized-7		2	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Centralized-1		1	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Centralized-2		1	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Centralized-3	7	1	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Centralized-4	7	1	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--
Centralized-5	1	1	4.7E-09	8.0E-12	4.7E-13	4.1E-09	7.0E-12	4.1E-13	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-6. PGDP—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	15 (4/11)	13 (11/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Decentralized		16	50 (33/17)	88 (85/3)	0	7 (7/0)	8 (8/0)	10 (8/2)	35 (1/34)	10 (3/7)	0	0	0	4 (0/4)
Regionalized-1		12	50 (33/17)	88 (85/3)	0	7 (7/0)	8 (8/0)	10 (8/2)	35 (1/34)	10 (3/7)	0	0	0	4 (0/4)
Regionalized-2	11	12	63 (28/35)	81 (74/7)	0	6 (6/0)	7 (7/0)	11 (7/4)	43 (1/42)	10 (2/8)	0	1 (1/0)	0	5 (0/5)
Regionalized-3		6	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Regionalized-4	7	6	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Regionalized-5	4	6	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Regionalized-6		2	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Regionalzied-7		2	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Centralized-1		1	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Centralized-2		1	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Centralized-3	7	1	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Centralized-4	7	1	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)
Centralized-5	1	1	18 (1/17)	7 (4/3)	0	0	0	2 (0/2)	14 (0/14)	3 (0/3)	0	0	0	2 (0/2)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-7. PGDP—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	13 (11/2)	--	--	--	5 (2/3)
Decentralized		16	--	66 (65/3)	--	--	--	20 (16/4)
Regionalized-1		12	--	66 (65/3)	--	--	--	20 (16/4)
Regionalized-2	11	12	--	61 (7/4/7)	--	--	--	22 (14/8)
Regionalized-3		6	--	7 (4/3)	--	--	--	5 (1/4)
Regionalized-4	7	6	--	7 (4/3)	--	--	--	5 (1/4)
Regionalized-5	4	6	--	7 (4/3)	--	--	--	5 (1/4)
Regionalized-6		2	--	7 (4/3)	--	--	--	5 (1/4)
Regionalzied-7		2	--	7 (4/3)	--	--	--	5 (1/4)
Centralized-1		1	--	7 (4/3)	--	--	--	5 (1/4)
Centralized-2		1	--	7 (4/3)	--	--	--	5 (1/4)
Centralized-3	7	1	--	7 (4/3)	--	--	--	5 (1/4)
Centralized-4	7	1	--	7 (4/3)	--	--	--	5 (1/4)
Centralized-5	1	1	--	7 (4/3)	--	--	--	5 (1/4)

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (4)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	2 (0/2)	0	0	0	2 (0/2)	--	--	--	--	--	--
Decentralized		16	1	10 (3/7)	0	3	0	8 (0/8)	--	--	--	--	--	--
Regionalized-1		12	1	10 (3/7)	0	3	0	8 (0/8)	--	--	--	--	--	--
Regionalized-2	11	12	1	11 (3/8)	0	4	0	10 (0/10)	0	0	0	0	0	0
Regionalized-3		6	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Regionalized-4	7	6	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Regionalized-5	4	6	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Regionalized-6		2	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Regionalzied-7		2	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Centralized-1		1	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Centralized-2		1	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Centralized-3	7	1	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Centralized-4	7	1	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Centralized-5	1	1	0	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all but the Regionalized-2 Alternative are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-8. PGDP—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance												
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-9. PGDP—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	2968	<0.1	<0.1	1682	<0.1	<0.1	<0.1
Decentralized		16	76679	0.5	<0.1	4569	<0.1	<0.1	<0.1
Regionalized-1		12	76679	0.5	<0.1	4569	<0.1	<0.1	<0.1
Regionalized-2	11	12	67852	0.5	<0.1	5847	<0.1	<0.1	<0.1
Regionalized-3		6	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Regionalized-4	7	6	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Regionalized-5	4	6	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Regionalized-6		2	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Regionalized-7		2	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Centralized-1		1	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Centralized-2		1	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Centralized-3	7	1	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Centralized-4	7	1	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1
Centralized-5	1	1	4926	<0.1	<0.1	1918	<0.1	<0.1	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by surface water in the Ohio River. Current water use = 15,000,000 gallons/day.
Wastewater discharged to the Ohio River. Average flow rate of the Ohio River = 174,521,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
<0.1 indicates that the percentage is less than 0.1%.

Table II-11.2-10. PGDP—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-11.2-11. PGDP—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	268	213	0.27	2.3	0.10	0.14
Decentralized		16	559	555	0.70	6.1	0.26	0.34
Regionalized-1		12	559	555	0.70	6.1	0.26	0.34
Regionalized-2	11	12	704	700	0.88	7.7	0.32	0.44
Regionalized-3		6	244	242	0.30	2.7	0.11	0.15
Regionalized-4	7	6	244	242	0.30	2.7	0.11	0.15
Regionalized-5	4	6	244	242	0.30	2.7	0.11	0.15
Regionalized-6		2	244	242	0.30	2.7	0.11	0.15
Regionalized-7		2	244	242	0.30	2.7	0.11	0.15
Centralized-1		1	244	242	0.30	2.7	0.11	0.15
Centralized-2		1	244	242	0.30	2.7	0.11	0.15
Centralized-3	7	1	244	242	0.30	2.7	0.11	0.15
Centralized-4	7	1	244	242	0.30	2.7	0.11	0.15
Centralized-5	1	1	244	242	0.30	2.7	0.11	0.15

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-12. PGDP—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	2.9	0.11	2968	0.01	1682	0.10	0.38	0.01	82	5
Decentralized		16	11.2	0.42	76679	0.23	4569	0.26	11.31	0.32	283	16
Regionalized-1		12	11.2	0.42	76679	0.23	4569	0.26	11.31	0.32	283	16
Regionalized-2	11	12	7.7	0.29	67852	0.26	5847	0.34	9.76	0.37	410	24
Regionalized-3		6	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Regionalized-4	7	6	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Regionalized-5	4	6	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Regionalized-6		2	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Regionalized-7		2	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Centralized-1		1	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Centralized-2		1	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Centralized-3	7	1	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Centralized-4	7	1	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7
Centralized-5	1	1	4.2	0.14	4926	0.02	1918	0.11	0.52	0.02	130	7

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-11.2-13. PGDP—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	303	14	39	238	12	303	0	0
Decentralized		16	632	47	134	388	63	286	0	346
Regionalized-1		12	632	47	134	388	63	286	0	346
Regionalized-2	11	12	797	79	183	470	65	485	0	312
Regionalized-3		6	276	22	60	174	20	276	0	0
Regionalized-4	7	6	276	22	60	174	20	276	0	0
Regionalized-5	4	6	276	22	60	174	20	276	0	0
Regionalized-6		2	276	22	60	174	20	276	0	0
Regionalized-7		2	276	22	60	174	20	276	0	0
Centralized-1		1	276	22	60	174	20	276	0	0
Centralized-2		1	276	22	60	174	20	276	0	0
Centralized-3	7	1	276	22	60	174	20	276	0	0
Centralized-4	7	1	276	22	60	174	20	276	0	0
Centralized-5	1	1	276	22	60	174	20	276	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.11.3 PGDP TRUW

Twelve tables immediately following portray the impacts of TRUW at PGDP. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	PGDP—TRUW—Treatment: Estimated Number of Fatalities	II-11.3-1	11-32
2.	PGDP—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-11.3-2	11-33
4.	PGDP—TRUW—Treatment: MEI Probability of Cancer Fatality	II-11.3-3	11-34
5.	PGDP—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-11.3-4	11-35
6.	PGDP—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-11.3-5	11-36
7.	PGDP—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-11.3-6	11-37
8.	PGDP—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-11.3-7	11-38
9.	PGDP—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-11.3-8	11-39
10.	PGDP—TRUW—Impacts on Water Resources Due to Increased Water Use	II-11.3-9	11-40
13.	PGDP—TRUW—Socioeconomic Impacts for Treatment	II-11.3-10	11-41
14.	PGDP—TRUW—Infrastructure Impacts for Treatment	II-11.3-11	11-42
15.	PGDP—TRUW—Cost	II-11.3-12	11-43

Table II-11.3-1. PGDP—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure
	CH Treat	RH Treat		Radiation Exposure	Physical Hazards		
No Action **	16	5	WIPP WAC	--	--	--	--
Decentralized ***	16	5	WIPP WAC	4.6E-07	1.3E-02	3.5E-09	2.7E-10
Regionalized-1	5	2	Reduce Gas	4.7E-07	2.5E-03	5.3E-09	4.1E-10
Regionalized-2	5	2	LDR	4.7E-07	2.5E-03	5.3E-09	4.1E-10
Regionalized-3	3	2	LDR	4.7E-07	2.5E-03	5.3E-09	4.1E-10
Centralized	WIPP	2	LDR	4.7E-07	2.5E-03	5.3E-09	4.1E-10

Notes:
-- = Treatment is not considered for this alternative.
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-11.3-2. PGDP—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	7.0E-06	1.2E-08	3.6E-13	7.0E-10	5.4E-07	9.2E-10	1.9E-13	5.4E-11	1.2E-03	1.6E-06	9.6E-13	6.9E-08
Regionalized-1	5	2	Reduce Gas	1.1E-05	1.8E-08	9.5E-13	1.1E-09	8.2E-07	1.4E-09	5.0E-13	8.2E-11	1.2E-03	1.7E-06	2.8E-12	7.1E-08
Regionalized-2	5	2	LDR	1.1E-05	1.8E-08	9.5E-13	1.1E-09	8.2E-07	1.4E-09	5.0E-13	8.2E-11	1.2E-03	1.7E-06	2.8E-12	7.1E-08
Regionalized-3	3	2	LDR	1.1E-05	1.8E-08	9.5E-13	1.1E-09	8.2E-07	1.4E-09	5.0E-13	8.2E-11	1.2E-03	1.7E-06	2.8E-12	7.1E-08
Centralized	WIPP	2	LDR	1.1E-05	1.8E-08	9.5E-13	1.1E-09	8.2E-07	1.4E-09	5.0E-13	8.2E-11	1.2E-03	1.7E-06	2.8E-12	7.1E-08

Notes:
-- = Treatment is not considered for this alternative.
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-11.3-3. PGDP—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	- -	- -
Decentralized***	16	5	WIPP WAC	3.9E-13	3.3E-13
Regionalized-1	5	2	Reduce Gas	5.9E-13	5.0E-13
Regionalized-2	5	2	LDR	5.9E-13	5.0E-13
Regionalized-3	3	2	LDR	5.9E-13	5.0E-13
Centralized	WIPP	2	LDR	5.9E-13	5.0E-13

Notes:
- - = Treatment is not considered under this alternative
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-11.3-4. PGDP—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite Population MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	--	--	--	--	--	--	--	--
Decentralized ***	16	5	WIPP WAC	7.8E-10	1.3E-12	<9.9E-14	7.8E-14	6.7E-10	1.1E-12	<9.9E-14	6.7E-14
Regionalized-1	5	2	Reduce Gas	1.2E-09	2.0E-12	<9.9E-14	1.2E-13	1.0E-09	1.7E-12	<9.9E-14	1.0E-13
Regionalized-2	5	2	LDR	1.2E-09	2.0E-12	<9.9E-14	1.2E-13	1.0E-09	1.7E-12	<9.9E-14	1.0E-13
Regionalized-3	3	2	LDR	1.2E-09	2.0E-12	<9.9E-14	1.2E-13	1.0E-09	1.7E-12	<9.9E-14	1.0E-13
Centralized	WIPP	2	LDR	1.2E-09	2.0E-12	<9.9E-14	1.2E-13	1.0E-09	1.7E-12	<9.9E-14	1.0E-13

Notes:
-- = Treatment is not considered for this alternative.
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites then to WIPP.
MEI = Maximally Exposed Individual

Table II-11.3-5. PGDP—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment		
	CH Treat	RH Treat		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	--	--	--
Decentralized***	16	5	WIPP WAC	8.0E-14	5.0E-13	2.6E-10
Regionalized-1	5	2	Reduce Gas	2.0E-13	1.0E-12	1.6E-09
Regionalized-2	5	2	LDR	2.0E-13	1.0E-12	1.6E-09
Regionalized-3	3	2	LDR	2.0E-13	1.0E-12	1.6E-09
Centralized	WIPP	2	LDR	2.1E-13	1.2E-12	1.6E-09

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Treatment is not considered under this alternative.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits

Table II-11.3-6. PGDP—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -	0	0	0	0	0	0
Decentralized***	16	5	WIPP WAC	2 (0/2)	1 (0/1)	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-1	5	2	Reduce Gas	2 (0/2)	1 (0/1)	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-2	5	2	LDR	3 (0/3)	2 (1/1)	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-3	3	2	LDR	3 (0/3)	2 (1/1)	0	0	0	0	1 (0/1)	0	0	0	0	0
Centralized	WIPP	2	LDR	3 (0/3)	2 (1/1)	0	0	0	0	1 (0/1)	0	0	0	0	0

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-11.3-7. PGDP—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	--	1 (1/0)	--	--	--	0
Regionalized-1	5	2	Reduce Gas	--	1 (1/0)	--	--	--	0
Regionalized-2	5	2	LDR	--	2 (1/1)	--	--	--	1 (0/1)
Regionalized-3	3	2	LDR	--	2 (1/1)	--	--	--	1 (0/1)
Centralized	WIPP	2	LDR	--	2 (1/1)	--	--	--	1 (0/1)

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (5)	Pb (4)	PM10 (4)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR only applies to pollutants in nonattainment.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions % of mobile-source emissions).
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-11.3-8. PGDP—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-11.3-9. PGDP—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	171	<0.1	<0.1	<0.1
Decentralized***	16	5	WIPP WAC	529	<0.1	<0.1	200	<0.1	<0.1	<0.1
Regionalized-1	5	2	Reduce Gas	529	<0.1	<0.1	200	<0.1	<0.1	<0.1
Regionalized-2	5	2	LDR	880	<0.1	<0.1	200	<0.1	<0.1	<0.1
Regionalized-3	3	2	LDR	880	<0.1	<0.1	200	<0.1	<0.1	<0.1
Centralized	WIPP	2	LDR	880	<0.1	<0.1	200	<0.1	<0.1	<0.1

Notes:
Water supplied by surface water in the Ohio River. Current water use = 15,000,000 gallons/day.
Wastewater discharged to the Ohio River. Average flow rate of the Ohio River = 174,521,000,000 gallons/day.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
<0.1 indicates that the precentage is less than 0.1%.

Table II-11.3-10. PGDP—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	29	23	0.03	0.2	0.01	0.01
Decentralized***	16	5	WIPP WAC	42	42	0.05	0.5	0.02	0.02
Regionalized-1	5	2	Reduce Gas	42	42	0.05	0.5	0.02	0.02
Regionalized-2	5	2	LDR	52	52	0.07	0.6	0.02	0.03
Regionalized-3	3	2	LDR	52	52	0.07	0.6	0.02	0.03
Centralized	WIPP	2	LDR	52	52	0.07	0.6	0.02	0.03

Notes:
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-11.3-11. PGDP—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	171	0.00	171	0.01	0.17	0.01	0	0.00
Decentralized***	16	5	WIPP WAC	0.6	0.02	529	0.00	200	0.01	0.18	0.01	24	1.30
Regionalized-1	5	2	Reduce Gas	0.6	0.02	529	0.00	200	0.01	0.26	0.01	24	1.30
Regionalized-2	5	2	LDR	0.6	0.02	880	0.00	200	0.01	0.25	0.01	35	2.00
Regionalized-3	3	2	LDR	0.6	0.02	880	0.00	200	0.01	0.25	0.01	35	2.00
Centralized	WIPP	2	LDR	0.6	0.02	880	0.00	200	0.01	0.25	0.01	35	2.00

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-11.3-12. PGDP—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	16	5	WIPP - WAC	32	0	0	28	4	0	32	0
Decentralized***	16	5	WIPP - WAC	48	5	10	28	5	0	48	0
Regionalized-1	5	2	Reduce Gas	48	5	10	28	5	0	48	0
Regionalized-2	5	2	LDR	59	5	19	30	5	0	59	0
Regionalized-3	3	2	LDR	59	5	19	30	5	0	59	0
Centralized	WIPP	2	LDR	59	5	19	30	5	0	59	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.12.0 Pantex Plant

Pantex currently is custodian of significant volumes of LLMWs and LLW. Each of the waste types is treated independently in the following sections.

II.12.1 Pantex LLMW

Fifteen tables immediately following portray the impacts of LLMW at Pantex. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	Pantex—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-12.1-1	12-2
2.	Pantex—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-12.1-2	12-3
3.	Pantex—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-12.1-3	12-4
4.	Pantex—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-12.1-4	12-5
5.	Pantex—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-12.1-5	12-6
6.	Pantex—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-12.1-6	12-7
7.	Pantex—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-12.1-7	12-8
8.	Pantex—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-12.1-8	12-9
9.	Pantex—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-12.1-9	12-10
10.	Pantex—LLMW—Impacts on Water Resources Due to Increased Water Use	II-12.1-10	12-11
11.	Pantex—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-12.1-11	12-12
12.	Pantex—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-12.1-12	12-13
13.	Pantex—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-12.1-13	12-14
14.	Pantex—LLMW—Infrastructure Impacts for Treatment and Disposal	II-12.1-14	12-15
15.	Pantex—LLMW—Cost	II-12.1-15	12-16

Table II-12.1-1. Pantex—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	1.8E-04	3.8E-03	1.1E-06	2.8E-07	- -	- -
Decentralized	37	16	3.4E-04	3.8E-02	3.5E-05	3.5E-06	3.0E-04	4.8E-03
Regionalized-1	11	12	3.4E-04	3.8E-02	3.5E-05	3.5E-06	3.0E-04	4.8E-03
Regionalized-2	7	6	1.7E-04	1.4E-02	2.3E-06	2.3E-07	- -	- -
Regionalized-3	7	1	1.7E-04	1.4E-02	2.3E-06	2.3E-07	- -	- -
Regionalized-4	4	6	1.7E-04	1.4E-02	2.3E-06	2.3E-07	- -	- -
Centralized	1	1	1.7E-04	1.4E-02	2.3E-06	2.3E-07	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-12.1-2. Pantex—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	2.2E-03	3.8E-06	7.0E-08	2.2E-07	5.6E-04	9.5E-07	8.0E-08	5.6E-08	4.4E-01	6.1E-04	7.3E-08	2.6E-05
Decentralized	37	16	6.9E-02	1.2E-04	3.5E-09	6.9E-06	6.9E-03	1.2E-05	4.0E-09	6.9E-07	8.4E-01	1.2E-03	8.2E-07	5.0E-05
Regionalized-1	11	12	6.9E-02	1.2E-04	3.5E-09	6.9E-06	6.9E-03	1.2E-05	4.0E-09	6.9E-07	8.4E-01	1.2E-03	8.2E-07	5.0E-05
Regionalized-2	7	6	4.7E-03	8.0E-06	3.6E-10	4.7E-07	4.7E-04	7.9E-07	4.1E-10	4.7E-08	4.2E-01	5.8E-04	5.5E-08	2.5E-05
Regionalized-3	7	1	4.7E-03	8.0E-06	3.6E-10	4.7E-07	4.7E-04	7.9E-07	4.1E-10	4.7E-08	4.2E-01	5.8E-04	5.5E-08	2.5E-05
Regionalized-4	4	6	4.7E-03	8.0E-06	3.6E-10	4.7E-07	4.7E-04	7.9E-07	4.1E-10	4.7E-08	4.2E-01	5.8E-04	5.5E-08	2.5E-05
Centralized	1	1	4.7E-03	8.0E-06	3.6E-10	4.7E-07	4.7E-04	7.9E-07	4.1E-10	4.7E-08	4.2E-01	5.8E-04	5.5E-08	2.5E-05

Notes:
T = Treatment
D = Disposal

Table II-12.1-3. Pantex—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	7.6E-01	1.1E-03	4.6E-05
Regionalized-1	11	12	7.6E-01	1.1E-03	4.6E-05
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-12.1-4. Pantex—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	9.2E-11	5.2E-10	- -
Decentralized	37	16	2.9E-09	6.6E-09	6.7E-07
Regionalized-1	11	12	2.9E-09	6.6E-09	6.7E-07
Regionalized-2	7	6	2.0E-10	4.4E-10	- -
Regionalized-3	7	1	2.0E-10	4.4E-10	- -
Regionalized-4	4	6	2.0E-10	4.4E-10	- -
Centralized	1	1	2.0E-10	4.4E-10	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-12.1-5. Pantex—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	1.8E-07	3.1E-10	5.8E-12	1.8E-11	1.1E-06	1.8E-09	1.4E-10	1.1E-10	--	--	--	--
Decentralized	37	16	5.9E-06	1.0E-08	2.9E-13	5.9E-10	1.3E-05	2.2E-08	6.8E-12	1.3E-09	1.3E-03	2.3E-06	1.2E-06	1.3E-07
Regionalized-1	11	12	5.9E-06	1.0E-08	2.9E-13	5.9E-10	1.3E-05	2.2E-08	6.8E-12	1.3E-09	1.3E-03	2.3E-06	1.23-06	1.3E-07
Regionalized-2	7	6	4.0E-07	6.8E-10	3.0E-14	4.0E-11	8.9E-07	1.5E-09	7.0E-13	8.9E-11	--	--	--	--
Regionalized-3	7	1	4.0E-07	6.8E-10	3.0E-14	4.0E-11	8.9E-07	1.5E-09	7.0E-13	8.9E-11	--	--	--	--
Regionalized-4	4	6	4.0E-07	6.8E-10	3.0E-14	4.0E-11	8.9E-07	1.5E-09	7.0E-13	8.9E-11	--	--	--	--
Centralized	1	1	4.0E-07	6.8E-10	3.0E-14	4.0E-11	8.9E-07	1.5E-09	7.0E-13	8.9E-11	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for this alternative.

Table II-12.1-6. Pantex—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	8.3E-09	2.0E-07	1.3E-06	- -
Decentralized	37	16	1.3E-09	3.0E-08	4.2E-05	4.0E-03
Regionalized-1	11	12	1.3E-09	3.0E-08	4.2E-05	4.0E-03
Regionalized-2	7	6	7.5E-12	1.8E-10	1.3E-06	- -
Regionalized-3	7	1	7.5E-12	1.8E-10	1.3E-06	- -
Regionalized-4	4	6	7.5E-12	1.8E-10	1.3E-06	- -
Centralized	1	1	7.5E-12	1.8E-10	1.3E-06	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-12.1-7. Pantex—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	2 (0/1)	1 (1/0)	0	0	0	0	1 (0/1)	0	0	0	0	0
Decentralized	37	16	22 (2/20)	9 (5/4)	0	0	0	2 (0/2)	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-1	11	12	21 (2/19)	9 (5/4)	0	0	0	2 (0/2)	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	7	6	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Regionalized-3	7	1	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Regionalized-4	4	6	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Centralized	1	1	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-12.1-8. Pantex—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized-1	11	12	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	0	1	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	0	1	0	1	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	1	0	1	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Pantex is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized and Regionalized-1 Alternatives.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-12.1-9. Pantex—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-12.1-10. Pantex—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	711	0.1	- -	305	0.1	- -	- -
Decentralized	37	16	4499	0.8	- -	1457	0.3	- -	- -
Regionalized-1	11	12	4499	0.8	- -	1457	0.3	- -	- -
Regionalized-2	7	6	116	<0.1	- -	387	0.1	- -	- -
Regionalized-3	7	1	116	<0.1	- -	387	0.1	- -	- -
Regionalized-4	4	6	116	<0.1	- -	387	0.1	- -	- -
Centralized	1	1	116	<0.1	- -	387	0.1	- -	- -

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Ogallala Aquifer. Current water use = 548,000 gallons/day.
Wastewater discharged to onsite playas.
- - = Stream Flow and Waste Water Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-12.1-11. Pantex—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites T	D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized	1	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

LLMW Alternatives	Number of Sites T	D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized	1	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-12.1-12. Pantex—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	1	0	0	2	0	0	0
Regionalized-1	11	12	1	0	0	2	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-12.1-13. Pantex—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	33	28	0.03	0.3	0.01	0.02
Decentralized	37	16	169	175	0.17	1.9	0.06	0.07
Regionalized-1	11	12	169	175	0.17	1.9	0.06	0.07
Regionalized-2	7	6	60	62	0.06	0.7	0.02	0.02
Regionalized-3	7	1	60	62	0.06	0.7	0.02	0.02
Regionalized-4	4	6	60	62	0.06	0.7	0.02	0.02
Centralized	1	1	60	62	0.06	0.7	0.02	0.02

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-12.1-14. Pantex—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	0.66	0.009	711	0.05	305	0.06	0.24	0.02	11	0.4
Decentralized	37	16	3.68	0.048	4499	0.3	1457	0.27	0.45	0.03	158	5
Regionalized-1	11	12	3.68	0.048	4499	0.3	1457	0.27	0.45	0.03	144	5
Regionalized-2	7	6	0.27	0.003	387	0.03	387	0.07	0.16	0.01	39	1
Regionalized-3	7	1	0.27	0.003	387	0.03	387	0.07	0.16	0.01	39	1
Regionalized-4	4	6	0.27	0.003	387	0.03	387	0.07	0.16	0.01	39	1
Centralized	1	1	0.27	0.003	387	0.03	387	0.07	0.16	0.01	39	1

Notes:
T is defined as Treatment, D is defined as Disposal
(1) Based on 1991 site employment

Table II-12.1-15. Pantex—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	38	3	4	21	11	15	23	0
Decentralized	37	16	192	32	68	81	11	152	0	40
Regionalized-1	11	12	192	32	68	81	11	152	0	40
Regionalized-2	7	6	68	8	18	32	11	68	0	0
Regionalized-3	7	1	68	8	18	32	11	68	0	0
Regionalized-4	4	6	68	8	18	32	11	68	0	0
Centralized	1	1	68	8	18	32	11	68	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.12.2 Pantex LLW

Thirteen tables immediately following portray the impacts of LLW at Pantex. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	Pantex—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-12.2-1	12-18
2.	Pantex—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-12.2-2	12-19
3.	Pantex—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-12.2-3	12-20
4.	Pantex—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-12.2-4	12-21
5.	Pantex—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-12.2-5	12-22
7.	Pantex—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-12.2-6	12-23
8.	Pantex—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-12.2-7	12-24
9.	Pantex—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-12.2-8	12-25
10.	Pantex—LLW—Impacts on Water Resources Due to Increased Water Use	II-12.2-9	12-26
11.	Pantex—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-12.2-10	12-27
13.	Pantex—LLW—Socioeconomic Impacts for Treatment and Disposal	II-12.2-11	12-28
14.	Pantex—LLW—Infrastructure Impacts for Treatment and Disposal	II-12.2-12	12-29
15.	Pantex—LLW—Cost	II-12.2-13	12-30

Table II-12.2-1. Pantex—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	9.7E-04	2.9E-02	8.8E-07	8.7E-08	- -	- -
Decentralized		16	7.8E-04	2.5E-02	4.4E-07	4.4E-08	5.8E-04	2.1E-02
Regionalized-1		12	7.8E-04	2.5E-02	4.4E-07	4.4E-08	5.8E-04	2.1E-02
Regionalized-2	11	12	7.8E-04	2.5E-02	4.4E-07	4.4E-08	5.8E-04	2.1E-02
Regionalized-3		6	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Regionalized-4	7	6	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Regionalized-5	4	6	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Regionalized-6		2	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Regionalized-7		2	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Centralized-1		1	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Centralized-2		1	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Centralized-3	7	1	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Centralized-4	7	1	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -
Centralized-5	1	1	7.8E-04	2.5E-02	4.4E-07	4.4E-08	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-12.2-2. Pantex—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	1.8E-03	3.0E-06	1.8E-07	1.7E-04	3.0E-07	1.7E-08	2.4E+00	3.4E-03	1.5E-04
Decentralized		16	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Regionalized-1		12	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Regionalized-2	11	12	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Regionalized-3		6	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Regionalized-4	7	6	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Regionalized-5	4	6	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Regionalized-6		2	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Regionalized-7		2	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Centralized-1		1	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Centralized-2		1	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Centralized-3	7	1	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Centralized-4	7	1	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04
Centralized-5	1	1	8.8E-04	1.5E-06	8.8E-08	8.7E-05	1.5E-07	8.7E-09	1.9E+00	2.7E-03	1.2E-04

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2-3. Pantex—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	1.5E+00	2.0E-03	8.7E-05
Regionalized-1		12	1.5E+00	2.0E-03	8.7E-05
Regionalized-2	11	12	1.5E+00	2.0E-03	8.7E-05
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2–4. Pantex—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	7.5E-11	1.7E-10	- -
Decentralized		16	3.7E-11	8.3E-11	<9.9E-14
Regionalized-1		12	3.7E-11	8.3E-11	<9.9E-14
Regionalized-2	11	12	3.7E-11	8.3E-11	<9.9E-14
Regionalized-3		6	3.7E-11	8.3E-11	- -
Regionalized-4	7	6	3.7E-11	8.3E-11	- -
Regionalized-5	4	6	3.7E-11	8.3E-11	- -
Regionalized-6		2	3.7E-11	8.3E-11	- -
Regionalized-7		2	3.7E-11	8.3E-11	- -
Centralized-1		1	3.7E-11	8.3E-11	- -
Centralized-2		1	3.7E-11	8.3E-11	- -
Centralized-3	7	1	3.7E-11	8.3E-11	- -
Centralized-4	7	1	3.7E-11	8.3E-11	- -
Centralized-5	1	1	3.7E-11	8.3E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2-5. Pantex—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	1.5E-07	2.5E-10	1.5E-11	3.3E-07	5.6E-10	3.3E-11	- -	- -	- -
Decentralized		16	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-1		12	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-2	11	12	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	<9.9E-14	<9.9E-14	<9.9E-14
Regionalized-3		6	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Regionalized-4	7	6	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Regionalized-5	4	6	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Regionalized-6		2	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Regionalized-7		2	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Centralized-1		1	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Centralized-2		1	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Centralized-3	7	1	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Centralized-4	7	1	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -
Centralized-5	1	1	7.5E-08	1.3E-10	7.5E-12	1.7E-07	2.8E-10	1.7E-11	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2-6. Pantex—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Decentralized		16	16 (4/12)	13 (11/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-1		12	16 (4/12)	13 (11/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-2	11	12	20 (7/13)	21 (18/3)	0	1 (1/0)	2 (2/0)	4 (2/2)	12 (0/12)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-3		6	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Regionalized-4	7	6	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Regionalized-5	4	6	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Regionalized-6		2	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Regionalzied-7		2	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Centralized-1		1	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Centralized-2		1	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Centralized-3	7	1	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Centralized-4	7	1	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)
Centralized-5	1	1	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	10 (0/10)	3 (0/3)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2-7. Pantex—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1		12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	7	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-5	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-6		2	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-7		2	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-1		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-2		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-4	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-5	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Pantex is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2-8. Pantex—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2-9. Pantex—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	1977	0.4	- -	671	0.1	- -	- -
Decentralized		16	2960	0.5	- -	933	0.2	- -	- -
Regionalized-1		12	2960	0.5	- -	933	0.2	- -	- -
Regionalized-2	11	12	4600	0.8	- -	3691	0.7	- -	- -
Regionalized-3		6	1977	0.4	- -	671	0.1	- -	- -
Regionalized-4	7	6	1977	0.4	- -	671	0.1	- -	- -
Regionalized-5	4	6	1977	0.4	- -	671	0.1	- -	- -
Regionalized-6		2	1977	0.4	- -	671	0.1	- -	- -
Regionalized-7		2	1977	0.4	- -	671	0.1	- -	- -
Centralized-1		1	1977	0.4	- -	671	0.1	- -	- -
Centralized-2		1	1977	0.4	- -	671	0.1	- -	- -
Centralized-3	7	1	1977	0.4	- -	671	0.1	- -	- -
Centralized-4	7	1	1977	0.4	- -	671	0.1	- -	- -
Centralized-5	1	1	1977	0.4	- -	671	0.1	- -	- -

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Ogallala Aquifer. Current water use = 548,000 gallons/day.
Wastewater discharged to onsite playas.
** Ten sites use existing facilities for Volume Reduction.
- - = Stream Flow is not considered for this site.

Table II-12.2-10. Pantex—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 236	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-12.2-11. Pantex—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income	% ROI Population Increase (2)
No Action	10**	6	120	124	0.12	1.3	0.04	0.09
Decentralized		16	191	197	0.19	2.1	0.06	0.09
Regionalized-1		12	191	197	0.19	2.1	0.06	0.09
Regionalized-2	11	12	197	203	0.20	2.2	0.07	0.09
Regionalized-3		6	120	124	0.12	1.3	0.04	0.09
Regionalized-4	7	6	120	124	0.12	1.3	0.04	0.09
Regionalized-5		6	120	124	0.12	1.3	0.04	0.09
Regionalized-6		2	120	124	0.12	1.3	0.04	0.09
Regionalized-7		2	120	124	0.12	1.3	0.04	0.09
Centralized-1		1	120	124	0.12	1.3	0.04	0.09
Centralized-2		1	120	124	0.12	1.3	0.04	0.09
Centralized-3	7	1	120	124	0.12	1.3	0.04	0.09
Centralized-4	7	1	120	124	0.12	1.3	0.04	0.09
Centralized-5	1	1	120	124	0.12	1.3	0.04	0.09

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2-12. Pantex—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Decentralized		16	1.9	0.025	2960	0.20	932	0.17	0.32	0.02	96	3
Regionalized-1		12	1.9	0.025	2960	0.20	932	0.17	0.32	0.02	96	3
Regionalized-2	11	12	4.5	0.058	4599	0.31	3691	0.68	0.79	0.05	98	3
Regionalized-3		6	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Regionalized-4	7	6	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Regionalized-5	4	6	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Regionalized-6		2	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Regionalized-7		2	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Centralized-1		1	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Centralized-2		1	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Centralized-3	7	1	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Centralized-4	7	1	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5
Centralized-5	1	1	1.7	0.0217	1977	0.13	671	0.12	0.19	0.01	130	5

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-12.2-13. Pantex—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	135	11	48	69	7	135	0	0
Decentralized		16	216	17	58	124	17	135	0	81
Regionalized-1		12	216	17	58	124	17	135	0	81
Regionalized-2	11	12	222	17	60	127	18	142	0	80
Regionalized-3		6	135	11	48	69	7	135	0	0
Regionalized-4	7	6	135	11	48	69	7	135	0	0
Regionalized-5	4	6	135	11	48	69	7	135	0	0
Regionalized-6		2	135	11	48	69	7	135	0	0
Regionalized-7		2	135	11	48	69	7	135	0	0
Centralized-1		1	135	11	48	69	7	135	0	0
Centralized-2		1	135	11	48	69	7	135	0	0
Centralized-3	7	1	135	11	48	69	7	135	0	0
Centralized-4	7	1	135	11	48	69	7	135	0	0
Centralized-5	1	1	135	11	48	69	7	135	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.13.0 PORTS

Ports currently is custodian of significant volumes of LLMW and LLW. Each of the waste types is treated independently in the following sections.

II.13.1 PORTS LLMW

Fifteen tables immediately following portray the impacts of LLMW at Ports. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	PORTS—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-13.1-1	13-2
2.	PORTS—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-13.1-2	13-3
3.	PORTS—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-13.1-3	13-4
4.	PORTS—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-13.1-4	13-5
5.	PORTS—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-13.1-5	13-6
6.	PORTS—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-13.1-6	13-7
7.	PORTS—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-13.1-7	13-8
8.	PORTS—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-13.1-8	13-9
9.	PORTS—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-13.1-9	13-10
10.	PORTS—LLMW—Impacts on Water Resources Due to Increased Water Use	II-13.1-10	13-11
11.	PORTS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-13.1-11	13-12
12.	PORTS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-13.1-12	13-13
13.	PORTS—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-13.1-13	13-14
14.	PORTS—LLMW—Infrastructure Impacts for Treatment and Disposal	II-13.1-14	13-15
15.	PORTS—LLMW—Cost	II-13.1-15	13-16

Table II-13.1-1. PORTS—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	1.3E-03	3.3E-02	3.2E-05	3.3E-06	- -	- -
Decentralized	37	16	1.4E-03	4.8E-01	2.7E-06	2.8E-07	3.6E-02	3.0E-02
Regionalized-1	11	12	5.9E-02	3.4E-01	4.9E-05	2.7E-06	5.8E-02	4.8E-02
Regionalized-2	7	6	7.7E-02	4.7E-01	1.1E-04	8.0E-06	- -	- -
Regionalized-3	7	1	7.7E-02	4.7E-01	1.1E-04	8.0E-06	- -	- -
Regionalized-4	4	6	8.3E-04	1.2E-01	1.8E-08	1.9E-09	- -	- -
Centralized	1	1	8.3E-04	1.2E-01	1.8E-08	1.9E-09	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-13.1-2. PORTS—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Workers			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	6.4E-02	1.1E-04	5.9E-05	6.4E-06	6.7E-03	1.1E-05	3.3E-05	6.7E-07	3.2E+00	4.5E-03	1.0E-05	1.9E-04
Decentralized	37	16	5.4E-03	9.1E-06	2.3E-06	5.4E-07	5.7E-04	9.6E-07	1.3E-06	5.7E-08	3.6E+00	5.0E-03	5.9E-04	2.1E-04
Regionalized-1	11	12	9.7E-02	1.7E-04	2.3E-06	9.7E-06	5.4E-03	9.1E-06	1.3E-06	5.4E-07	1.5E+02	2.1E-01	5.8E-04	8.9E-03
Regionalized-2	7	6	2.1E-01	3.6E-04	3.7E-06	2.1E-05	1.6E-02	2.7E-05	2.1E-06	1.6E-06	1.9E+02	2.7E-01	1.0E-03	1.1E-02
Regionalized-3	7	1	2.1E-01	3.6E-04	3.7E-06	2.1E-05	1.6E-02	2.7E-05	2.1E-06	1.6E-06	1.9E+02	2.7E-01	1.0E-03	1.1E-02
Regionalized-4	4	6	3.6E-05	6.1E-08	4.9E-08	3.6E-09	3.7E-06	6.4E-09	2.8E-08	3.7E-10	2.1E+00	2.9E-03	8.1E-06	1.2E-04
Centralized	1	1	3.6E-05	6.1E-08	4.9E-08	3.6E-09	3.7E-06	6.4E-09	2.8E-08	3.7E-10	2.1E+00	2.9E-03	8.1E-06	1.2E-04

Notes:
T = Treatment
D = Disposal

Table II-13.1-3. PORTS—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	9.0E+01	1.3E-01	5.4E-03
Regionalized-1	11	12	1.5E+02	2.0E-01	8.7E-03
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-13.1-4. PORTS—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	4.0E-09	1.9E-09	- -
Decentralized	37	16	3.4E-10	1.6E-10	7.7E-06
Regionalized-1	11	12	6.0E-09	1.5E-09	2.1E-05
Regionalized-2	7	6	1.3E-08	4.5E-09	- -
Regionalized-3	7	1	1.3E-08	4.5E-09	- -
Regionalized-4	4	6	2.2E-12	1.1E-12	- -
Centralized	1	1	2.2E-12	1.1E-12	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-13.1-5. PORTS—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	8.0E-06	1.4E-08	9.8E-09	8.0E-10	3.8E-06	6.4E-09	1.9E-08	3.8E-10	--	--	--	--
Decentralized	37	16	6.8E-07	1.2E-09	3.9E-10	6.8E-11	3.2E-07	5.4E-10	7.4E-10	3.2E-11	1.3E-02	2.2E-05	1.6E-05	1.3E-06
Regionalized-1	11	12	1.2E-05	2.0E-08	3.8E-10	1.2E-09	3.0E-06	5.2E-09	7.4E-10	3.0E-10	3.5E-02	6.0E-05	2.8E-05	3.5E-06
Regionalized-2	7	6	2.6E-05	4.5E-08	6.1E-10	2.6E-09	9.1E-06	1.5E-08	1.2E-09	9.1E-10	--	--	--	--
Regionalized-3	7	1	2.6E-05	4.5E-08	6.1E-10	2.6E-09	9.1E-06	1.5E-08	1.2E-09	9.1E-10	--	--	--	--
Regionalized-4	4	6	4.5E-09	7.6E-12	8.2E-12	4.5E-13	2.1E-09	3.6E-12	1.6E-11	2.1E-13	--	--	--	--
Centralized	1	1	4.5E-09	7.6E-12	8.2E-12	4.5E-13	2.1E-09	3.6E-12	1.6E-11	2.1E-13	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for this alternative.

Table II-13.1-6. PORTS—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	1.2E-05	2.2E-05	3.0E-05	- -
Decentralized	37	16	7.5E-07	1.4E-06	2.0E-03	1.4E+00
Regionalized-1	11	12	7.6E-07	1.5E-06	2.0E-03	2.1E+00
Regionalized-2	7	6	1.1E-06	2.1E-06	3.2E-03	- -
Regionalized-3	7	1	1.1E-06	2.1E-06	3.2E-03	- -
Regionalized-4	4	6	1.0E-08	1.9E-08	3.6E-05	- -
Centralized	1	1	1.0E-08	1.9E-08	3.6E-05	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-13.1-7. PORTS—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	8 (1/7)	3 (2/1)	0	0	0	1 (0/1)	8 (1/7)	2 (1/1)	0	0	0	1 (0/1)
Decentralized	37	16	65 (5/60)	24 (12/12)	0	0	0	8 (1/7)	45 (1/44)	13 (4/9)	0	2 (2/0)	0	5 (0/5)
Regionalized-1	11	12	67 (5/62)	26 (14/12)	0	1 (1/0)	1 (1/0)	8 (1/7)	45 (1/44)	13 (4/9)	0	2 (2/0)	0	5 (0/5)
Regionalized-2	7	6	63 (4/59)	22 (10/12)	0	1 (1/0)	1 (1/0)	8 (1/7)	38 (0/38)	13 (5/8)	0	4 (4/0)	0	5 (0/5)
Regionalized-3	7	1	63 (4/59)	22 (10/12)	0	1 (1/0)	1 (1/0)	8 (1/7)	38 (0/38)	13 (5/8)	0	4 (4/0)	0	5 (0/5)
Regionalized-4	4	6	16 (1/15)	5 (2/3)	0	0	0	2 (0/2)	12 (0/12)	2 (0/2)	0	0	0	1 (0/1)
Centralized	1	1	16 (1/15)	5 (2/3)	0	0	0	2 (0/2)	12 (0/12)	2 (0/2)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-13.1-8. PORTS—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized-1	11	12	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	1	3	0	1	0	0	--	--	--	--	--	--
Decentralized	37	16	1	9	0	13	0	0	0	0	0	1	0	0
Regionalized-1	11	12	1	11	0	15	0	0	0	0	0	1	1	0
Regionalized-2	7	6	0	13	0	25	1	0	0	0	0	2	1	0
Regionalized-3	7	1	0	13	0	25	1	0	0	0	0	2	1	0
Regionalized-4	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Ports is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for the No Action, Regionalized-4, and Centralized Alternatives.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-13.1-9. PORTS—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligib
Percentages <1% are shown as zeros.

Table II-13.1-10. PORTS—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	2190	<0.1	- -	1893	<0.1	- -	<0.1
Decentralized	37	16	18018	0.1	- -	6727	<0.1	- -	<0.1
Regionalized-1	11	12	19863	0.1	- -	6787	<0.1	- -	<0.1
Regionalized-2	7	6	16024	0.1	- -	6709	<0.1	- -	<0.1
Regionalized-3	7	1	16024	0.1	- -	6709	<0.1	- -	<0.1
Regionalized-4	4	6	3664	<0.1	- -	1888	<0.1	- -	<0.1
Centralized	1	1	3664	<0.1	- -	1888	<0.1	- -	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Alluvial Aquifer. Current water use = 14,000,000 gallons/day.
Wastewater discharged to the Scioto River. Average flow rate of the Scioto River = 3,036,000,000 gallons/day.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-13.1-11. PORTS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-13.1-12. PORTS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	2	0	20	0	8	0	0
Regionalized-1	11	12	0	3	0	30	0	10	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	80	0	0	100	10	0	0
Regionalized-1	11	12	100	0	0	200	20	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-13.1-13. PORTS—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	186	153	0.20	1.6	0.06	0.09
Decentralized	37	16	726	751	0.96	8.0	0.31	0.35
Regionalized-1	11	12	741	765	0.98	8.2	0.31	0.36
Regionalized-2	7	6	662	685	0.88	7.3	0.28	0.32
Regionalized-3	7	1	662	685	0.88	7.3	0.28	0.30
Regionalized-4	4	6	211	218	0.28	2.3	0.09	0.09
Centralized	1	1	211	218	0.28	2.3	0.09	0.09

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-13.1-14. PORTS—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment
No Action	3	-	1.3	0.04	2190	0.01	1893	0.16	0.81	0.04	55	2
Decentralized	37	16	10.6	0.33	18018	0.05	6727	0.56	1.62	0.08	467	20
Regionalized 1	11	12	12.2	0.38	19863	0.05	6787	0.57	1.84	0.10	484	20
Regionalized 2	7	6	10.3	0.32	16024	0.04	6709	0.56	1.31	0.07	457	19
Regionalized 3	7	1	10.3	0.32	16024	0.04	6709	0.56	1.31	0.07	451	19
Regionalized 4	4	6	2.6	0.08	3664	0.01	1888	0.16	0.37	0.02	113	5
Centralized	1	1	2.6	0.08	3664	0.01	1888	0.16	0.37	0.02	116	5

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-13.1-15. PORTS—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	210	8	28	154	19	95	115	0
Decentralized	37	16	822	76	236	465	45	685	0	137
Regionalized-1	11	12	838	82	240	468	48	672	0	166
Regionalized-2	7	6	749	80	224	411	34	749	0	0
Regionalized-3	7	1	749	80	224	411	34	749	0	0
Regionalized-4	4	6	240	18	58	153	10	240	0	0
Centralized	1	1	240	18	58	153	10	240	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.13.2 PORTS LLW

Thirteen tables immediately following portray the impacts of LLW at Ports. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	PORTS—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-13.2-1	13-18
2.	PORTS—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-13.2-2	13-19
3.	PORTS—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-13.2-3	13-20
4.	PORTS—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-13.2-4	13-21
5.	PORTS—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-13.2-5	13-22
7.	PORTS—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-13.2-6	13-23
8.	PORTS—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-13.2-7	13-24
9.	PORTS—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-13.2-8	13-25
10.	PORTS—LLW—Impacts on Water Resources Due to Increased Water Use	II-13.2-9	13-26
11.	PORTS—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-13.2-10	13-27
13.	PORTS—LLW—Socioeconomic Impacts for Treatment and Disposal	II-13.2-11	13-28
14.	PORTS—LLW—Infrastructure Impacts for Treatment and Disposal	II-13.2-12	13-29
15.	PORTS—LLW—Cost	II-13.2-13	13-30

Table II-13.2-1. PORTS—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	5.6E-03	2.4E-01	1.7E-09	1.8E-10	- -	- -
Decentralized		16	4.6E-03	1.5E-01	2.4E-10	2.6E-11	1.3E-02	4.3E-01
Regionalized-1		12	4.6E-03	1.5E-01	2.4E-10	2.6E-11	3.1E-02	4.9E-01
Regionalized-2	11	12	2.8E-02	7.1E-01	5.3E-05	5.4E-06	2.7E-02	2.9E-01
Regionalized-3		6	4.6E-03	2.3E-01	1.8E-09	1.8E-10	- -	- -
Regionalized-4	7	6	3.7E-02	7.2E-01	1.9E-02	5.9E-04	- -	- -
Regionalized-5	4	6	4.6E-03	2.3E-01	1.8E-09	1.8E-10	- -	- -
Regionalized-6		2	4.6E-03	2.3E-01	1.8E-09	1.8E-10	- -	- -
Regionalized-7		2	4.6E-03	2.3E-01	1.8E-09	1.8E-10	- -	- -
Centralized-1		1	4.6E-03	2.3E-01	1.8E-09	1.8E-10	- -	- -
Centralized-2		1	4.6E-03	2.3E-01	1.8E-09	1.8E-10	- -	- -
Centralized-3	7	1	3.7E-02	7.2E-01	1.9E-02	5.9E-04	- -	- -
Centralized-4	7	1	3.7E-02	7.2E-01	1.9E-02	5.9E-04	- -	- -
Centralized-5	1	1	4.6E-03	2.3E-01	1.8E-09	1.8E-10	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-13.2-2. PORTS—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	3.3E-06	5.7E-09	3.3E-10	3.5E-07	6.0E-10	3.5E-11	1.4E+01	2.0E-02	8.4E-04
Decentralized		16	4.9E-07	8.3E-10	4.9E-11	5.1E-08	8.7E-11	5.1E-12	1.1E+01	1.6E-02	6.8E-04
Regionalized-1		12	4.9E-07	8.3E-10	4.9E-11	5.1E-08	8.7E-11	5.1E-12	1.1E+01	1.6E-02	6.8E-04
Regionalized-2	11	12	1.1E-01	1.8E-04	1.1E-05	1.1E-02	1.8E-05	1.1E-06	6.9E+01	9.6E-02	4.1E-03
Regionalized-3		6	3.5E-06	6.0E-09	3.5E-10	3.7E-07	6.3E-10	3.7E-11	1.1E+01	1.6E-02	6.8E-04
Regionalized-4	7	6	3.8E+01	6.4E-02	3.8E-03	1.2E+00	2.0E-03	1.2E-04	9.2E+01	1.3E-01	5.5E-03
Regionalized-5	4	6	3.5E-06	5.9E-09	3.5E-10	3.7E-07	6.2E-10	3.7E-11	1.1E+01	1.6E-02	6.8E-04
Regionalized-6		2	3.5E-06	6.0E-09	3.5E-10	3.7E-07	6.3E-10	3.7E-11	1.1E+01	1.6E-02	6.8E-04
Regionalized-7		2	3.5E-06	6.0E-09	3.5E-10	3.7E-07	6.3E-10	3.7E-11	1.1E+01	1.6E-02	6.8E-04
Centralized-1		1	3.5E-06	6.0E-09	3.5E-10	3.7E-07	6.3E-10	3.7E-11	1.1E+01	1.6E-02	6.8E-04
Centralized-2		1	3.5E-06	6.0E-09	3.5E-10	3.7E-07	6.3E-10	3.7E-11	1.1E+01	1.6E-02	6.8E-04
Centralized-3	7	1	3.8E+01	6.4E-02	3.8E-03	1.2E+00	2.0E-03	1.2E-04	9.2E+01	1.3E-01	5.5E-03
Centralized-4	7	1	3.8E+01	6.4E-02	3.8E-03	1.2E+00	2.0E-03	1.2E-04	9.2E+01	1.3E-01	5.5E-03
Centralized-5	1	1	3.5E-06	6.0E-09	3.5E-10	3.7E-07	6.2E-10	3.7E-11	1.1E+01	1.6E-02	6.8E-04

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2–3. PORTS—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	3.3E+01	4.6E-02	2.0E-03
Regionalized-1		12	7.8E+01	1.1E-01	4.7E-03
Regionalized-2	11	12	6.6E+01	9.3E-02	4.0E-03
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2–4. PORTS—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	2.1E-13	9.9E-14	- -
Decentralized		16	3.1E-14	1.4E-14	6.1E-08
Regionalized-1		12	3.1E-14	1.4E-14	5.0E-07
Regionalized-2	11	12	6.6E-09	3.1E-09	8.8E-07
Regionalized-3		6	2.2E-13	1.0E-13	- -
Regionalized-4	7	6	2.3E-06	3.4E-07	- -
Regionalized-5	4	6	2.2E-13	1.0E-13	- -
Regionalized-6		2	2.2E-13	1.0E-13	- -
Regionalized-7		2	2.2E-13	1.0E-13	- -
Centralized-1		1	2.2E-13	1.0E-13	- -
Centralized-2		1	2.2E-13	1.0E-13	- -
Centralized-3	7	1	2.3E-06	3.4E-07	- -
Centralized-4	7	1	2.3E-06	3.4E-07	- -
Centralized-5	1	1	2.2E-13	1.0E-13	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2-5. PORTS—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	4.2E-10	7.2E-13	4.2E-14	2.0E-10	3.4E-13	2.0E-14	- -	- -	- -
Decentralized		16	6.2E-11	1.1E-13	<9.9E-14	2.9E-11	4.9E-14	<9.9E-14	1.2E-04	2.1E-07	1.2E-08
Regionalized-1		12	6.2E-11	1.1E-13	<9.9E-14	2.9E-11	4.9E-14	<9.9E-14	1.0E-03	1.7E-06	1.0E-07
Regionalized-2	11	12	1.3E-05	2.2E-08	1.3E-09	6.1E-06	1.0E-08	6.1E-10	1.7E-03	2.9E-06	1.7E-07
Regionalized-3		6	4.4E-10	7.5E-13	4.4E-14	2.1E-10	3.5E-13	2.1E-14	- -	- -	- -
Regionalized-4	7	6	4.6E-03	7.9E-06	4.6E-07	6.8E-04	1.2E-06	6.8E-08	- -	- -	- -
Regionalized-5	4	6	4.4E-10	7.5E-13	4.4E-14	2.1E-10	3.5E-13	2.1E-14	- -	- -	- -
Regionalized-6		2	4.4E-10	7.5E-13	4.4E-14	2.1E-10	3.5E-13	2.1E-14	- -	- -	- -
Regionalized-7		2	4.4E-10	7.5E-13	4.4E-14	2.1E-10	3.5E-13	2.1E-14	- -	- -	- -
Centralized-1		1	4.4E-10	7.5E-13	4.4E-14	2.1E-10	3.5E-13	2.1E-14	- -	- -	- -
Centralized-2		1	4.4E-10	7.5E-13	4.4E-14	2.1E-10	3.5E-13	2.1E-14	- -	- -	- -
Centralized-3	7	1	4.6E-03	7.9E-06	4.6E-07	6.8E-04	1.2E-06	6.8E-08	- -	- -	- -
Centralized-4	7	1	4.6E-03	7.9E-06	4.6E-07	6.8E-04	1.2E-06	6.8E-08	- -	- -	- -
Centralized-5	1	1	4.4E-10	7.5E-13	4.4E-14	2.1E-10	3.5E-13	2.1E-14	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2-6. PORTS—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	32 (11/21)	32 (28/4)	0	2 (2/0)	3 (3/0)	6 (3/3)	17 (1/16)	6 (2/4)	0	0	0	2 (0/2)
Decentralized		16	174 (124/50)	335 (325/10)	0	26 (26/0)	31 (31/0)	37 (31/6)	43 (2/41)	15 (5/10)	0	1 (1/0)	0	5 (0/5)
Regionalized-1		12	219 (169/50)	451 (441/10)	0	35 (35/0)	42 (42/0)	49 (43/6)	32 (3/29)	13 (6/7)	0	1 (1/0)	0	4 (0/4)
Regionalized-2	11	12	245 (155/90)	422 (404/18)	0	32 (32/0)	38 (38/0)	50 (39/11)	86 (3/83)	24 (6/18)	0	2 (2/0)	0	10 (0/10)
Regionalized-3		6	17 (6/11)	16 (14/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	5 (0/5)	0	0	0	2 (0/2)
Regionalized-4	7	6	89 (27/62)	83 (71/12)	0	6 (6/0)	7 (7/0)	14 (7/7)	58 (0/58)	17 (2/15)	0	1 (1/0)	0	7 (0/7)
Regionalized-5	4	6	17 (6/11)	16 (14/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	5 (0/5)	0	0	0	2 (0/2)
Regionalized-6		2	17 (6/11)	16 (14/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	5 (0/5)	0	0	0	2 (0/2)
Regionalzied-7		2	17 (6/11)	16 (14/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	5 (0/5)	0	0	0	2 (0/2)
Centralized-1		1	17 (6/11)	16 (14/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	5 (0/5)	0	0	0	2 (0/2)
Centralized-2		1	17 (6/11)	16 (14/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	5 (0/5)	0	0	0	2 (0/2)
Centralized-3	7	1	89 (27/62)	83 (71/12)	0	6 (6/0)	7 (7/0)	14 (7/7)	58 (0/58)	17 (2/15)	0	1	0	7 (0/7)
Centralized-4	7	1	89 (27/62)	83 (71/12)	0	6 (6/0)	7 (7/0)	14 (7/7)	58 (0/58)	17 (2/15)	0	1	0	7 (0/7)
Centralized-5	1	1	17 (6/11)	16 (14/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	12 (0/12)	5 (0/5)	0	0	0	2 (0/2)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2-7. PORTS—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	1	4	0	2	0	0	--	--	--	--	--	--
Decentralized		16	2	11	0	5	0	1	--	--	--	--	--	--
Regionalized-1		12	3	16	0	7	0	1	--	--	--	--	--	--
Regionalized-2	11	12	3	16	0	10	0	1	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	7	6	0	4	0	6	0	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-6		2	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-7		2	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-1		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-2		1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	0	4	0	6	0	0	0	0	0	0	0	0
Centralized-4	7	1	0	4	0	6	0	0	0	0	0	0	0	0
Centralized-5	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) Ports is in an attainment area for all criteria pollutants, therefore the GCR do not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all but the Regionalized-2 and -4, and Centralized-3 and -4 Alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2-8. PORTS—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	5	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	5	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	5	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2-9. PORTS—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	8079	0.1	- -	22144	0.2	- -	<0.1
Decentralized		16	130210	0.9	- -	4659	<0.1	- -	<0.1
Regionalized-1		12	178908	1.3	- -	4780	<0.1	- -	<0.1
Regionalized-2	11	12	157092	1.1	- -	11265	0.1	- -	<0.1
Regionalized-3		6	3997	<0.1	- -	1094	<0.1	- -	<0.1
Regionalized-4	7	6	20383	0.1	- -	7814	0.1	- -	<0.1
Regionalized-5	4	6	3997	<0.1	- -	1094	<0.1	- -	<0.1
Regionalized-6		2	3997	<0.1	- -	1094	<0.1	- -	<0.1
Regionalized-7		2	3997	<0.1	- -	1094	<0.1	- -	<0.1
Centralized-1		1	3997	<0.1	- -	1094	<0.1	- -	<0.1
Centralized-2		1	3997	<0.1	- -	1094	<0.1	- -	<0.1
Centralized-3	7	1	20383	0.1	- -	7814	0.1	- -	<0.1
Centralized-4	7	1	20383	0.1	- -	7814	0.1	- -	<0.1
Centralized-5	1	1	3997	<0.1	- -	1094	<0.1	- -	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Alluvial Aquifer. Current water use = 14,000,000 gallons/day.
Wastewater discharged to the Scioto River. Average flow rate of the Scioto River = 3,036,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-13.2-10. PORTS—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 236	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
- - = Disposal is not considered for this Alternative.

Table II-13.2-11. PORTS—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	474	392	0.50	4.2	0.16	0.20
Decentralized		16	1079	1115	1.43	11.9	0.46	0.24
Regionalized-1		12	1228	1269	1.63	13.5	0.52	0.23
Regionalized-2	11	12	1269	1312	1.69	14.0	0.54	0.62
Regionalized-3		6	149	154	0.20	1.6	0.06	0.08
Regionalized-4	7	6	860	888	1.14	9.5	0.37	0.42
Regionalized-5		6	149	154	0.20	1.6	0.06	0.08
Regionalized-6		2	149	154	0.20	1.6	0.06	0.08
Regionalized-7		2	149	154	0.20	1.6	0.06	0.08
Centralized-1		1	149	154	0.20	1.6	0.06	0.08
Centralized-2		1	149	154	0.20	1.6	0.06	0.08
Centralized-3	7	1	860	888	1.14	9.5	0.37	0.42
Centralized-4	7	1	860	888	1.14	9.5	0.37	0.42
Centralized-5	1	1	149	154	0.20	1.6	0.06	0.08

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2-12. PORTS—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	23.0	0.72	22144	0.06	22144	1.85	5.31	0.28	164	7
Decentralized		16	16.6	0.52	130210	0.35	4659	0.39	19.48	1.01	387	16
Regionalized-1		12	43.5	1.40	178908	0.48	4780	0.40	26.84	1.39	387	16
Regionalized-2	11	12	44.7	1.40	157092	0.42	11265	0.94	23.02	1.19	696	29
Regionalized-3		6	2.0	0.06	3997	0.01	1094	0.09	0.44	0.02	85	4
Regionalized-4	7	6	10.1	0.32	20383	0.06	7814	0.66	2.82	0.15	483	20
Regionalized-5	4	6	2.0	0.06	3997	0.01	1094	0.09	0.44	0.02	85	4
Regionalized-6		2	2.0	0.06	3997	0.01	1094	0.09	0.44	0.02	85	4
Regionalized-7		2	2.0	0.06	3997	0.01	1094	0.09	0.44	0.02	85	4
Centralized-1		1	2.0	0.06	3997	0.01	1094	0.09	0.44	0.02	85	4
Centralized-2		1	2.0	0.06	3997	0.01	1094	0.09	0.44	0.02	85	4
Centralized-3	7	1	10.1	0.32	20383	0.06	7814	0.66	2.82	0.15	482	20
Centralized-4	7	1	10.1	0.32	20383	0.06	7814	0.66	2.82	0.15	482	20
Centralized-5	1	1	2.0	0.06	3997	0.01	1094	0.09	0.44	0.02	85	4

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-13.2-13. PORTS—LLW—Cost

LLW Alternatives	T	D	Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
				Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	536	26	79	403	28	536	0	0
Decentralized		16	1221	77	491	513	141	169	0	1052
Regionalized-1		12	1389	119	533	555	183	169	0	1221
Regionalized-2	11	12	1436	130	307	873	125	914	0	522
Regionalized-3		6	169	15	38	106	11	169	0	0
Regionalized-4	7	6	973	98	204	610	60	973	0	0
Regionalized-5	4	6	169	15	38	106	11	169	0	0
Regionalized-6		2	169	15	38	106	11	169	0	0
Regionalized-7		2	169	15	38	106	11	169	0	0
Centralized-1		1	169	15	38	106	11	169	0	0
Centralized-2		1	169	15	38	106	11	169	0	0
Centralized-3	7	1	973	98	204	610	60	973	0	0
Centralized-4	7	1	973	98	204	610	60	973	0	0
Centralized-5	1	1	169	15	38	106	11	169	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.14.0 RFETS

RFETS currently is custodian of significant volumes of LLMW, LLW, and TRUW. Each of the waste types is treated independently in the following sections.

14.1 RFETS LLMW

Fifteen tables immediately following portray the impacts of LLMW at RFETS. These tables are presented as follows:

Impact Category No.	Description	Table No.	Page No.
1.	RFETS—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-14.1-1	14-2
2.	RFETS—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-14.1-2	14-3
3.	RFETS—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-14.1-3	14-4
4.	RFETS—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-14.1-4	14-5
5.	RFETS—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-14.1-5	14-6
6.	RFETS—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-14.1-6	14-7
7.	RFETS—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-14.1-7	14-8
8.	RFETS—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-14.1-8	14-9
9.	RFETS—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-14.1-9	14-10
10.	RFETS—LLMW—Impacts on Water Resources Due to Increased Water Use	II-14.1-10	14-11
11.	RFETS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-14.1-11	14-12
12.	RFETS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-14.1-12	14-13
13.	RFETS—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-14.1-13	14-14
14.	RFETS—LLMW—Infrastructure Impacts for Treatment and Disposal	II-14.1-14	14-15
15.	RFETS—LLMW—Cost	II-14.1-15	14-16

Table II-14.1-1. RFETS—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	1.8E-03	2.3E-01	1.3E-02	6.7E-04	- -	- -
Decentralized	37	16	1.0E-03	6.2E-01	8.8E-05	4.5E-06	2.3E-03	6.9E-02
Regionalized-1	11	12	1.0E-03	6.2E-01	8.8E-05	4.5E-06	2.3E-03	6.9E-02
Regionalized-2	7	6	1.2E-03	6.2E-01	8.9E-05	4.5E-06	- -	- -
Regionalized-3	7	1	1.2E-03	6.2E-01	8.9E-05	4.5E-06	- -	- -
Regionalized-4	4	6	9.9E-04	2.1E-01	6.3E-06	3.2E-07	- -	- -
Centralized	1	1	9.9E-04	2.1E-01	6.3E-06	3.2E-07	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-14.1-2. RFETS—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	2.6E+01	4.5E-02	1.0E-03	2.6E-03	7.3E+00	1.2E-04	2.0E-04	7.3E-04	4.5E+00	6.3E-03	3.6E-05	2.7E-04
Decentralized	37	16	1.8E-01	3.0E-04	5.0E-05	1.8E-05	9.0E-03	1.5E-05	1.0E-05	9.0E-07	2.5E+00	3.6E-03	5.6E-04	1.5E-04
Regionalized-1	11	12	1.8E-01	3.0E-04	5.0E-05	1.8E-05	9.0E-03	1.5E-05	1.0E-05	9.0E-07	2.5E+00	3.6E-03	5.6E-04	1.5E-04
Regionalized-2	7	6	1.8E-01	3.0E-04	2.6E-05	1.8E-05	9.1E-03	1.5E-05	5.3E-06	9.1E-07	2.9E+00	4.1E-03	5.6E-04	1.7E-04
Regionalized-3	7	1	1.8E-01	3.0E-04	2.6E-05	1.8E-05	9.1E-03	1.5E-05	5.3E-06	9.1E-07	2.9E+00	4.1E-03	5.6E-04	1.7E-04
Regionalized-4	4	6	1.3E-02	2.1E-05	2.4E-06	1.3E-06	6.4E-04	1.1E-06	4.8E-07	6.4E-08	2.5E+00	3.5E-03	2.5E-05	1.5E-04
Centralized	1	1	1.3E-02	2.1E-05	2.4E-06	1.3E-06	6.4E-04	1.1E-06	4.8E-07	6.4E-08	2.5E+00	3.5E-03	2.5E-05	1.5E-04

Notes:
T = Treatment
D = Disposal

Table II-14.1-3. RFETS—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	5.8E+00	8.2E-03	3.5E-04
Regionalized-1	11	12	5.8E+00	8.2E-03	3.5E-04
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-14.1-4. RFETS—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.8E-07	4.0E-07	- -
Decentralized	37	16	1.2E-09	2.7E-09	3.9E-07
Regionalized-1	11	12	1.2E-09	2.7E-09	3.9E-07
Regionalized-2	7	6	1.2E-09	2.7E-09	- -
Regionalized-3	7	1	1.2E-09	2.7E-09	- -
Regionalized-4	4	6	8.5E-11	1.9E-10	- -
Centralized	1	1	8.5E-11	1.9E-10	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-14.1-5. RFETS—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	3.6E-04	6.1E-07	8.0E-09	3.6E-08	8.0E-04	1.4E-06	1.0E-07	8.0E-08	- -	- -	- -	- -
Decentralized	37	16	2.4E-06	4.0E-09	4.0E-10	2.4E-10	5.4E-06	9.1E-09	5.1E-09	5.4E-10	7.8E-04	1.3E-06	2.8E-04	7.8E-08
Regionalized-1	11	12	2.4E-06	4.0E-09	4.0E-10	2.4E-10	5.4E-06	9.1E-09	5.1E-09	5.4E-10	7.8E-04	1.3E-06	2.8E-04	7.8E-08
Regionalized-2	7	6	2.4E-06	4.1E-09	2.1E-10	2.4E-10	5.4E-06	9.2E-09	2.7E-09	5.4E-10	- -	- -	- -	- -
Regionalized-3	7	1	2.4E-06	4.1E-09	2.1E-10	2.4E-10	5.4E-06	9.2E-09	2.7E-09	5.4E-10	- -	- -	- -	- -
Regionalized-4	4	6	1.7E-07	2.9E-10	1.9E-11	1.7E-11	3.8E-07	6.5E-10	2.4E-10	3.8E-11	- -	- -	- -	- -
Centralized	1	1	1.7E-07	2.9E-10	1.9E-11	1.7E-11	3.8E-07	6.5E-10	2.4E-10	3.8E-11	- -	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for this alternative.

Table II-14.1-6. RFETS—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	9.1E-07	1.2E-05	1.7E-05	- -
Decentralized	37	16	1.2E-07	1.5E-06	3.4E-04	3.0E+00
Regionalized-1	11	12	1.2E-07	1.5E-06	3.4E-04	3.0E+00
Regionalized-2	7	6	7.4E-08	9.5E-07	3.4E-04	- -
Regionalized-3	7	1	7.4E-08	9.5E-07	3.4E-04	- -
Regionalized-4	4	6	4.0E-09	5.1E-08	2.7E-05	- -
Centralized	1	1	4.0E-09	5.1E-08	2.7E-05	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-14.1-7. RFETS—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	95 (31/64)	94 (81/13)	0	6 (6/0)	8 (8/0)	16 (8/8)	23 (1/22)	6 (2/4)	0	0	0	3 (0/3)
Decentralized	37	16	169 (33/136)	114 (87/27)	0	7 (7/0)	8 (8/0)	24 (8/16)	82 (2/80)	25 (9/16)	0	5 (5/0)	0	10 (0/10)
Regionalized-1	11	12	169 (33/136)	114 (87/27)	0	7 (7/0)	8 (8/0)	24 (8/16)	82 (2/80)	25 (9/16)	0	5 (5/0)	0	10 (0/10)
Regionalized-2	7	6	107 (5/102)	32 (12/20)	0	1 (1/0)	1 (1/0)	13 (1/12)	53 (1/52)	17 (6/11)	0	5 (5/0)	0	6 (0/6)
Regionalized-3	7	1	107 (5/102)	32 (12/20)	0	1 (1/0)	1 (1/0)	13 (1/12)	53 (1/52)	17 (6/11)	0	5 (5/0)	0	6 (0/6)
Regionalized-4	4	6	47 (2/45)	16 (7/9)	0	1 (1/0)	1 (1/0)	6 (1/5)	24 (0/24)	5 (0/5)	0	0	0	3 (0/3)
Centralized	1	1	47 (2/45)	16 (7/9)	0	1 (1/0)	1 (1/0)	6 (1/5)	24 (0/24)	5 (0/5)	0	0	0	3 (0/3)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-14.1-8. RFETS—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	95 (31/64)	94 (81/13)	--	7 (7/0)	--	31 (16/15)
Decentralized	37	16	169 (33/136)	114 (87/27)	--	7 (7/0)	--	50 (17/33)
Regionalized-1	11	12	169 (33/136)	114 (87/27)	--	7 (7/0)	--	50 (17/33)
Regionalized-2	7	6	107 (5/102)	32 (12/20)	--	1 (1/0)	--	27 (2/25)
Regionalized-3	7	1	107 (5/102)	32 (12/20)	--	1 (1/0)	--	27 (2/25)
Regionalized-4	4	6	48 (3/45)	16 (7/9)	--	1 (1/0)	--	12 (1/11)
Centralized	1	1	48 (3/45)	16 (7/9)	--	1 (1/0)	--	12 (1/11)

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (6)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	23 (1/22)	7 (3/4)	0	0	0	6 (1/5)	--	--	--	--	--	--
Decentralized	37	16	81 (1/80)	25 (9/16)	0	5 (5/0)	1	20 (1/19)	0	0	0	0	5	0
Regionalized-1	11	12	81 (1/80)	25 (9/16)	0	5 (5/0)	1	20 (1/19)	0	0	0	0	5	0
Regionalized-2	7	6	53 (1/52)	17 (6/11)	0	5 (5/0)	1	13 (0/13)	0	0	0	0	5	0
Regionalized-3	7	1	53 (1/52)	17 (6/11)	0	5 (5/0)	1	13 (0/13)	0	0	0	0	5	0
Regionalized-4	4	6	24 (0/24)	5 (0/5)	0	0	0	6 (0/6)	--	--	--	--	--	--
Centralized	1	1	24 (0/24)	5 (0/5)	0	0	0	6 (0/6)	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for the No Action, Regionalized-4, and Centralized Alternatives.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emission / % of transportation emission).

Table II-14.1-9. RFETS—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Decentralized	37	16	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-1	11	12	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-2	7	6	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-3	7	1	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-4	4	6	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Centralized	1	1	0	0	0	- -	- -	0	- -	- -	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	- -	0	0	0	- -	0	0	0	- -	- -
Decentralized	37	16	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-1	11	12	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-2	7	6	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-3	7	1	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-4	4	6	- -	0	0	0	- -	0	0	0	- -	- -
Centralized	1	1	- -	0	0	0	- -	0	0	0	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-14.1-10. RFETS—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	75070	27.6	- -	5199	1.9	- -	<0.1
Decentralized	37	16	89025	32.7	- -	11099	4.1	- -	<0.1
Regionalized-1	11	12	89025	32.7	- -	11099	4.1	- -	<0.1
Regionalized-2	7	6	20720	7.6	- -	9238	3.4	- -	<0.1
Regionalized-3	7	1	20720	7.6	- -	9238	3.4	- -	<0.1
Regionalized-4	4	6	7271	2.7	- -	3478	1.3	- -	<0.1
Centralized	1	1	7271	2.7	- -	3478	1.3	- -	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by municipal water from the Denver Water Board.
Current water use = 272,000 gallons/day
Wastewater discharged to Walnut Creek. Average flow rate of Walnut Creek = 142,000,000 gallons/day.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-14.1-11. RFETS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-14.1-12. RFETS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	3	0	20	0	100	0	0
Regionalized-1	11	12	0	3	0	20	0	100	0	0
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	200	0	0	400	10	1	0
Regionalized-1	11	12	200	0	0	400	10	1	0
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-14.1-13. RFETS—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	912	765	0.06	8.6	0.02	0.04
Decentralized	37	16	1614	1693	0.14	19.0	0.05	0.07
Regionalized-1	11	12	1614	1693	0.14	19.0	0.05	0.07
Regionalized-2	7	6	1091	1144	0.10	12.9	0.03	0.05
Regionalized-3	7	1	1091	1144	0.10	12.9	0.03	0.05
Regionalized-4	4	6	554	581	0.05	6.5	0.02	0.02
Centralized	1	1	554	581	0.05	6.5	0.02	0.02

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-14.1-14. RFETS—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment
No Action	3	-	25.9	0.45	75070	7.51	5199	1.04	10.75	31.17	497	7
Decentralized	37	16	32.9	0.57	89025	8.90	11099	2.22	11.49	33.31	1055	14
Regionalized 1	11	12	32.9	0.57	89025	8.90	11099	2.22	11.49	33.31	1055	14
Regionalized 2	7	6	13.1	0.23	20720	2.07	9238	1.85	1.60	4.65	778	11
Regionalized 3	7	1	13.1	0.23	20720	2.07	9238	1.85	1.60	4.65	778	11
Regionalized 4	4	6	6.2	0.11	7271	0.73	3478	0.70	0.86	2.50	347	5
Centralized	1	1	6.2	0.11	7271	0.73	3478	0.70	0.86	2.50	347	5

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-14.1-15. RFETS—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	1032	56	271	467	238	537	494	0
Decentralized	37	16	1826	117	587	808	314	1234	0	591
Regionalized-1	11	12	1826	117	587	808	314	1234	0	591
Regionalized-2	7	6	1236	99	434	661	42	1236	0	0
Regionalized-3	7	1	1236	99	434	661	42	1236	0	0
Regionalized-4	4	6	627	43	190	368	26	627	0	0
Centralized	1	1	627	43	190	368	26	627	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.14.2 RFETS LLW

Thirteen tables immediately following portray the impacts of LLW at RFETS. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	RFETS—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-14.2-1	14-18
2.	RFETS—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-14.2-2	14-19
3.	RFETS—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-14.2-3	14-20
4.	RFETS—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-14.2-4	14-21
5.	RFETS—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-14.2-5	14-22
7.	RFETS—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-14.2-6	14-23
8.	RFETS—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-14.2-7	14-24
9.	RFETS—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-14.2-8	14-25
10.	RFETS—LLW—Impacts on Water Resources Due to Increased Water Use	II-14.2-9	14-26
11.	RFETS—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-14.2-10	14-27
13.	RFETS—LLW—Socioeconomic Impacts for Treatment and Disposal	II-14.2-11	14-28
14.	RFETS—LLW—Infrastructure Impacts for Treatment and Disposal	II-14.2-12	14-29
15.	RFETS—LLW—Cost	II-14.2-13	14-30

Table II-14.2-1. RFETS—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	1.9E-03	1.2E-01	1.2E-07	6.2E-09	- -	- -
Decentralized		16	1.1E-03	7.0E-02	3.6E-07	1.8E-08	2.8E-03	1.4E-01
Regionalized-1		12	1.1E-03	7.0E-02	3.6E-07	1.8E-08	2.8E-03	1.4E-01
Regionalized-2	11	12	1.1E-03	2.2E-01	1.9E-04	9.5E-06	1.6E-03	6.6E-02
Regionalized-3		6	1.2E-03	8.0E-02	4.0E-07	2.0E-08	- -	- -
Regionalized-4	7	6	1.1E-03	2.2E-01	1.9E-04	9.5E-06	- -	- -
Regionalized-5	4	6	1.2E-03	7.9E-02	4.0E-07	2.0E-08	- -	- -
Regionalized-6		2	1.2E-03	8.0E-02	4.0E-07	2.0E-08	- -	- -
Regionalized-7		2	1.2E-03	8.0E-02	4.0E-07	2.0E-08	- -	- -
Centralized-1		1	1.2E-03	8.0E-02	4.0E-07	2.0E-08	- -	- -
Centralized-2		1	1.2E-03	8.0E-02	4.0E-07	2.0E-08	- -	- -
Centralized-3	7	1	1.1E-03	2.2E-01	1.9E-04	9.5E-06	- -	- -
Centralized-4	7	1	1.1E-03	2.2E-01	1.9E-04	9.5E-06	- -	- -
Centralized-5	1	1	1.2E-03	7.9E-02	4.0E-07	2.0E-08	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-14.2-2. RFETS—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	2.4E-04	4.1E-07	2.4E-08	1.2E-05	2.1E-08	1.2E-09	4.6E+00	6.5E-03	2.8E-04
Decentralized		16	7.1E-04	1.2E-06	7.1E-08	3.7E-05	6.2E-08	3.7E-09	2.9E+00	4.0E-03	1.7E-04
Regionalized-1		12	7.1E-04	1.2E-06	7.1E-08	3.7E-05	6.2E-08	3.7E-09	2.9E+00	4.0E-03	1.7E-04
Regionalized-2	11	12	3.7E-01	6.3E-04	3.7E-05	1.9E-02	3.2E-05	1.9E-06	2.9E+00	4.0E-03	1.7E-04
Regionalized-3		6	8.0E-04	1.4E-06	8.0E-08	4.1E-05	6.9E-08	4.1E-09	2.9E+00	4.0E-03	1.7E-04
Regionalized-4	7	6	3.7E-01	6.3E-04	3.7E-05	1.9E-02	3.2E-05	1.9E-06	2.9E+00	4.0E-03	1.7E-04
Regionalized-5	4	6	8.0E-04	1.4E-06	8.0E-08	4.1E-05	6.9E-08	4.1E-09	2.9E+00	4.0E-03	1.7E-04
Regionalized-6		2	8.0E-04	1.4E-06	8.0E-08	4.1E-05	6.9E-08	4.1E-09	2.9E+00	4.0E-03	1.7E-04
Regionalized-7		2	8.0E-04	1.4E-06	8.0E-08	4.1E-05	6.9E-08	4.1E-09	2.9E+00	4.0E-03	1.7E-04
Centralized-1		1	8.0E-04	1.4E-06	8.0E-08	4.1E-05	6.9E-08	4.1E-09	2.9E+00	4.0E-03	1.7E-04
Centralized-2		1	8.0E-04	1.4E-06	8.0E-08	4.1E-05	6.9E-08	4.1E-09	2.9E+00	4.0E-03	1.7E-04
Centralized-3	7	1	3.7E-01	6.3E-04	3.7E-05	1.9E-02	3.2E-05	1.9E-06	2.9E+00	4.0E-03	1.7E-04
Centralized-4	7	1	3.7E-01	6.3E-04	3.7E-05	1.9E-02	3.2E-05	1.9E-06	2.9E+00	4.0E-03	1.7E-04
Centralized-5	1	1	8.0E-04	1.4E-06	8.0E-08	4.1E-05	6.9E-08	4.1E-09	2.9E+00	4.0E-03	1.7E-04

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-3. RFETS—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	7.1E+00	9.9E-03	4.3E-04
Regionalized-1		12	7.1E+00	9.9E-03	4.3E-04
Regionalized-2	11	12	4.0E+00	5.6E-03	2.4E-04
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-4. RFETS—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	1.6E-12	3.7E-12	- -
Decentralized		16	4.9E-12	1.1E-11	2.7E-08
Regionalized-1		12	4.9E-12	1.1E-11	2.7E-08
Regionalized-2	11	12	2.5E-09	5.7E-09	8.1E-08
Regionalized-3		6	5.4E-12	1.2E-11	- -
Regionalized-4	7	6	2.5E-09	5.7E-09	- -
Regionalized-5	4	6	5.4E-12	1.2E-11	- -
Regionalized-6		2	5.4E-12	1.2E-11	- -
Regionalized-7		2	5.4E-12	1.2E-11	- -
Centralized-1		1	5.4E-12	1.2E-11	- -
Centralized-2		1	5.4E-12	1.2E-11	- -
Centralized-3	7	1	2.5E-09	5.7E-09	- -
Centralized-4	7	1	2.5E-09	5.7E-09	- -
Centralized-5	1	1	5.4E-12	1.2E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-5. RFETS—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	3.3E-09	5.6E-12	3.3E-13	7.4E-09	1.3E-11	7.4E-13	--	--	--
Decentralized		16	9.7E-09	1.7E-11	9.7E-13	2.2E-08	3.7E-11	2.2E-12	5.4E-05	9.2E-08	5.4E-09
Regionalized-1		12	9.7E-09	1.7E-11	9.7E-13	2.2E-08	3.7E-11	2.2E-12	5.4E-05	9.2E-08	5.4E-09
Regionalized-2	11	12	5.1E-06	8.6E-09	5.1E-10	1.1E-05	1.9E-08	1.1E-09	1.6E-04	2.8E-07	1.6E-08
Regionalized-3		6	1.1E-08	1.8E-11	1.1E-12	2.4E-08	4.2E-11	2.5E-12	--	--	--
Regionalized-4	7	6	5.1E-06	8.6E-09	5.1E-10	1.1E-05	1.9E-08	1.1E-09	--	--	--
Regionalized-5	4	6	1.1E-08	1.8E-11	1.1E-12	2.5E-08	4.2E-11	2.5E-12	--	--	--
Regionalized-6		2	1.1E-08	1.8E-11	1.1E-12	2.5E-08	4.2E-11	2.5E-12	--	--	--
Regionalized-7		2	1.1E-08	1.8E-11	1.1E-12	2.5E-08	4.2E-11	2.5E-12	--	--	--
Centralized-1		1	1.1E-08	1.8E-11	1.1E-12	2.5E-08	4.2E-11	2.5E-12	--	--	--
Centralized-2		1	1.1E-08	1.8E-11	1.1E-12	2.5E-08	4.2E-11	2.5E-12	--	--	--
Centralized-3	7	1	5.1E-06	8.6E-09	5.1E-10	1.1E-05	1.9E-08	1.1E-09	--	--	--
Centralized-4	7	1	5.1E-06	8.6E-09	5.1E-10	1.1E-05	1.9E-08	1.1E-09	--	--	--
Centralized-5	1	1	1.1E-08	1.8E-11	1.1E-12	2.5E-08	4.2E-11	2.5E-12	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-6. RFETS—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	12 (4/8)	12 (10/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	7 (0/7)	2 (0/2)	0	0	0	1 (0/1)
Decentralized		16	28 (16/12)	45 (43/2)	0	3 (3/0)	4 (4/0)	5 (4/1)	39 (0/39)	8 (0/8)	0	0	0	5 (0/5)
Regionalized-1		12	28 (16/12)	45 (43/2)	0	3 (3/0)	4 (4/0)	5 (4/1)	39 (0/39)	8 (0/8)	0	0	0	5 (0/5)
Regionalized-2	11	12	38 (28/10)	76 (74/2)	0	6 (6/0)	7 (7/0)	8 (7/1)	56 (0/55)	13 (2/11)	0	1 (1/0)	0	7 (0/7)
Regionalized-3		6	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-4	7	6	26 (21/5)	55 (54/1)	0	4 (4/0)	5 (5/0)	6 (5/1)	33 (0/33)	8 (1/7)	0	1 (1/0)	0	4 (0/4)
Regionalized-5	4	6	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-6		2	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Regionalzied-7		2	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Centralized-1		1	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Centralized-2		1	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)
Centralized-3	7	1	26 (21/5)	55 (54/1)	0	4 (4/0)	5 (5/0)	6 (5/1)	33 (0/33)	8 (1/7)	0	1 (1/0)	0	4 (0/4)
Centralized-4	7	1	26 (21/5)	55 (54/1)	0	4 (4/0)	5 (5/0)	6 (5/1)	33 (0/33)	8 (1/7)	0	1 (1/0)	0	4 (0/4)
Centralized-5	1	1	15 (1/14)	6 (3/3)	0	0	0	2 (0/2)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-7. RFETS—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	12 (4/8)	12 (10/2)	--	1 (1/0)	--	4 (2/2)
Decentralized		16	28 (16/12)	45 (43/2)	--	3 (3/0)	--	11 (8/3)
Regionalized-1		12	28 (16/12)	45 (43/2)	--	3 (3/0)	--	11 (8/3)
Regionalized-2	11	12	38 (28/10)	76 (74/2)	--	6 (6/0)	--	16 (14/2)
Regionalized-3		6	15 (1/14)	6 (3/3)	--	0	--	4 (1/3)
Regionalized-4	7	6	26 (21/5)	55 (54/1)	--	4 (4/0)	--	11 (10/1)
Regionalized-5	4	6	15 (1/14)	6 (3/3)	--	0	--	4 (1/3)
Regionalized-6		2	15 (1/14)	6 (3/3)	--	0	--	4 (1/3)
Regionalized-7		2	15 (1/14)	6 (3/3)	--	0	--	4 (1/3)
Centralized-1		1	15 (1/14)	6 (3/3)	--	0	--	4 (1/3)
Centralized-2		1	15 (1/14)	6 (3/3)	--	0	--	4 (1/3)
Centralized-3	7	1	26 (21/5)	55 (54/1)	--	4 (4/0)	--	11 (10/1)
Centralized-4	7	1	26 (21/5)	55 (54/1)	--	4 (4/0)	--	11 (10/1)
Centralized-5	1	1	15 (1/14)	6 (3/3)	--	0	--	4 (1/3)

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (6)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	7 (0/7)	2 (0/2)	0	0	0	2 (0/2)	--	--	--	--	--	--
Decentralized		16	39 (0/39)	8 (0/8)	0	0	0	9 (0/9)	--	--	--	--	--	--
Regionalized-1		12	39 (0/39)	8 (0/8)	0	0	0	9 (0/9)	--	--	--	--	--	--
Regionalized-2	11	12	55 (0/55)	12 (1/11)	0	1 (1/0)	0	13 (0/13)	0	0	0	0	0	0
Regionalized-3		6	11 (0/11)	2 (0/2)	0	0	0	3 (0/3)	--	--	--	--	--	--
Regionalized-4	7	6	33 (0/33)	8 (1/7)	0	1 (1/0)	0	8 (0/8)	0	0	0	0	0	0
Regionalized-5	4	6	11 (0/11)	2 (0/2)	0	0	0	3 (0/3)	--	--	--	--	--	--
Regionalized-6		2	11 (0/11)	2 (0/2)	0	0	0	3 (0/3)	--	--	--	--	--	--
Regionalized-7		2	11 (0/11)	2 (0/2)	0	0	0	3 (0/3)	--	--	--	--	--	--
Centralized-1		1	11 (0/11)	2 (0/2)	0	0	0	3 (0/3)	--	--	--	--	--	--
Centralized-2		1	11 (0/11)	2 (0/2)	0	0	0	3 (0/3)	--	--	--	--	--	--
Centralized-3	7	1	33 (0/33)	8 (1/7)	0	1 (1/0)	0	8 (0/8)	0	0	0	0	0	0
Centralized-4	7	1	33 (0/33)	8 (1/7)	0	1 (1/0)	0	8 (0/8)	0	0	0	0	0	0
Centralized-5	1	1	11 (0/11)	2 (0/2)	0	0	0	3 (0/3)	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions)
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all but the Regionalized-2 and -4, and Centralized-3 and -4 Alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-8. RFETS—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-9. RFETS—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	2490	0.9	- -	914	0.3	- -	<0.1
Decentralized		16	12497	4.6	- -	5080	1.9	- -	<0.1
Regionalized-1		12	12497	4.6	- -	5080	1.9	- -	<0.1
Regionalized-2	11	12	17980	6.6	- -	11997	4.4	- -	<0.1
Regionalized-3		6	4025	1.5	- -	1478	0.5	- -	<0.1
Regionalized-4	7	6	11527	4.2	- -	9106	3.3	- -	<0.1
Regionalized-5	4	6	4025	1.5	- -	1478	0.5	- -	<0.1
Regionalized-6		2	4025	1.5	- -	1478	0.5	- -	<0.1
Regionalized-7		2	4025	1.5	- -	1478	0.5	- -	<0.1
Centralized-1		1	4025	1.5	- -	1478	0.5	- -	<0.1
Centralized-2		1	4025	1.5	- -	1478	0.5	- -	<0.1
Centralized-3	7	1	11527	4.2	- -	9106	3.3	- -	<0.1
Centralized-4	7	1	11527	4.2	- -	9106	3.3	- -	<0.1
Centralized-5	1	1	4025	1.5	- -	1478	0.5	- -	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by municipal water from the Denver Water Board. Current water use = 272,000 gallons/day.
Wastewater discharged to Walnut Creek. Average flow rate of Walnut Creek = 142,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
- - = Wastewater discharged to evaporation ponds.
<0.1 indicates that the percentage is less than 0.1%.

Table II-14.2-10. RFETS—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-14.2-11. RFETS—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	219	184	0.02	2.1	0.01	0.01
Decentralized		16	623	654	0.05	7.4	0.02	0.03
Regionalized-1		12	623	654	0.05	7.4	0.02	0.03
Regionalized-2	11	12	923	968	0.08	10.9	0.03	0.05
Regionalized-3		6	201	211	0.02	2.4	0.01	0.01
Regionalized-4	7	6	610	640	0.05	7.2	0.02	0.03
Regionalized-5		6	201	211	0.02	2.4	0.01	0.01
Regionalized-6		2	201	211	0.02	2.4	0.01	0.01
Regionalized-7		2	201	211	0.02	2.4	0.01	0.01
Centralized-1		1	201	211	0.02	2.4	0.01	0.01
Centralized-2		1	201	211	0.02	2.4	0.01	0.01
Centralized-3	7	1	610	640	0.05	7.2	0.02	0.03
Centralized-4	7	1	610	640	0.05	7.2	0.02	0.03
Centralized-5	1	1	201	211	0.02	2.4	0.01	0.01

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-12. RFETS—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	1.1	0.02	2490	0.25	914	0.18	0.20	0.58	64	1
Decentralized		16	7.1	0.12	12496	1.25	5080	1.02	1.43	4.16	258	4
Regionalized-1		12	7.1	0.12	12496	1.25	5080	1.02	1.43	4.16	258	4
Regionalized-2	11	12	11.4	0.20	17980	1.84	11997	1.63	1.67	4.85	558	8
Regionalized-3		6	2.9	0.05	4025	0.40	1478	0.30	0.41	1.19	110	1
Regionalized-4	7	6	2.5	0.04	11527	1.15	9106	1.82	1.00	2.88	442	6
Regionalized-5	4	6	2.9	0.04	4025	0.33	1478	0.30	0.41	0.96	110	1
Regionalized-6		2	2.9	0.05	4025	0.40	1478	0.30	0.41	1.19	110	1
Regionalized-7		2	2.9	0.05	4025	0.40	1478	0.30	0.41	1.19	110	1
Centralized-1		1	2.9	0.05	4025	0.40	1478	0.30	0.41	1.19	110	1
Centralized-2		1	2.9	0.05	4025	0.40	1478	0.30	0.41	1.19	110	1
Centralized-3	7	1	2.5	0.04	11527	1.15	9106	1.82	1.00	2.88	442	7
Centralized-4	7	1	2.5	0.04	11527	1.15	9106	1.82	1.00	2.88	442	7
Centralized-5	1	1	2.9	0.04	4025	0.33	1478	0.30	0.41	0.96	110	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-14.2-13. RFETS—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	248	10	32	194	12	248	0	0
Decentralized		16	705	61	96	452	96	190	0	515
Regionalized-1		12	705	61	96	452	96	190	0	515
Regionalized-2	11	12	1044	100	260	588	96	690	0	354
Regionalized-3		6	228	18	54	141	15	228	0	0
Regionalized-4	7	6	690	67	225	361	37	690	0	0
Regionalized-5	4	6	228	18	54	141	15	228	0	0
Regionalized-6		2	228	18	54	141	15	228	0	0
Regionalized-7		2	228	18	54	141	15	228	0	0
Centralized-1		1	228	18	54	141	15	228	0	0
Centralized-2		1	228	18	54	141	15	228	0	0
Centralized-3	7	1	690	67	225	361	37	690	0	0
Centralized-4	7	1	690	67	225	361	37	690	0	0
Centralized-5	1	1	228	18	54	141	15	228	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.14.3 RFETS TRUW

Twelve tables immediately following portray the impacts of TRUW at RFETS. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	RFETS—TRUW—Treatment: Estimated Number of Fatalities	II-14.3-1	14-32
2.	RFETS—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-14.3-2	14-33
4.	RFETS—TRUW—Treatment: MEI Probability of Cancer Fatality	II-14.3-3	14-34
5.	RFETS—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-14.3-4	14-35
6.	RFETS—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-14.3-5	14-36
7.	RFETS—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-14.3-6	14-37
8.	RFETS—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-14.3-7	14-38
9.	RFETS—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-14.3-8	14-39
10.	RFETS—TRUW—Impacts on Water Resources Due to Increased Water Use	II-14.3-9	14-40
13.	RFETS—TRUW—Socioeconomic Impacts for Treatment	II-14.3-10	14-41
14.	RFETS—TRUW—Infrastructure Impacts for Treatment	II-14.3-11	14-42
15.	RFETS—TRUW—Cost	II-14.3-12	14-43

Table II-14.3-1. RFETS—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure
	CH Treat	RH Treat		Radiation Exposure	Physical Hazards		
No Action **	16	5	WIPP WAC	8.2E-05	7.3E-02	3.0E-06	1.5E-07
Decentralized ***	16	5	WIPP WAC	7.7E-03	2.1E-01	9.3E-06	4.7E-07
Regionalized-1	5	2	Reduce Gas	7.7E-03	3.3E-01	1.5E-05	7.6E-07
Regionalized-2	5	2	LDR	7.3E-03	5.6E-01	1.1E-01	5.6E-03
Regionalized-3	3	2	LDR	3.0E-02	1.3E-01	1.2E-05	6.1E-07
Centralized	WIPP	2	LDR	3.0E-02	1.3E-01	1.2E-05	6.1E-07

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-14.3-2. RFETS—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	6.0E-03	1.0E-05	1.0E-10	6.0E-07	3.1E-04	5.2E-07	2.1E-11	3.1E-08	2.1E-01	2.9E-04	4.0E-09	1.2E-05
Decentralized***	16	5	WIPP WAC	1.9E-02	3.1E-05	4.8E-10	1.9E-06	9.4E-04	1.6E-06	9.6E-11	9.4E-08	1.9E+01	2.7E-02	6.8E-09	1.2E-03
Regionalized-1	5	2	Reduce Gas	3.0E-02	5.1E-05	6.3E-10	3.0E-06	1.5E-03	2.6E-06	1.3E-10	1.5E-07	1.9E+01	2.7E-02	2.1E-08	1.2E-03
Regionalized-2	5	2	LDR	2.2E+02	3.7E-01	8.4E-10	2.2E-02	1.1E+01	1.9E-02	1.7E-10	1.1E-03	1.8E+01	2.5E-02	6.2E-08	1.1E-03
Regionalized-3	3	2	LDR	2.4E-02	4.1E-05	1.1E-09	2.4E-06	1.2E-03	2.1E-06	2.3E-10	1.2E-07	7.4E+01	1.0E-01	2.6E-08	4.4E-03
Centralized	WIPP	2	LDR	2.4E-02	4.1E-05	1.1E-09	2.4E-06	1.2E-03	2.1E-06	2.3E-10	1.2E-07	7.4E+01	1.0E-01	2.6E-08	4.4E-03

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-14.3-3. RFETS—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	4.1E-11	9.2E-11
Decentralized***	16	5	WIPP WAC	1.3E-10	2.8E-10
Regionalized-1	5	2	Reduce Gas	2.0E-10	4.6E-10
Regionalized-2	5	2	LDR	1.5E-06	3.3E-06
Regionalized-3	3	2	LDR	1.6E-10	3.7E-10
Centralized	WIPP	2	LDR	1.6E-10	3.7E-10

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-14.3-4. RFETS—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite Population MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	8.2E-08	1.4E-10	<9.9E-14	8.2E-12	1.8E-07	3.1E-10	1.1E-14	1.8E-11
Decentralized ***	16	5	WIPP WAC	2.5E-07	4.3E-10	<9.9E-14	2.5E-11	5.7E-07	9.6E-10	4.9E-14	5.7E-11
Regionalized-1	5	2	Reduce Gas	4.0E-07	6.9E-10	<9.9E-14	4.0E-11	9.1E-07	1.6E-09	6.5E-14	9.1E-11
Regionalized-2	5	2	LDR	3.0E-03	5.0E-06	<9.9E-14	3.0E-07	6.7E-03	1.1E-05	8.5E-14	6.7E-07
Regionalized-3	3	2	LDR	3.3E-07	5.6E-10	<9.9E-14	3.3E-11	7.4E-07	1.3E-09	1.2E-13	7.4E-11
Centralized	WIPP	2	LDR	3.3E-07	5.6E-10	<9.9E-14	3.3E-11	7.4E-07	1.3E-09	1.2E-13	7.4E-11

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
MEI = Maximally Exposed Individual

Table II-14.3-5. RFETS—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment	Treatment		
	CH Treat	RH Treat	Treatment Standard	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	2.1E-11	2.7E-10	5.3E-07
Decentralized***	16	5	WIPP WAC	1.1E-10	1.4E-09	1.2E-06
Regionalized-1	5	2	Reduce Gas	2.0E-10	2.5E-09	1.2E-06
Regionalized-2	5	2	LDR	1.2E-09	1.5E-08	2.6E-05
Regionalized-3	3	2	LDR	1.5E-10	1.9E-09	2.3E-06
Centralized	WIPP	2	LDR	1.5E-10	1.9E-09	2.3E-06

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-14.3-6. RFETS—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites: CH Treat	Number of Sites: RH Treat	Treatment Standard	Construction Emissions in Tons/Year (1): CO	NO2	Pb	PM10	SO2	VOC	Operations & Maintenance Emissions in Tons/Year (2): CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Decentralized***	16	5	WIPP WAC	19 (3/16)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	17 (0/17)	3 (0/3)	0	0	0	2 (0/2)
Regionalized-1	5	2	Reduce Gas	20 (3/17)	11 (8/3)	0	1 (1/0)	1 (1/0)	3 (1/2)	20 (0/20)	4 (0/4)	0	0	0	2 (0/2)
Regionalized-2	5	2	LDR	29 (4/25)	15 (10/5)	0	1 (1/0)	1 (1/0)	4 (/13)	24 (0/24)	5 (0/5)	0	0	0	3 (0/3)
Regionalized-3	3	2	LDR	7 (1/6)	4 (3/1)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized	WIPP	2	LDR	7 (1/6)	4 (3/1)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-14.3-7. RFETS—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treat STD	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	19 (3/16)	11 (3/3)	--	1 (1/0)	--	6 (2/4)
Regionalized-1	5	2	Reduce Gas	20 (3/17)	11 (8/3)	--	1 (1/0)	--	6 (2/4)
Regionalized-2	5	2	LDR	29 (4/25)	15 (10/5)	--	1 (1/0)	--	8 (2/6)
Regionalized-3	3	2	LDR	7 (1/6)	4 (3/1)	--	0	--	2 (1/1)
Centralized	WIPP	2	LDR	7 (1/6)	4 (3/1)	--	0	--	2 (1/1)

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (6)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	8 (0/8)	2 (0/2)	0	0	0	2 (0/2)	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	17 (0/17)	3 (0/3)	0	0	0	4 (0/4)	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	20 (0/20)	4 (0/4)	0	0	0	5 (0/5)	--	--	--	--	--	--
Regionalized-2	5	2	LDR	24 (0/24)	5 (0/5)	0	0	1	6 (0/6)	0	0	0	0	0	0
Regionalized-3	3	2	LDR	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	--	--	--	--	--	--
Centralized	WIPP	2	LDR	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR only applies to pollutants in nonattainment.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for alternatives that do not involve treatment to LDR (incineration) are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

Table II-14.3-8. RFETS—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	3	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-14.3-9. RFETS—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	2342	0.9	- -	<0.1
Decentralized***	16	5	WIPP WAC	5827	2.1	- -	3229	1.2	- -	<0.1
Regionalized-1	5	2	Reduce Gas	6029	2.2	- -	3985	1.5	- -	<0.1
Regionalized-2	5	2	LDR	8223	3.0	- -	4866	1.8	- -	<0.1
Regionalized-3	3	2	LDR	2173	0.8	- -	708	0.3	- -	<0.1
Centralized	WIPP	2	LDR	2173	0.8	- -	708	0.3	- -	<0.1

Notes:
Water supplied by municipal water from the Denver Water Board. Current water use = 272,000 gallons/day.
Wastewater discharged to Walnut Creek. Average flow rate of Walnut Creek = 142,000,000 gallons/day.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Stream Flow is not considered for this site.
<0.1 indiicates that the percentage is less than 0.1%.

Table II-14.3-10. RFETS—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	246	206	0.02	2.3	0.01	0.01
Decentralized***	16	5	WIPP WAC	333	349	0.03	3.9	0.01	0.01
Regionalized-1	5	2	Reduce Gas	372	391	0.03	4.4	0.01	0.02
Regionalized-2	5	2	LDR	470	493	0.04	5.5	0.01	0.02
Regionalized-3	3	2	LDR	112	117	0.01	1.3	0.00	0.00
Centralized	WIPP	2	LDR	112	117	0.01	1.3	0.00	0.00

Notes:
(1) In current 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-14.3-11. RFETS—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	2342	0.23	2342	0.47	0.12	0.35	0	0.00
Decentralized***	16	5	WIPP WAC	2.5	0.04	5827	0.59	3229	0.65	0.52	1.1	173	2.30
Regionalized-1	5	2	Reduce Gas	2.6	0.04	6029	0.61	3985	0.8	0.54	1.57	178	2.40
Regionalized-2	5	2	LDR	2.8	0.05	8223	0.82	4866	0.97	0.87	2.53	266	3.60
Regionalized-3	3	2	LDR	1.2	0.02	2173	0.22	708	0.14	0.45	1.31	62	0.80
Centralized	WIPP	2	LDR	1.2	0.02	2173	0.22	708	0.14	0.45	1.31	62	0.80

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-14.3-12. RFETS—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	278	0	0	257	21	0	262	16
Decentralized***	16	5	WIPP - WAC	377	21	95	227	34	46	311	20
Regionalized-1	5	2	Reduce Gas	421	22	98	257	45	46	346	30
Regionalized-2	5	2	LDR	531	34	145	303	49	46	457	29
Regionalized-3	3	2	LDR	127	8	34	68	16	46	81	0
Centralized	WIPP	2	LDR	127	8	34	68	16	46	81	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.15.0 SNL-NM

SNL-NM currently is custodian of significant volumes of LLMW and LLW. Each of the waste types is treated independently in the following sections.

II.15.1 SNL-NM LLMW

Fifteen tables immediately following portray the impacts of LLMW at SNL-NM. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	SNL-NM—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-15.1-1	15-2
2.	SNL-NM—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-15.1-2	15-3
3.	SNL-NM—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-15.1-3	15-4
4.	SNL-NM—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-15.1-4	15-5
5.	SNL-NM—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-15.1-5	15-6
6.	SNL-NM—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-15.1-6	15-7
7.	SNL-NM—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-15.1-7	15-8
8.	SNL-NM—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-15.1-8	15-9
9.	SNL-NM—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-15.1-9	15-10
10.	SNL-NM—LLMW—Impacts on Water Resources Due to Increased Water Use	II-15.1-10	15-11
11.	SNL-NM—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-15.1-11	15-12
12.	SNL-NM—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-15.1-12	15-13
13.	SNL-NM—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-15.1-13	15-14
14.	SNL-NM—LLMW—Infrastructure Impacts for Treatment and Disposal	II-15.1-14	15-15
15.	SNL-NM—LLMW—Cost	II-15.1-15	15-16

Table II-15.1-1. SNL-NM—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	2.4E-05	6.3E-04	3.8E-05	7.4E-07	- -	- -
Decentralized	37	16	3.3E-04	5.1E-03	1.4E-04	7.8E-07	3.4E-05	7.4E-04
Regionalized-1	11	12	1.7E-05	1.2E-03	1.8E-08	3.5E-10	- -	- -
Regionalized-2	7	6	1.7E-05	1.2E-03	1.8E-08	3.5E-10	- -	- -
Regionalized-3	7	1	1.7E-05	1.2E-03	1.8E-08	3.5E-10	- -	- -
Regionalized-4	4	6	1.7E-05	1.2E-03	1.8E-08	3.5E-10	- -	- -
Centralized	1	1	1.7E-05	1.2E-03	1.8E-08	3.5E-10	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-15.1-2. SNL-NM—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	7.7E-02	1.3E-04	7.3E-07	7.7E-06	1.5E-03	2.5E-06	8.1E-08	1.5E-07	6.0E-02	8.4E-05	4.2E-10	3.6E-06
Decentralized	37	16	2.8E-01	4.7E-04	2.1E-08	2.8E-05	1.6E-03	2.7E-06	2.4E-09	1.6E-07	8.2E-01	1.2E-03	1.7E-08	4.9E-05
Regionalized-1	11	12	3.6E-05	6.1E-08	5.4E-10	3.6E-09	6.9E-07	1.2E-09	6.0E-11	6.9E-11	4.3E-02	6.1E-05	3.4E-10	2.6E-06
Regionalized-2	7	6	3.6E-05	6.1E-08	5.4E-10	3.6E-09	6.9E-07	1.2E-09	6.0E-11	6.9E-11	4.3E-02	6.1E-05	3.4E-10	2.6E-06
Regionalized-3	7	1	3.6E-05	6.1E-08	5.4E-10	3.6E-09	6.9E-07	1.2E-09	6.0E-11	6.9E-11	4.3E-02	6.1E-05	3.4E-10	2.6E-06
Regionalized-4	4	6	3.6E-05	6.1E-08	5.4E-10	3.6E-09	6.9E-07	1.2E-09	6.0E-11	6.9E-11	4.3E-02	6.1E-05	3.4E-10	2.6E-06
Centralized	1	1	3.6E-05	6.1E-08	5.4E-10	3.6E-09	6.9E-07	1.2E-09	6.0E-11	6.9E-11	4.3E-02	6.1E-05	3.4E-10	2.6E-06

Notes:
T = Treatment
D = Disposal

Table II-15.1-3. SNL-NM—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	8.6E-02	1.2E-04	5.2E-06
Regionalized-1	11	12	- -	- -	- -
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-15.1-4. SNL-NM—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.5E-09	3.1E-10	- -
Decentralized	37	16	5.4E-09	3.2E-10	4.5E-05
Regionalized-1	11	12	7.1E-13	1.4E-13	- -
Regionalized-2	7	6	7.1E-13	1.4E-13	- -
Regionalized-3	7	1	7.1E-13	1.4E-13	- -
Regionalized-4	4	6	7.1E-13	1.4E-13	- -
Centralized	1	1	7.1E-13	1.4E-13	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-15.1-5. SNL-NM—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	3.0E-06	5.2E-09	3.1E-11	3.0E-10	6.2E-07	1.1E-09	3.1E-11	6.2E-11	--	--	--	--
Decentralized	37	16	1.1E-05	1.9E-08	9.1E-13	1.1E-09	6.4E-07	1.1E-09	9.1E-13	6.4E-11	9.0E-02	1.5E-04	8.9E-07	9.0E-06
Regionalized-1	11	12	1.4E-09	2.4E-12	2.3E-14	1.4E-13	2.9E-10	4.9E-13	2.3E-14	2.9E-14	--	--	--	--
Regionalized-2	7	6	1.4E-09	2.4E-12	2.3E-14	1.4E-13	2.9E-10	4.9E-13	2.3E-14	2.9E-14	--	--	--	--
Regionalized-3	7	1	1.4E-09	2.4E-12	2.3E-14	1.4E-13	2.9E-10	4.9E-13	2.3E-14	2.9E-14	--	--	--	--
Regionalized-4	4	6	1.4E-09	2.4E-12	2.3E-14	1.4E-13	2.9E-10	4.9E-13	2.3E-14	2.9E-14	--	--	--	--
Centralized	1	1	1.4E-09	2.4E-12	2.3E-14	1.4E-13	2.9E-10	4.9E-13	2.3E-14	2.9E-14	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered for this alternative.

Table II-15.1-6. SNL-NM—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	3.9E-08	3.9E-08	4.9E-08	- -
Decentralized	37	16	3.3E-09	3.3E-09	2.8E-06	2.3E-02
Regionalized-1	11	12	3.4E-11	3.4E-11	4.9E-08	- -
Regionalized-2	7	6	3.4E-11	3.4E-11	4.9E-08	- -
Regionalized-3	7	1	3.4E-11	3.4E-11	4.9E-08	- -
Regionalized-4	4	6	3.4E-11	3.4E-11	4.9E-08	- -
Centralized	1	1	3.4E-11	3.4E-11	4.9E-08	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-15.1-7. SNL-NM—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	3 (0/3)	1 (0/1)	0	0	0	0	1 (0/1)	0	0	0	0	0
Decentralized	37	16	8 (0/8)	3 (1/2)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-15.1-8. SNL-NM—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	3 (0/3)	--	--	--	--	--
Decentralized	37	16	9 (0/9)	--	--	--	--	--
Regionalized-1	11	12	0	--	--	--	--	--
Regionalized-2	7	6	0	--	--	--	--	--
Regionalized-3	7	1	0	--	--	--	--	--
Regionalized-4	4	6	0	--	--	--	--	--
Centralized	1	1	0	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (5)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	1 (0/1)	0	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	2 (0/2)	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	7	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission)
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions)

Table II-15.1-9. SNL-NM—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Decentralized	37	16	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-1	11	12	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-2	7	6	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-3	7	1	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-4	4	6	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Centralized	1	1	0	0	0	- -	- -	0	- -	- -	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	Vinyl Chloride
No Action	3	-	- -	0	0	0	- -	0	0	0	- -	- -
Decentralized	37	16	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-1	11	12	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-2	7	6	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-3	7	1	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-4	4	6	- -	0	0	0	- -	0	0	0	- -	- -
Centralized	1	1	- -	0	0	0	- -	0	0	0	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-15.1-10. SNL-NM—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	--	--	--	18	<0.1	--	--
Decentralized	37	16	2079	0.2	--	289	<0.1	--	--
Regionalized-1	11	12	--	--	--	18	<0.1	--	--
Regionalized-2	7	6	--	--	--	18	<0.1	--	--
Regionalized-3	7	1	--	--	--	18	<0.1	--	--
Regionalized-4	4	6	--	--	--	18	<0.1	--	--
Centralized	1	1	--	--	--	18	<0.1	--	--

Notes:
T = Treatment
D = Disposal
Notes: Water supplied by the City of Albuquerque and Kirtland AFB. Current water use = 1,000,000 gallons/day. Wastewater discharged to the City of Albuquerque WWTP.
- - = Construction is not considered for this site except for the Decentralized Alternative, and for operations waste water as a percent of stream flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-15.1-11. SNL-NM—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D																					
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	900	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
	T	D																						
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-15.1-12. SNL-NM—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	1	0	0	1	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-15.1-13. SNL-NM—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	28	23	0.01	0.3	0.00	0.00
Decentralized	37	16	65	67	0.02	0.7	0.01	0.07
Regionalized-1	11	12	6	6	0.00	0.1	0.00	0.00
Regionalized-2	7	6	6	6	0.00	0.1	0.00	0.00
Regionalized-3	7	1	6	6	0.00	0.1	0.00	0.00
Regionalized-4	4	6	6	6	0.00	0.1	0.00	0.00
Centralized	1	1	6	6	0.00	0.1	0.00	0.00

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-15.1-14. SNL-NM—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment FTE	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment
No Action	3	-	0.0	0.00	18	0.00	18	0.00	0.01	0.01	7	0.1
Decentralized	37	16	1.7	0.83	2079	0.05	289	0.05	0.15	0.31	66	1
Regionalized-1	11	12	0.0	0.00	18	0.00	18	0.00	0.01	0.01	0	0
Regionalized-2	7	6	0.0	0.00	18	0.00	18	0.00	0.01	0.01	0	0
Regionalized-3	7	1	0.0	0.00	18	0.00	18	0.00	0.01	0.01	0	0
Regionalized-4	4	6	0.0	0.00	18	0.00	18	0.00	0.01	0.01	0	0
Centralized	1	1	0.0	0.00	18	0.00	18	0.00	0.01	0.01	0	0

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-15.1-15. SNL-NM—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	32	4	8	9	12	19	12	0
Decentralized	37	16	73	14	28	28	3	73	0	0 (2)
Regionalized-1	11	12	6	0	0	2	5	6	0	0
Regionalized-2	7	6	6	0	0	2	5	6	0	0
Regionalized-3	7	1	6	0	0	2	5	6	0	0
Regionalized-4	4	6	6	0	0	2	5	6	0	0
Centralized	1	1	6	0	0	2	5	6	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Disposal occurs at SNL-NM, but throughput is below de minimis value for costing.

II.15.2 SNL-NM LLW

Thirteen tables immediately following portray the impacts of LLW at SNL-NM. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	SNL-NM—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-15.2-1	15-18
2.	SNL-NM—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-15.2-2	15-19
3.	SNL-NM—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-15.2-3	15-20
4.	SNL-NM—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-15.2-4	15-21
5.	SNL-NM—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-15.2-5	15-22
7.	SNL-NM—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-15.2-6	15-23
8.	SNL-NM—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-15.2-7	15-24
9.	SNL-NM—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-15.2-8	15-25
10.	SNL-NM—LLW—Impacts on Water Resources Due to Increased Water Use	II-15.2-9	15-26
11.	SNL-NM—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-15.2-10	15-27
13.	SNL-NM—LLW—Socioeconomic Impacts for Treatment and Disposal	II-15.2-11	15-28
14.	SNL-NM—LLW—Infrastructure Impacts for Treatment and Disposal	II-15.2-12	15-29
15.	SNL-NM—LLW—Cost	II-15.2-13	15-30

Table II-15.2-1. SNL-NM—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	5.1E-04	5.0E-02	1.7E-06	2.9E-08	- -	- -
Decentralized		16	2.2E-02	4.3E-02	1.8E-06	3.0E-08	6.3E-02	3.2E-02
Regionalized-1		12	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Regionalized-2	11	12	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Regionalized-3		6	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Regionalized-4	7	6	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Regionalized-5	4	6	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Regionalized-6		2	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Regionalized-7		2	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Centralized-1		1	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Centralized-2		1	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -
Centralized-3	7	1	2.2E-02	5.5E-02	1.8E-06	3.0E-08	- -	- -
Centralized-4	7	1	2.2E-02	5.5E-02	1.8E-06	3.0E-08	- -	- -
Centralized-5	1	1	4.1E-04	5.1E-02	1.8E-06	3.0E-08	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-15.2-2. SNL-NM—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	3.4E-03	5.8E-06	3.4E-07	5.8E-05	9.9E-08	5.8E-09	1.3E+00	1.8E-03	7.6E-05
Decentralized		16	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	5.4E+01	7.6E-02	3.3E-03
Regionalized-1		12	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Regionalized-2	11	12	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Regionalized-3		6	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Regionalized-4	7	6	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Regionalized-5	4	6	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Regionalized-6		2	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Regionalized-7		2	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Centralized-1		1	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Centralized-2		1	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05
Centralized-3	7	1	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	5.4E+01	7.6E-02	3.3E-03
Centralized-4	7	1	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	5.4E+01	7.6E-02	3.3E-03
Centralized-5	1	1	3.6E-03	6.2E-06	3.6E-07	6.1E-05	1.0E-07	6.1E-09	1.0E+00	1.5E-03	6.2E-05

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-15.2-3. SNL-NM—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	1.6E+02	2.2E-01	9.4E-03
Regionalized-1		12	- -	- -	- -
Regionalized-2	11	12	- -	- -	- -
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-15.2–4. SNL-NM—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	6.8E-11	1.2E-11	- -
Decentralized		16	7.1E-11	1.3E-11	1.6E-02
Regionalized-1		12	7.2E-11	1.3E-11	- -
Regionalized-2	11	12	7.2E-11	1.3E-11	- -
Regionalized-3		6	7.2E-11	1.3E-11	- -
Regionalized-4	7	6	7.2E-11	1.3E-11	- -
Regionalized-5	4	6	7.2E-11	1.3E-11	- -
Regionalized-6		2	7.2E-11	1.3E-11	- -
Regionalized-7		2	7.2E-11	1.3E-11	- -
Centralized-1		1	7.2E-11	1.3E-11	- -
Centralized-2		1	7.2E-11	1.3E-11	- -
Centralized-3	7	1	7.2E-11	1.3E-11	- -
Centralized-4	7	1	7.2E-11	1.3E-11	- -
Centralized-5	1	1	7.2E-11	1.3E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-15.2-5. SNL-NM—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	1.4E-07	2.3E-10	1.4E-11	2.4E-08	4.2E-11	2.4E-12	- -	- -	- -
Decentralized		16	1.4E-07	2.4E-10	1.4E-11	2.5E-08	4.3E-11	2.5E-12	3.2E+01	5.3E-02	3.2E-03
Regionalized-1		12	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Regionalized-2	11	12	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Regionalized-3		6	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Regionalized-4	7	6	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Regionalized-5	4	6	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Regionalized-6		2	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Regionalized-7		2	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Centralized-1		1	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Centralized-2		1	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Centralized-3	7	1	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Centralized-4	7	1	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -
Centralized-5	1	1	1.4E-07	2.4E-10	1.4E-11	2.6E-08	4.3E-11	2.6E-12	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-15.2-6. SNL-NM—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	9 (2/7)	5 (4/1)	0	0	0	1 (0/1)	3 (0/3)	1 (0/1)	0	0	0	0
Decentralized		16	10 (1/9)	5 (3/2)	0	0	0	1 (0/1)	13 (0/13)	3 (0/3)	0	0	0	2 (0/2)
Regionalized-1		12	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	11	12	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-3		6	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-4	7	6	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-5	4	6	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-6		2	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-7		2	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-1		1	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-2		1	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-3	7	1	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-4	7	1	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-5	1	1	10 (1/9)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-15.2-7. SNL-NM—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	9 (2/7)	--	--	--	--	--
Decentralized		16	10 (1/9)	--	--	--	--	--
Regionalized-1		12	10 (1/9)	--	--	--	--	--
Regionalized-2	11	12	10 (1/9)	--	--	--	--	--
Regionalized-3		6	10 (1/9)	--	--	--	--	--
Regionalized-4	7	6	10 (1/9)	--	--	--	--	--
Regionalized-5	4	6	10 (1/9)	--	--	--	--	--
Regionalized-6		2	10 (1/9)	--	--	--	--	--
Regionalized-7		2	10 (1/9)	--	--	--	--	--
Centralized-1		1	10 (1/9)	--	--	--	--	--
Centralized-2		1	10 (1/9)	--	--	--	--	--
Centralized-3	7	1	10 (1/9)	--	--	--	--	--
Centralized-4	7	1	10 (1/9)	--	--	--	--	--
Centralized-5	1	1	10 (1/9)	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (5)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	3 (0/3)	0	0	0	0	0	--	--	--	--	--	--
Decentralized		16	13 (0/13)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-1		12	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	11	12	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3		6	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	7	6	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-5	4	6	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-6		2	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Regionalized-7		2	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Centralized-1		1	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Centralized-2		1	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Centralized-4	7	1	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--
Centralized-5	1	1	5 (0/5)	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions)
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** Ten sites use existing facilities for Volume Reduction.

Table II-15.2-8. SNL-NM—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action			--	--	--	--	--	--	--	--	--	--
Decentralized	10**	6	--	--	--	--	--	--	--	--	--	--
Regionalized-1		16	--	--	--	--	--	--	--	--	--	--
Regionalized-2		12	--	--	--	--	--	--	--	--	--	--
Regionalized-3	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-4		6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3		1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	7	1	--	--	--	--	--	--	--	--	--	--
Centralized - 5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-15.2-9. SNL-NM—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	1077	0.1	- -	622	0.1	- -	- -
Decentralized		16	3675	0.4	- -	1146	0.1	- -	- -
Regionalized-1		12	2499	0.2	- -	627	0.1	- -	- -
Regionalized-2	11	12	2499	0.2	- -	627	0.1	- -	- -
Regionalized-3		6	2499	0.2	- -	627	0.1	- -	- -
Regionalized-4	7	6	2499	0.2	- -	627	0.1	- -	- -
Regionalized-5	4	6	2499	0.2	- -	627	0.1	- -	- -
Regionalized-6		2	2499	0.2	- -	627	0.1	- -	- -
Regionalized-7		2	2499	0.2	- -	627	0.1	- -	- -
Centralized-1		1	2499	0.2	- -	627	0.1	- -	- -
Centralized-2		1	2499	0.2	- -	627	0.1	- -	- -
Centralized-3	7	1	2499	0.2	- -	627	0.1	- -	- -
Centralized-4	7	1	2499	0.2	- -	627	0.1	- -	- -
Centralized-5	1	1	2499	0.2	- -	627	0.1	- -	- -

Notes:
T = Treatment
D = Disposal
Water supplied by the City of Albuquerque and Kirtland AFB. Current water use = 1,000,000 gallons/day.
Wastewater discharged to the City of Albuquerque WWTP.
** Ten sites use existing facilities for Volume Reduction.
- - = Stream Flow is not considered for this site.

Table II-15.2-10. SNL-NM—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	900	2000	0
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	200	0	0	0	2	0	0	0	100	1	0	30000	0	
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-15.2-11. SNL-NM—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	100	83	0.02	0.9	0.01	0.01
Decentralized		16	215	223	0.06	2.4	0.02	0.03
Regionalized-1		12	96	99	0.03	1.1	0.01	0.01
Regionalized-2	11	12	96	99	0.03	1.1	0.01	0.01
Regionalized-3		6	96	99	0.03	1.1	0.01	0.01
Regionalized-4	7	6	96	99	0.03	1.1	0.01	0.01
Regionalized-5		6	96	99	0.03	1.1	0.01	0.01
Regionalized-6		2	96	99	0.03	1.1	0.01	0.01
Regionalized-7		2	96	99	0.03	1.1	0.01	0.01
Centralized-1		1	96	99	0.03	1.1	0.01	0.01
Centralized-2		1	96	99	0.03	1.1	0.01	0.01
Centralized-3	7	1	96	99	0.03	1.1	0.01	0.01
Centralized-4	7	1	96	99	0.03	1.1	0.01	0.01
Centralized-5	1	1	96	99	0.03	1.1	0.01	0.01

Notes:
T = Treatment
D = Disposal
(1) In constant 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-15.2-12. SNL-NM—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	0.9	0.44	1077	0.03	622	0.11	0.12	0.24	51	1
Decentralized		16	3.0	0.97	3675	0.09	1146	0.21	0.39	0.77	110	1
Regionalized-1		12	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Regionalized-2	11	12	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Regionalized-3		6	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Regionalized-4	7	6	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Regionalized-5	4	6	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Regionalized-6		2	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Regionalized-7		2	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Centralized-1		1	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Centralized-2		1	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Centralized-3	7	1	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Centralized-4	7	1	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1
Centralized-5	1	1	1.9	0.92	2499	0.06	627	0.11	0.24	0.46	69	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-15.2-13. SNL-NM—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	113	8	25	75	4	113	0	0
Decentralized		16	243	22	47	105	69	108	0	135
Regionalized-1		12	108	10	37	52	10	108	0	0
Regionalized-2	11	12	108	10	37	52	10	108	0	0
Regionalized-3		6	108	10	37	52	10	108	0	0
Regionalized-4	7	6	108	10	37	52	10	108	0	0
Regionalized-5	4	6	108	10	37	52	10	108	0	0
Regionalized-6		2	108	10	37	52	10	108	0	0
Regionalized-7		2	108	10	37	52	10	108	0	0
Centralized-1		1	108	10	37	52	10	108	0	0
Centralized-2		1	108	10	37	52	10	108	0	0
Centralized-3	7	1	108	10	37	52	10	108	0	0
Centralized-4	7	1	108	10	37	52	10	108	0	0
Centralized-5	1	1	108	10	37	52	10	108	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.15.3 SNL-NM TRUW

SNL-NM has a small amount of TRUW that factored into the transportation analysis but did not warrant analysis of impacts onsite. Therefore, Section 15.3 has been intentionally left blank.

II.16.0 SRS

SRS currently is custodian of significant volumes of LLMW, LLW, and TRUW. Each of the waste types is treated independently in the following sections.

II.16.1 SRS LLMW

Seventeen tables immediately following portray the impacts of LLMW at SRS. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	SRS—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-16.1-1	16-3
2.	SRS—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-16.1-2	16-4
3.	SRS—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-16.1-3	16-5
4.	SRS—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-16.1-4	16-6
5.	SRS—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-16.1-5	16-7
6.	SRS—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-16.1-6	16-8
7.	SRS—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-16.1-7	16-9
8.	SRS—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-16.1-8	16-10
9.	SRS—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-16.1-9	16-11
10.	SRS—LLMW—Impacts on Water Resources Due to Increased Water Use	II-16.1-10	16-12
11.	SRS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-16.1-11	16-13
11.	SRS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) from Disposal (Remote-Handled)	II-16.1-12	16-14
12.	SRS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-16.1-13	16-15
12.	SRS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Remote-Handled)	II-16.1-14	16-16

13.	SRS—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-16.1-15	16-17
14.	SRS—LLMW—Infrastructure Impacts for Treatment and Disposal	II-16.1-16	16-18
15.	SRS—LLMW—Cost	II-16.1-17	16-19

Table II-16.1-1. SRS—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	1.4E-01	6.9E-02	1.6E-03	6.5E-05	- -	- -
Decentralized	37	16	1.1E-01	3.3E-01	1.7E-03	6.1E-05	3.9E-02	1.0E-01
Regionalized-1	11	12	1.1E-01	3.3E-01	1.8E-03	6.1E-05	3.9E-02	1.0E-01
Regionalized-2	7	6	1.1E-01	3.3E-01	1.8E-03	6.1E-05	3.9E-02	1.0E-01
Regionalized-3	7	1	1.1E-01	3.3E-01	1.8E-03	6.1E-05	- -	- -
Regionalized-4	4	6	1.1E-01	3.3E-01	1.8E-03	6.1E-05	3.9E-02	1.0E-01
Centralized	1	1	3.3E-02	4.9E-02	1.3E-06	6.5E-08	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-16.1-2. SRS—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	3.1E+00	5.3E-03	2.9E-06	3.1E-04	1.3E-01	2.2E-04	1.4E-06	1.3E-05	3.4E+02	4.8E-01	1.1E-03	2.0E-02
Decentralized	37	16	3.5E+00	5.9E-03	9.8E-07	3.5E-04	1.2E-01	2.1E-04	4.9E-07	1.2E-05	2.6E+02	3.7E-01	7.0E-04	1.6E-02
Regionalized -1	11	12	3.5E+00	6.0E-03	9.8E-07	3.5E-04	1.2E-01	2.1E-04	4.9E-07	1.2E-05	2.7E+02	3.8E-01	7.0E-04	1.6E-02
Regionalized-2	7	6	3.5E+00	6.0E-03	9.8E-07	3.5E-04	1.2E-01	2.1E-04	4.9E-07	1.2E-05	2.7E+02	3.8E-01	7.0E-04	1.6E-02
Regionalized-3	7	1	3.5E+00	6.0E-03	9.4E-07	3.5E-04	1.2E-01	2.1E-04	4.7E-07	1.2E-05	2.7E+02	3.8E-01	7.0E-04	1.6E-02
Regionalized-4	4	6	3.5E+00	6.0E-03	9.8E-07	3.5E-04	1.2E-01	2.1E-04	4.9E-07	1.2E-05	2.7E+02	3.8E-01	7.0E-04	1.6E-02
Centralized	1	1	2.7E-03	4.6E-06	6.1E-08	2.7E-07	1.3E-04	2.2E-07	3.1E-08	1.3E-08	8.2E+01	1.1E-01	3.8E-05	4.9E-03

Notes:
T = Treatment
D = Disposal

Table II-16.1-3. SRS—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	9.7E+01	1.4E-01	5.8E-03
Regionalized-1	11	12	9.7E+01	1.4E-01	5.8E-03
Regionalized-2	7	6	9.7E+01	1.4E-01	5.8E-03
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	9.7E+01	1.4E-01	5.8E-03
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-16.1-4. SRS—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.5E-08	5.7E-08	- -
Decentralized	37	16	1.7E-08	5.3E-08	2.4E-05
Regionalized-1	11	12	1.7E-08	5.3E-08	2.4E-05
Regionalized-2	7	6	1.7E-08	5.3E-08	2.4E-05
Regionalized-3	7	1	1.7E-08	5.3E-08	- -
Regionalized-4	4	6	1.7E-08	5.3E-08	2.4E-05
Centralized	1	1	1.3E-11	5.7E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-16.1-5. SRS—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probabhlity	Radiation Genetic Effects Probability
No Action	3	-	2.9E-05	5.0E-08	3.7E-11	2.9E-09	1.1E-04	1.9E-07	1.6E-09	1.1E-08	- -	- -	- -	- -
Decentralized	37	16	3.3E-05	5.6E-08	1.3E-11	3.3E-09	1.1E-04	1.8E-07	5.6E-10	1.1E-08	4.9E-02	8.2E-05	2.5E-04	4.9E-06
Regionalized-1	11	12	3.3E-05	5.7E-08	1.3E-11	3.3E-09	1.1E-04	1.8E-07	5.6E-10	1.1E-08	4.9E-02	8.2E-05	2.5E-04	4.9E-06
Regionalized-2	7	6	3.3E-05	5.7E-08	1.3E-11	3.3E-09	1.1E-04	1.8E-07	5.6E-10	1.1E-08	4.9E-02	8.2E-05	2.5E-04	4.9E-06
Regionalized-3	7	1	3.3E-05	5.7E-08	1.2E-11	3.3E-09	1.1E-04	1.8E-07	5.4E-10	1.1E-08	- -	- -	- -	- -
Regionalized-4	4	6	3.3E-05	5.7E-08	1.3E-11	3.3E-09	1.1E-04	1.8E-07	5.6E-10	1.1E-08	4.9E-02	8.2E-05	2.5E-04	4.9E-06
Centralized	1	1	2.5E-08	4.3E-11	7.9E-13	2.5E-12	1.1E-07	1.9E-10	3.5E-11	1.1E-11	- -	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.

Table II-16.1-6. SRS—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	3.8E-08	1.7E-06	5.8E-03	- -
Decentralized	37	16	1.6E-08	6.9E-07	5.8E-03	2.7E+00
Regionalized-1	11	12	1.6E-08	6.9E-07	5.8E-03	2.7E+00
Regionalized-2	7	6	1.6E-08	6.9E-07	5.8E-03	2.7E+00
Regionalized-3	7	1	1.4E-08	6.3E-07	5.8E-03	- -
Regionalized-4	4	6	1.6E-08	6.9E-07	5.8E-03	2.7E+00
Centralized	1	1	1.6E-10	7.0E-09	1.0E-04	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-16.1-7. SRS—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	82 (30/52)	89 (79/10)	0	6 (6/0)	8 (8/0)	14 (8/6)	23 (2/21)	9 (5/4)	0	1 (1/0)	0	2 (0/2)
Decentralized	37	16	123 (19/104)	70 (49/21)	0	4 (4/0)	5 (5/0)	17 (5/12)	60 (1/59)	15 (3/12)	0	2 (0/2)	0	7 (0/7)
Regionalized-1	11	12	128 (19/109)	71 (49/22)	0	4 (4/0)	5 (5/0)	18 (5/13)	62 (1/61)	15 (3/12)	0	2 (0/2)	0	7 (0/7)
Regionalized-2	7	6	128 (19/109)	71 (49/22)	0	4 (4/0)	5 (5/0)	18 (5/13)	62 (1/61)	15 (3/12)	0	2 (0/2)	0	7 (0/7)
Regionalized-3	7	1	99 (4/95)	29 (10/19)	0	1 (1/0)	1 (1/0)	12 (1/11)	47 (0/47)	11 (2/9)	0	1 (1/0)	0	6 (0/6)
Regionalized-4	4	6	128 (19/109)	71 (49/22)	0	4 (4/0)	5 (5/0)	18 (5/13)	62 (1/61)	15 (3/12)	0	2 (0/2)	0	7 (0/7)
Centralized	1	1	39 (1/38)	10 (2/8)	0	0	0	5 (0/5)	11 (0/11)	2 (0/2)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-16.1-8. SRS—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized-1	11	12	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	2	13	0	10	0	1	0	0	0	0	0	0
Decentralized	37	16	1	8	0	10	0	0	0	0	0	0	0	0
Regionalized-1	11	12	1	8	0	10	0	0	0	0	0	0	0	0
Regionalized-2	7	6	1	8	0	10	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	6	0	9	0	0	0	0	0	0	0	0
Regionalized-4	4	6	1	8	0	10	0	0	0	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) SRS is in an attainment area for all criteria pollutants, therefore the GCR doe not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the No Action and minimum treatment (no incineration) alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-16.1-9. SRS—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Decentralized	37	16	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-1	11	12	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-2	7	6	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-3	7	1	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Regionalized-4	4	6	0	0	0	- -	- -	0	- -	- -	0	0	0	0
Centralized	1	1	0	0	0	- -	- -	0	- -	- -	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	- -	0	0	0	- -	0	0	0	- -	- -
Decentralized	37	16	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-1	11	12	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-2	7	6	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-3	7	1	- -	0	0	0	- -	0	0	0	- -	- -
Regionalized-4	4	6	- -	0	0	0	- -	0	0	0	- -	- -
Centralized	1	1	- -	0	0	0	- -	0	0	0	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-16.1-10. SRS—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	74593	4.7	- -	7487	0.5	- -	<0.1
Decentralized	37	16	34974	2.2	- -	8956	0.6	- -	<0.1
Regionalized-1	11	12	35688	2.2	- -	8980	0.6	- -	<0.1
Regionalized-2	7	6	35688	2.2	- -	8980	0.6	- -	<0.1
Regionalized-3	7	1	16697	1.0	- -	7577	0.5	- -	<0.1
Regionalized-4	4	6	35717	2.2	- -	8968	0.6	- -	<0.1
Centralized	1	1	2832	0.2	- -	1053	0.1	- -	<0.1

Notes:
T = Treatment
D = Disposal
Notes: Water supplied by groundwater. Current water use = 1,600,000 gallons/day.
Wastewater discharged to the Savannah River. Average flow rate of the Savannah River = 6,463,000,000 gallons/day.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-16.1-11. SRS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	4
Regionalized-1	11	12	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	4
Regionalized-2	7	6	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	4
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	4
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal of CH-LLMW at this site for this alternative.

Table II-16.1-12. SRS—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) from Disposal (Remote-Handled)

LLMW Alternatives	T	D *	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LLMW Alternatives	T	D *	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Regionalized-1	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Regionalized-2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Regionalized-3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Regionalized-4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0

Notes:
T = Treatment
D = Disposal
* = In addition to the CH-LLMW disposal sites indicated below, disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR and SRS) for all alternatives except No Action.
- - = No disposal at this site for this alternative.

Table II-16.1-13. SRS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	3	0	300	0	100	40	0
Regionalized-1	11	12	0	3	0	300	0	100	40	0
Regionalized-2	7	6	0	3	0	300	0	100	40	0
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	0	3	0	300	0	100	40	0
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	200	0	0	500	30	10	0
Regionalized-1	11	12	200	0	0	500	30	10	0
Regionalized-2	7	6	200	0	0	500	30	10	0
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	200	0	0	500	30	10	0
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-16.1-14. SRS—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Remote-Handled)

LLMW Alternatives	T	D *	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	1	0	0
Regionalized-1	11	12	0	0	0	0	0	1	0	0
Regionalized-2	7	6	0	0	0	0	0	1	0	0
Regionalized-3	7	1	0	0	0	0	0	1	0	0
Regionalized-4	4	6	0	0	0	0	0	1	0	0
Centralized	1	1	0	0	0	0	0	1	0	0

LLMW Alternatives	T	D *	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	1	0	0	3	0	0	0
Regionalized-1	11	12	1	0	0	3	0	0	0
Regionalized-2	7	6	1	0	0	3	0	0	0
Regionalized-3	7	1	1	0	0	3	0	0	0
Regionalized-4	4	6	1	0	0	3	0	0	0
Centralized	1	1	1	0	0	3	0	0	0

Notes:
T = Treatment
D = Disposal
* = In addition to the CH-LLMW disposal sites indicated below, disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR and SRS) for all alternatives except No Action.
"--" = No disposal at this site for this alternative.

Table II-16.1-15. SRS—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	506	436	0.17	4.7	0.06	0.11
Decentralized	37	16	1058	1139	0.45	12.3	0.17	0.31
Regionalized-1	11	12	1100	1184	0.46	12.8	0.18	0.32
Regionalized-2	7	6	1100	1184	0.46	12.8	0.18	0.32
Regionalized-3	7	1	844	909	0.36	9.8	0.13	0.21
Regionalized-4	4	6	1100	1184	0.46	12.8	0.18	0.32
Centralized	1	1	222	239	0.09	2.6	0.04	0.04

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-16.1-16. SRS—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment
No Action	3	-	24.9	0.02	74593	1.49	7487	1.00	10.46	5.98	232	1
Decentralized	37	16	22.6	0.02	34974	0.70	8956	1.19	2.51	1.44	727	4
Regionalized-1	11	12	22.6	0.02	35688	0.71	8980	1.20	2.51	1.44	760	4
Regionalized-2	7	6	22.6	0.02	35688	0.71	8980	1.20	2.55	1.46	649	4
Regionalized-3	7	1	12.8	0.01	16697	0.33	7577	1.01	1.41	0.80	760	4
Regionalized-4	4	6	22.6	0.02	35717	0.71	8968	1.20	2.51	1.44	788	5
Centralized	1	1	12.8	0.00	2832	0.06	1053	0.14	1.41	0.81	207	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-16.1-17. SRS—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	572	37	111	389	36	339	234	0
Decentralized	37	16	1198	133	331	603	122	908	0	289
Regionalized-1	11	12	1245	142	349	628	125	955	0	289
Regionalized-2	7	6	1245	142	349	628	125	955	0	289
Regionalized-3	7	1	955	116	308	483	46	955	0	0
Regionalized-4	4	6	1245	142	349	628	125	955	0	289
Centralized	1	1	253	37	96	104	14	253	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.16.2 SRS LLW

Thirteen tables immediately following portray the impacts of LLW at SRS. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	SRS—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-16.2-1	16-21
2.	SRS—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-16.2-2	16-22
3.	SRS—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-16.2-3	16-23
4.	SRS—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-16.2-4	16-24
5.	SRS—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-16.2-5	16-25
7.	SRS—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-16.2-6	16-26
8.	SRS—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-16.2-7	16-27
9.	SRS—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-16.2-8	16-28
10.	SRS—LLW—Impacts on Water Resources Due to Increased Water Use	II-16.2-9	16-29
11.	SRS—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-16.2-10	16-30
13.	SRS—LLW—Socioeconomic Impacts for Treatment and Disposal	II-16.2-11	16-31
14.	SRS—LLW—Infrastructure Impacts for Treatment and Disposal	II-16.2-12	16-32
15.	SRS—LLW—Cost	II-16.2-13	16-33

Table II-16.2-1. SRS—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	3.3E-01	5.2E-01	5.9E-04	3.2E-05	7.3E-01	2.1E+00
Decentralized		16	2.3E-01	4.4E-01	1.9E-05	1.3E-06	5.8E-01	3.5E+00
Regionalized-1		12	2.3E-01	4.4E-01	1.9E-05	1.3E-06	5.8E-01	3.5E+00
Regionalized-2	11	12	2.8E-01	5.6E-01	6.1E-04	3.3E-05	5.7E-01	3.0E+00
Regionalized-3		6	2.3E-01	4.4E-01	1.9E-05	1.3E-06	5.8E-01	3.5E+00
Regionalized-4	7	6	2.8E-01	5.6E-01	6.1E-04	3.3E-05	5.7E-01	3.0E+00
Regionalized-5	4	6	2.8E-01	5.6E-01	6.1E-04	3.3E-05	5.7E-01	3.0E+00
Regionalized-6		2	2.3E-01	4.4E-01	1.9E-05	1.3E-06	6.1E-01	5.8E+00
Regionalized-7		2	2.3E-01	4.4E-01	1.9E-05	1.3E-06	6.1E-01	5.8E+00
Centralized-1		1	2.3E-01	4.4E-01	1.9E-05	1.3E-06	--	--
Centralized-2		1	2.3E-01	4.4E-01	1.9E-05	1.3E-06	--	--
Centralized-3	7	1	2.8E-01	5.6E-01	6.1E-04	3.3E-05	--	--
Centralized-4	7	1	2.8E-01	5.6E-01	6.1E-04	3.3E-05	--	--
Centralized-5	1	1	2.3E-01	4.4E-01	1.2E-05	1.1E-06	--	--

Notes:
T = Treatment
D = Disposal
-- = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-16.2-2. SRS—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	1.2E+00	2.0E-03	1.2E-04	6.4E-02	1.1E-04	6.4E-06	8.3E+02	1.2E+00	5.0E-02
Decentralized		16	3.7E-02	6.3E-05	3.7E-06	2.6E-03	4.4E-06	2.6E-07	5.7E+02	7.9E-01	3.4E-02
Regionalized-1		12	3.7E-02	6.3E-05	3.7E-06	2.6E-03	4.4E-06	2.6E-07	5.7E+02	7.9E-01	3.4E-02
Regionalized-2	11	12	1.2E+00	2.1E-03	1.2E-04	6.6E-02	1.1E-04	6.6E-06	6.9E+02	9.6E-01	4.1E-02
Regionalized-3		6	3.7E-02	6.3E-05	3.7E-06	2.6E-03	4.4E-06	2.6E-07	5.7E+02	7.9E-01	3.4E-02
Regionalized-4	7	6	1.2E+00	2.1E-03	1.2E-04	6.6E-02	1.1E-04	6.6E-06	6.9E+02	9.6E-01	4.1E-02
Regionalized-5	4	6	1.2E+00	2.1E-03	1.2E-04	6.6E-02	1.1E-04	6.6E-06	6.9E+02	9.6E-01	4.1E-02
Regionalized-6		2	3.7E-02	6.3E-05	3.7E-06	2.6E-03	4.4E-06	2.6E-07	5.7E+02	7.9E-01	3.4E-02
Regionalized-7		2	3.7E-02	6.3E-05	3.7E-06	2.6E-03	4.4E-06	2.6E-07	5.7E+02	7.9E-01	3.4E-02
Centralized-1		1	3.7E-02	6.3E-05	3.7E-06	2.6E-03	4.4E-06	2.6E-07	5.7E+02	8.0E-01	3.4E-02
Centralized-2		1	3.7E-02	6.3E-05	3.7E-06	2.6E-03	4.4E-06	2.6E-07	5.7E+02	8.0E-01	3.4E-02
Centralized-3	7	1	1.2E+00	2.1E-03	1.2E-04	6.7E-02	1.1E-04	6.7E-06	6.9E+02	9.6E-01	4.1E-02
Centralized-4	7	1	1.2E+00	2.1E-03	1.2E-04	6.7E-02	1.1E-04	6.7E-06	6.9E+02	9.6E-01	4.1E-02
Centralized-5	1	1	2.5E-02	4.2E-05	2.5E-06	2.2E-03	3.7E-06	2.2E-06	5.7E+02	7.9E-01	3.4E-02

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-3. SRS—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	1.8E+03	2.5E+00	1.1E-01
Decentralized		16	1.5E+03	2.0E+00	8.7E-02
Regionalized-1		12	1.5E+03	2.0E+00	8.7E-02
Regionalized-2	11	12	1.4E+03	2.0E+00	8.5E-02
Regionalized-3		6	1.5E+03	2.0E+00	8.7E-02
Regionalized-4	7	6	1.4E+03	2.0E+00	8.5E-02
Regionalized-5	4	6	1.4E+03	2.0E+00	8.5E-02
Regionalized-6		2	1.5E+03	2.1E+00	9.1E-02
Regionalized-7		2	1.5E+03	2.1E+00	9.1E-02
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-4. SRS—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	5.6E-09	2.9E-08	3.7E-05
Decentralized		16	1.7E-10	1.1E-09	2.8E-05
Regionalized-1		12	1.7E-10	1.1E-09	3.0E-05
Regionalized-2	11	12	5.7E-09	3.0E-08	3.6E-05
Regionalized-3		6	1.7E-10	1.1E-09	3.0E-05
Regionalized-4	7	6	5.7E-09	3.0E-08	3.6E-05
Regionalized-5	4	6	5.7E-09	3.0E-08	3.6E-05
Regionalized-6		2	1.7E-10	1.1E-09	4.3E-05
Regionalized-7		2	1.7E-10	1.1E-09	4.3E-05
Centralized-1		1	1.8E-10	1.1E-09	- -
Centralized-2		1	1.8E-10	1.1E-09	- -
Centralized-3	7	1	5.7E-09	3.0E-08	- -
Centralized-4	7	1	5.7E-09	3.0E-08	- -
Centralized-5	1	1	1.2E-10	9.5E-10	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-5. SRS—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	1.1E-05	1.9E-08	1.1E-09	5.7E-05	9.7E-08	5.7E-09	7.4E-02	1.3E-04	7.4E-06
Decentralized		16	3.5E-07	5.9E-10	3.5E-11	2.3E-06	3.8E-09	2.3E-10	5.7E-02	9.6E-05	5.7E-06
Regionalized-1		12	3.5E-07	5.9E-10	3.5E-11	2.3E-06	3.8E-09	2.3E-10	6.0E-02	1.0E-04	6.0E-06
Regionalized-2	11	12	1.1E-05	1.9E-08	1.1E-09	5.9E-05	1.0E-07	5.9E-09	7.2E-02	1.2E-04	7.2E-06
Regionalized-3		6	3.5E-07	5.9E-10	3.5E-11	2.3E-06	3.8E-09	2.3E-10	6.0E-02	1.0E-04	6.0E-06
Regionalized-4	7	6	1.1E-05	1.9E-08	1.1E-09	5.9E-05	1.0E-07	5.9E-09	7.2E-02	1.2E-04	7.2E-06
Regionalized-5	4	6	1.1E-05	1.9E-08	1.1E-09	5.9E-05	1.0E-07	5.9E-09	7.2E-02	1.2E-04	7.2E-06
Regionalized-6		2	3.5E-07	5.9E-10	3.5E-11	2.3E-06	3.8E-09	2.3E-10	8.6E-02	1.5E-04	8.6E-06
Regionalized-7		2	3.5E-07	5.9E-10	3.5E-11	2.3E-06	3.8E-09	2.3E-10	8.6E-02	1.5E-04	8.6E-06
Centralized-1		1	3.5E-07	5.9E-10	3.5E-11	2.3E-06	3.9E-09	2.3E-10	--	--	--
Centralized-2		1	3.5E-07	5.9E-10	3.5E-11	2.3E-06	3.9E-09	2.3E-10	--	--	--
Centralized-3	7	1	1.2E-05	2.0E-08	1.2E-09	5.9E-05	1.0E-07	5.9E-09	--	--	--
Centralized-4	7	1	1.2E-05	2.0E-08	1.2E-09	5.9E-05	1.0E-07	5.9E-09	--	--	--
Centralized-5	1	1	2.3E-07	3.9E-10	2.3E-11	1.9E-06	3.2E-09	1.9E-10	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-6. SRS—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	48 (19/29)	56 (50/6)	0	4 (4/0)	5 (5/0)	8 (5/3)	213 (2/211)	46 (4/42)	0	1 (1/0)	0	25 (0/25)
Decentralized		16	83 (23/60)	73 (61/12)	0	5 (5/0)	6 (6/0)	13 (6/7)	197 (1/196)	40 (1/39)	0	0	0	24 (0/24)
Regionalized-1		12	259 (199/60)	529 (517/12)	0	41 (41/0)	49 (49/0)	57 (50/7)	197 (1/196)	40 (1/39)	0	0	0	24 (0/24)
Regionalized-2	11	12	107 (22/85)	75 (58/17)	0	5 (5/0)	6 (6/0)	16 (6/10)	198 (1/197)	41 (2/39)	0	1 (1/0)	0	24 (0/24)
Regionalized-3		6	83 (23/60)	73 (61/12)	0	5 (5/0)	6 (6/0)	13 (6/7)	198 (1/197)	40 (1/39)	0	0	0	24 (0/24)
Regionalized-4	7	6	107 (22/85)	75 (58/17)	0	5 (5/0)	6 (6/0)	16 (6/10)	198 (1/197)	41 (2/39)	0	1 (1/0)	0	24 (0/24)
Regionalized-5	4	6	119 (35/84)	109 (92/17)	0	7 (7/0)	9 (9/0)	19 (9/10)	198 (1/197)	41 (2/39)	0	1 (1/0)	0	24 (0/24)
Regionalized-6		2	97 (37/60)	107 (95/12)	0	8 (8/0)	9 (9/0)	16 (9/7)	324 (1/323)	76 (2/74)	0	1 (0/1)	0	39 (0/39)
Regionalized-7		2	97 (37/60)	107 (95/12)	0	8 (8/0)	9 (9/0)	16 (9/7)	324 (1/323)	76 (2/74)	0	1 (0/1)	0	39 (0/39)
Centralized-1		1	87 (7/80)	35 (19/16)	0	1 (1/0)	2 (2/0)	12 (2/10)	76 (0/76)	21 (1/20)	0	0	0	9 (0/9)
Centralized-2		1	87 (7/80)	35 (19/16)	0	1 (1/0)	2 (2/0)	12 (2/10)	76 (0/76)	21 (1/20)	0	0	0	9 (0/9)
Centralized-3	7	1	94 (9/85)	35 (19/16)	0	2 (2/0)	2 (2/0)	12 (2/10)	91 (0/91)	24 (1/23)	0	1 (1/0)	0	11 (0/11)
Centralized-4	7	1	94 (9/85)	40 (23/17)	0	2 (2/0)	2 (2/0)	12 (2/10)	91 (0/91)	24 (1/23)	0	1 (1/0)	0	11 (0/11)
Centralized-5	1	1	66 (7/59)	35 (19/16)	0	2 (1/0)	2 (2/0)	11 (2/10)	66 (0/66)	19 (1/18)	0	0	0	8 (0/8)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-7. SRS—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	2	11	0	6	0	1	0	0	0	0	0	0
Decentralized		16	1	3	0	2	0	0	--	--	--	--	--	--
Regionalized-1		12	1	3	0	2	0	0	--	--	--	--	--	--
Regionalized-2	11	12	1	6	0	5	0	0	0	0	0	0	0	0
Regionalized-3		6	1	3	0	2	0	0	--	--	--	--	--	--
Regionalized-4	7	6	1	6	0	5	0	0	0	0	0	0	0	0
Regionalized-5	4	6	1	6	0	5	0	0	0	0	0	0	0	0
Regionalized-6		2	1	5	0	2	0	0	--	--	--	--	--	--
Regionalized-7		2	1	5	0	2	0	0	--	--	--	--	--	--
Centralized-1		1	0	2	0	1	0	0	--	--	--	--	--	--
Centralized-2		1	0	2	0	1	0	0	--	--	--	--	--	--
Centralized-3	7	1	0	4	0	4	0	0	0	0	0	0	0	0
Centralized-4	7	1	0	4	0	4	0	0	0	0	0	0	0	0
Centralized-5	1	1	0	2	0	1	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) SRS is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the minimum treatment (no incineration) alternatives, and the Centralized - 5 Alternative are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-8. SRS—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-9. SRS—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	13690	0.9	- -	21968	1.4	- -	<0.1
Decentralized		16	105325	6.6	- -	25298	1.6	- -	<0.1
Regionalized-1		12	105325	6.6	- -	25298	1.6	- -	<0.1
Regionalized-2	11	12	99729	6.2	- -	25682	1.6	- -	<0.1
Regionalized-3		6	105325	6.6	- -	25298	1.6	- -	<0.1
Regionalized-4	7	6	99729	6.2	- -	25682	1.6	- -	<0.1
Regionalized-5	4	6	99729	6.2	- -	25682	1.6	- -	<0.1
Regionalized-6		2	174220	10.9	- -	40247	2.5	- -	<0.1
Regionalized-7		2	174220	10.9	- -	40247	2.5	- -	<0.1
Centralized-1		1	24652	1.5	- -	7911	0.5	- -	<0.1
Centralized-2		1	24652	1.5	- -	7911	0.5	- -	<0.1
Centralized-3	7	1	27709	1.7	- -	10438	0.7	- -	<0.1
Centralized-4	7	1	27709	1.7	- -	10438	0.7	- -	<0.1
Centralized-5	1	1	24652	1.5	- -	7911	0.5	- -	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater. Current water use = 1,600,000 gallons/day.
Wastewater discharged to the Savannah River. Average flow rate of the Savannah River = 6,463,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
- - = Streamflow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-16.2-10. SRS—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Regionalized-2	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Regionalized-6		2	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0
Regionalized-7		2	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	5	0	0	900	0	0
Decentralized		16	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	4	0	0	700	0	0
Regionalized-1		12	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	4	0	0	700	0	0
Regionalized-2	11	12	0	0	8	0	0	0	0	0	3	0	0	0	1	0	0	0	5	0	0	900	0	0
Regionalized-3		6	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	4	0	0	700	0	0
Regionalized-4	7	6	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	5	0	0	900	0	0
Regionalized-5	4	6	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	5	0	0	900	0	0
Regionalized-6		2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	500	0	0
Regionalized-7		2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	500	0	0
Centralized-1		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
- - = Disposal is not considered for this Alternative.

Table II-16.2-11. SRS—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	4128	3555	1.40	38.4	0.53	0.48
Decentralized		16	4365	4699	1.84	50.7	0.69	0.82
Regionalized-1		12	4365	4699	1.84	50.7	0.69	0.82
Regionalized-2	11	12	4136	4452	1.75	48.1	0.69	0.77
Regionalized-3		6	4365	4699	1.84	50.7	0.69	0.82
Regionalized-4	7	6	4136	4452	1.75	48.1	0.69	0.77
Regionalized-5		6	4136	4452	1.75	48.1	0.69	0.77
Regionalized-6		2	5860	6308	2.48	68.1	0.93	1.33
Regionalized-7		2	5860	6308	2.48	68.1	0.93	1.33
Centralized-1		1	942	1014	0.40	10.9	0.15	0.19
Centralized-2		1	942	1014	0.40	10.9	0.15	0.19
Centralized-3	7	1	1125	1211	0.48	13.1	0.18	0.23
Centralized-4	7	1	1125	1211	0.48	13.1	0.18	0.23
Centralized-5	1	1	942	1014	0.40	10.9	0.15	0.19

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-12. SRS—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	23.0	0.02	13690	0.27	21968	2.95	5.31	3.03	224	1
Decentralized		16	49.8	0.03	105325	2.11	25298	3.37	6.46	3.69	3818	22
Regionalized-1		12	49.8	0.03	105325	2.11	25298	3.37	6.46	3.69	3818	22
Regionalized-2	11	12	46.6	0.02	99729	1.99	25682	3.42	6.52	3.73	3289	19
Regionalized-3		6	49.8	0.03	105325	2.11	25298	3.37	6.46	3.69	3818	22
Regionalized-4	7	6	46.6	0.02	99729	1.99	25682	3.42	6.52	3.73	3290	19
Regionalized-5	4	6	46.6	0.03	99729	1.99	25478	3.42	6.52	3.73	3290	19
Regionalized-6		2	82.5	0.06	174220	3.48	40247	5.37	9.77	5.58	6213	36
Regionalized-7		2	82.5	0.06	174220	3.48	40247	5.37	9.77	5.58	6213	36
Centralized-1		1	12.5	0.01	24652	0.49	7911	1.05	6.46	3.69	618	4
Centralized-2		1	12.5	0.01	24652	0.49	7911	1.05	6.46	3.69	618	4
Centralized-3	7	1	13.4	0.01	27709	0.55	10438	1.39	6.36	3.63	660	4
Centralized-4	7	1	13.4	0.01	27709	0.55	10438	1.39	6.36	3.63	660	4
Centralized-5		1	12.5	0.01	24652	0.49	7911	1.05	6.46	3.69	618	4

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-16.2-13. SRS—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	4670	35	1658	2761	216	947	0	3723
Decentralized		16	4939	322	1969	2438	210	904	0	4035
Regionalized-1		12	4939	322	1969	2438	210	904	0	4035
Regionalized-2	11	12	4679	327	1758	2369	225	1267	0	3412
Regionalized-3		6	4939	322	1969	2437	210	904	0	4035
Regionalized-4	7	6	4679	327	1758	2369	225	1267	0	3412
Regionalized-5	4	6	4679	327	1758	2369	225	1267	0	3412
Regionalized-6		2	6630	439	2682	3300	210	904	0	5726
Regionalized-7		2	6630	439	2682	3300	210	904	0	5726
Centralized-1		1	1066	79	321	622	44	1066	0	0
Centralized-2		1	1066	79	321	622	44	1066	0	0
Centralized-3	7	1	1272	116	299	801	56	1272	0	0
Centralized-4	7	1	1272	116	299	801	56	1272	0	0
Centralized-5	1	1	1066	79	321	622	44	1066	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.16.3 SRS TRUW

Twelve tables immediately following portray the impacts of TRUW at SRS. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	SRS—TRUW—Treatment: Estimated Number of Fatalities	II-16.3-1	16-35
2.	SRS—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-16.3-2	16-36
4.	SRS—TRUW—Treatment: MEI Probability of Cancer Fatality	II-16.3-3	16-37
5.	SRS—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-16.3-4	16-38
6.	SRS—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-16.3-5	16-39
7.	SRS—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-16.3-6	16-40
8.	SRS—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-16.3-7	16-41
9.	SRS—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-16.3-8	16-42
10.	SRS—TRUW—Impacts on Water Resources Due to Increased Water Use	II-16.3-9	16-43
13.	SRS—TRUW—Socioeconomic Impacts for Treatment	II-16.3-10	16-44
14.	SRS—TRUW—Infrastructure Impacts for Treatment	II-16.3-11	16-45
15.	SRS—TRUW—Cost	II-16.3-12	16-46

Table II-16.3-1. SRS—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites			WM Worker		Offsite Population	Noninvolved Workers
	CH Treat	RH Treat	Treat STD	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure
No Action **	16	5	WIPP WAC	3.8E-02	2.6E-02	2.2E-05	2.3E-06
Decentralized ***	16	5	WIPP WAC	6.9E-02	8.8E-02	7.2E-05	7.8E-06
Regionalized-1	5	2	Reduce Gas	7.7E-02	1.5E-01	1.4E-04	1.5E-05
Regionalized-2	5	2	LDR	7.4E-02	1.8E-01	2.3E-03	2.4E-04
Regionalized-3	3	2	LDR	7.4E-02	1.8E-01	2.3E-03	2.4E-04
Centralized	WIPP	2	LDR	1.0E-01	7.3E-02	3.4E-05	3.7E-06

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-16.3-2. SRS—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treat	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat	STD	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	4.3E-02	7.4E-05	7.2E-13	4.3E-06	4.7E-03	8.0E-06	3.6E-13	4.7E-07	9.4E+01	1.3E-01	4.1E-10	5.7E-03
Decentralized***	16	5	WIPP WAC	1.5E-01	2.5E-04	1.9E-11	1.5E-05	1.6E-02	2.7E-05	9.5E-12	1.6E-06	1.7E+02	2.4E-01	4.2E-09	1.0E-02
Regionalized-1	5	2	Reduce Gas	2.7E-01	4.6E-04	3.1E-11	2.7E-05	2.9E-01	4.9E-05	1.5E-11	2.9E-06	1.9E+02	2.7E-01	2.2E-08	1.2E-02
Regionalized-2	5	2	LDR	4.5E+00	7.7E-03	2.9E-11	4.5E-04	4.8E-01	8.2E-04	1.5E-11	4.8E-05	1.9E+02	2.6E-01	3.7E-08	1.1E-02
Regionalized-3	3	2	LDR	4.5E+00	7.7E-03	2.9E-11	4.5E-04	4.8E-01	8.2E-04	1.5E-11	4.8E-05	1.9E+02	2.6E-01	3.7E-08	1.1E-02
Centralized	WIPP	2	LDR	6.80E-02	1.2E-04	1.4E-11	6.8E-06	7.3E-03	1.3E-05	6.8E-12	7.3E-07	2.6E+02	3.6E-01	4.0E-09	1.5E-02

Notes:

** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

T = Treatment

D = Disposal

Table II-16.3-3. SRS—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	2.0E-10	2.0E-09
Decentralized***	16	5	WIPP WAC	6.8E-10	6.8E-09
Regionalized-1	5	2	Reduce Gas	1.3E-09	1.3E-08
Regionalized-2	5	2	LDR	2.1E-08	2.1E-07
Regionalized-3	3	2	LDR	2.1E-08	2.1E-07
Centralized	WIPP	2	LDR	3.2E-10	3.2E-09

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-16.3-4. SRS—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite Population MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	4.1E-07	6.9E-10	<9.9E-14	4.1E-11	4.1E-06	6.9E-09	<9.9E-14	4.1E-10
Decentralized ***	16	5	WIPP WAC	1.4E-06	2.3E-09	<9.9E-14	1.4E-10	1.4E-05	2.3E-08	1.1E-14	1.4E-09
Regionalized-1	5	2	Reduce Gas	2.5E-06	4.3E-09	<9.9E-14	2.5E-10	2.5E-05	4.3E-08	1.8E-14	2.5E-09
Regionalized-2	5	2	LDR	4.2E-05	7.2E-08	<9.9E-14	4.2E-09	4.2E-04	7.1E-07	1.7E-14	4.2E-08
Regionalized-3	3	2	LDR	4.2E-05	7.2E-08	<9.9E-14	4.2E-09	4.2E-04	7.1E-07	1.7E-14	4.2E-08
Centralized	WIPP	2	LDR	6.4E-07	1.1E-09	<9.9E-14	6.4E-11	6.4E-06	1.1E-08	<9.9E-14	6.4E-10

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
MEI = Maximally Exposed Individual

Table II-16.3-5. SRS—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment		
	CH Treat	RH Treat		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	<9.9E-14	2.5E-13	5.2E-09
Decentralized***	16	5	WIPP WAC	2.8E-13	1.2E-11	6.7E-08
Regionalized-1	5	2	Reduce Gas	4.5E-13	2.0E-11	7.9E-08
Regionalized-2	5	2	LDR	4.5E-13	2.0E-11	1.3E-07
Regionalized-3	3	2	LDR	4.5E-13	2.0E-11	1.3E-07
Centralized	WIPP	2	LDR	2.0E-13	8.9E-12	6.7E-08

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-16.3-6. SRS—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -	7 (0/7)	1 (0/1)	0	0	0	1 (0/1)
Decentralized***	16	5	WIPP WAC	31 (8/23)	25 (20/5)	0	2 (2/0)	2 (2/0)	5 (2/3)	23 (0/23)	5 (0/5)	0	0	0	3 (3/0)
Regionalized-1	5	2	Reduce Gas	53 (10/43)	34 (25/9)	0	2 (2/0)	2 (2/0)	7 (2/5)	39 (0/39)	8 (1/8)	0	0	0	5 (0/5)
Regionalized-2	5	2	LDR	68 (11/57)	40 (29/11)	0	2 (2/0)	3 (3/0)	10 (3/7)	40 (0/40)	8 (1/8)	0	0	0	5 (0/5)
Regionalized-3	3	2	LDR	68 (11/57)	40 (29/11)	0	2 (2/0)	3 (3/0)	10 (3/7)	40 (0/40)	8 (1/8)	0	0	0	5 (0/5)
Centralized	WIPP	2	LDR	14 (5/9)	16 (14/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	9 (0/9)	2 (0/2)	0	0	0	1 (0/1)

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-16.3-7. SRS—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--
Centralized	WIPP	2	LDR	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	0	1	0	0	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	1	0	1	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	2	0	9	4	0	0	0	0	0	0	0
Regionalized-3	3	2	LDR	0	2	0	9	4	0	0	0	0	0	0	0
Centralized	WIPP	2	LDR	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) SRS is in an attainment area for all criteria pollutants, therfore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-16.3-8. SRS—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

Number of TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance												
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-16.3-9. SRS—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	1973	0.1	- -	<0.1
Decentralized***	16	5	WIPP WAC	13231	0.8	- -	4116	0.3	- -	<0.1
Regionalized-1	5	2	Reduce Gas	18457	1.2	- -	7185	0.4	- -	<0.1
Regionalized-2	5	2	LDR	22118	1.4	- -	7366	0.5	- -	<0.1
Regionalized-3	3	2	LDR	22118	1.4	- -	7366	0.5	- -	<0.1
Centralized	WIPP	2	LDR	8530	0.5	- -	847	0.1	- -	<0.1

Notes:
Water supplied by groundwater. Current water use = 1,600,000 gallons/day.
Wastewater discharged to the Savannah River. Average flow rate of the Savannah River = 6,463,000,000 gallons/day.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Stream Flow is not considered for this site.

Table II-16.3-10. SRS—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	142	123	0.05	1.3	0.02	0.02
Decentralized***	16	5	WIPP WAC	446	480	0.19	5.2	0.07	0.08
Regionalized-1	5	2	Reduce Gas	757	814	0.32	8.8	0.12	0.14
Regionalized-2	5	2	LDR	905	975	0.38	10.5	0.14	0.16
Regionalized-3	3	2	LDR	905	975	0.38	10.5	0.14	0.16
Centralized	WIPP	2	LDR	164	176	0.07	1.9	0.03	0.03

Notes:
(1) In current 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP to assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-16.3-11. SRS—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	1973	0.04	1973	0.26	0.07	0.04	0	0.00
Decentralized***	16	5	WIPP WAC	6.3	0.00	13231	0.26	4116	0.55	0.58	0.33	244	1.40
Regionalized-1	5	2	Reduce Gas	7.8	0.01	18457	0.37	7185	0.96	0.94	0.54	475	2.80
Regionalized-2	5	2	LDR	8.2	0.01	22118	0.44	7366	0.98	1.17	0.67	625	3.60
Regionalized-3	3	2	LDR	8.2	0.01	22118	0.44	7366	0.98	1.17	0.67	625	3.60
Centralized	WIPP	2	LDR	4.3	0.00	8530	0.17	847	0.11	0.19	0.11	86	0.50

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-16.3-12. SRS—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	161	0	0	144	17	0	144	17
Decentralized***	16	5	WIPP - WAC	505	30	134	251	90	15	457	33
Regionalized-1	5	2	Reduce Gas	856	68	246	421	120	15	780	61
Regionalized-2	5	2	LDR	1024	87	327	509	100	15	982	28
Regionalized-3	3	2	LDR	1024	87	327	509	100	15	982	28
Centralized	WIPP	2	LDR	186	8	51	71	55	15	170	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In Current 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.16.4 SRS HLW

Nine of the 14 impact categories apply to HLW at SRS. These impacts are presented in the following tables.

Impact Category

No.	Description	Table No.	Page No.
1.	SRS—HLW—Storage: Estimated Number of Fatalities	II-16.4-1	16-48
2.	SRS—HLW—Storage: Estimated Number of Cancer Incidences and Genetic Effects	II-16.4-2	16-49
7.	SRS—HLW—Emissions in Tons per Year of Criteria Air Pollutants	II-16.4-3	16-50
8.	SRS—HLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-16.4-4	16-51
9.	SRS—HLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-16.4-5	16-52
10.	SRS—HLW—Impacts on Water Resources Due to Increased Water Use	II-16.4-6	16-53
13.	SRS—HLW—Socioeconomic Impacts for Storage	II-16.4-7	16-54
14.	SRS—HLW—Infrastructure Impacts for Storage	II-16.4-8	16-55
15.	SRS—HLW—Cost	II-16.4-9	16-56

Table II-16.4-1. SRS—HLW—Storage: Estimated Number of Fatalities

HLW Alternatives	Number of Storage Sites	WM Workers	
		Radiation Exposure	Physical Hazards
No Action	4	9.8E-01	3.6E-01
Decentralized	4	9.3E-01	3.3E-01
Regionalized-1	3	9.8E-01	3.5E-01
Regionalized-2	3	9.3E-01	3.3E-01
Centralized	1	7.8E-01	2.8E-01

Table II-16.4-2. SRS—HLW—Storage: Estimated Number of Cancer Incidences and Genetic Effects

HLW Alternatives	Number of Storage Sites	WM Workers		
		Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	4	2.5E+03	3.4E+00	1.5E-01
Decentralized	4	2.3E+03	3.3E+00	1.4E-01
Regionalized-1	3	2.5E+03	3.4E+00	1.5E-01
Regionalized-2	3	2.3E+03	3.3E+00	1.4E-01
Centralized	1	1.9E+03	2.7E+00	1.2E-01

Table II-16.4-3. SRS—HLW—Emissions in Tons per Year of Criteria Air Pollutants

HLW Alternatives	Number of Storage Sites	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	4	4 (2/2)	5 (5/0)	0	0	0	0	7 (0/7)	2 (0/2)	0	0	0	1 (0/1)
Decentralized	4	4 (2/2)	5 (5/0)	0	0	0	0	7 (0/7)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-1	3	4 (2/2)	5 (5/0)	0	0	1 (1/0)	1 (1/0)	7 (0/7)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-2	3	4 (2/2)	5 (5/0)	0	0	0	0	6 (0/6)	2 (0/2)	0	0	0	1 (0/1)
Centralized	1	4 (2/2)	5 (5/0)	0	0	0	0	7 (0/7)	1 (0/1)	0	0	0	1 (0/1)

Notes:
S = Storage
Data is based on repository beginning to accept HLW canisters in 2015.
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)

Table II-16.4-4. SRS—HLW—Percent of Standard/Guideline for Criteria Air Pollutants

HLW Alternatives	Number of Storage Sites	Construction					
		Percent of Tons/Year General Conformity Rule (1)					
		CO	NO2	Pb	PM10	SO2	VOC
No Action	4	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--

HLW Alternatives	Number of Storage Sites	Operations & Maintenance										
		Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)				
		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2
No Action	4	--	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) SRS is in an attainment area for all criteria pollutants, therfore the GCR does not apply.
(2) Stationary-source emissions from HLW storage facilities are assumed to be negligible.
(3) Stationary-source emissions from HLW storage facilities are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-16.4-5. SRS—HLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HLW Alternatives	Number of Storage Sites	Operations & Maintenance											
		Total Radio-nuclides	Other Hazardous and Toxic Air Pollutants	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	4	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--	--	--

HLW Alternatives	Number of Storage Sites	Operations & Maintenance									
		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	4	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--

Notes:
-- = Emissions of hazardous and toxic air pollutants, including radionuclides, from HLW storage facilities are assumed to be negligible.

Table II-16.4-6. SRS—HLW—Impacts on Water Resources Due to Increased Water Use

HLW Alternatives	Number of Storage Sites	Construction			Operations			
		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	4	28	<0.1	- -	1,900	0.1	- -	<0.1
Decentralized	4	28	<0.1	- -	1,900	0.1	- -	<0.1
Regionalized-1	3	28	<0.1	- -	1,900	0.1	- -	<0.1
Regionalized-2	3	28	<0.1	- -	1,900	0.1	- -	<0.1
Centralized	1	28	<0.1	- -	1,900	0.1	- -	<0.1

Notes:
Water supplied by groundwater. Current water use = 1,600,000 gallons/day.
Wastewater discharged to the Savannah River. Average flow rate of the Savannah River = 6,463,000,000 gallons/d
Data is based on repository beginning to accept HLW canisters in 2015.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-16.4-7. SRS—HLW—Socioeconomic Impacts for Storage

HLW Alternatives	Number of Storage Sites	Effect of Implementation of Alternatives					
			Jobs		Income		
		Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	4	257	265	0.10	2.9	0.04	0.03
Decentralized	4	311	321	0.13	3.5	0.05	0.03
Regionalized-1	3	309	319	0.13	3.4	0.05	0.03
Regionalized-2	3	311	321	0.13	3.5	0.05	0.03
Centralized	1	146	151	0.06	1.6	0.02	0.03

Notes:
(1) In 1990 dollars. The economic multiplies analysis only was applied to costs through 2015.
(2) Compared to 1990 baseline.

Table II-16.4-8. SRS—HLW—Infrastructure Impacts for Storage

HLW Alternatives	Number of Storage Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	4	2	0.00	1,900	0.04	1,900	0.3	0.05	0.03	16	0
Decentralized	4	2	0.00	1,900	0.04	1,900	0.3	0.05	0.03	16	0
Regionalized-1	3	4	0.00	1,900	0.04	1,900	0.3	0.05	0.03	17	0
Regionalized-2	3	2	0.00	1,900	0.04	1,900	0.3	0.05	0.03	16	0
Centralized	1	0	0.00	1,900	0.04	1,900	0.3	0.05	0.03	16	0

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.

Table II-16.4-9. SRS—HLW—Cost

HLW Alternatives	Number of Storage Sites	Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)		Cost by Functional Area (1)	
			Construction (Millions) (2)	Operations & Maintenance (3) (Millions)	Storage (Millions)	Handling (Millions)
No Action	4	490	40	451	159	332
Decentralized	4	567	40	527	91	476
Regionalized-1	3	594	40	554	94	500
Regionalized-2	3	567	40	527	91	476
Centralized	1	283	0	283	17	266
Centralized Delayed Acceptance	1	401	0	401	17	384

Notes:
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of Life Cycle Components = Sum of Functional Areas.
(2) Construction costs are for the interim storage facilities.
(3) Operations and maintenance costs include operation and maintenance of the interim storage facilities, and the handling of canisters (unloading/loading of canisters into or out of the interim storage facilities).

II.16.5 SRS HW

Eleven of the 14 impact categories apply to HW at SRS. These impacts are presented in the following tables.

Impact Category

No.	Description	Table No.	Page No.
1.	SRS—HW—Treatment: Estimated Number of Fatalities	II-16.5-1	16-58
2.	SRS—HW—Treatment: Estimated Number of Cancer Incidences	II-16.5-2	16-59
5.	SRS—HW—Treatment: MEI Probability of Cancer Incidences	II-16.5-3	16-60
6.	SRS—HW—Treatment: Noncancer Health Risk From Chemical Exposure	II-16.5-4	16-61
7.	SRS—HW—Emissions in Tons per Year of Criteria Air Pollutants	II-16.5-5	16-62
8.	SRS—HW—Percent of Standard/Guideline for Criteria Air Pollutants	II-16.5-6	16-63
9.	SRS—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-16.5-7	16-64
10.	SRS—HW—Impacts on Water Resources Due to Increased Water Use	II-16.5-8	16-65
13.	SRS—HW—Socioeconomic Impacts for Treatment	II-16.5-9	16-66
14.	SRS—HW—Infrastructure Impacts for Treatment	II-16.5-10	16-67
15.	SRS—HW—Cost	II-16.5-11	16-68

Table II-16.5-1. SRS—HW—Treatment: Estimated Number of Fatalities

HW Alternatives	Number of Treatment Sites	WM Workers Physical Hazards
No Action	2	- -
Decentralized	3	8.4E-03
Regionalized-1	5	7.9E-03
Regionalized-2	2	- -

Notes:
- - = Treatment is not considered for this alternative

Table II-16.5-2. SRS—HW—Treatment: Estimated Number of Cancer Incidences

HW Alternatives	Number of Treatment Sites	Treatment		
		Offsite Population Chemical Cancer Incidence	Noninvolved Workers Chemical Cancer Incidence	WM Workers Chemical Cancer Incidence
No Action	2	- -	- -	- -
Decentralized	3	1.3E-03	6.5E-04	1.0E-01
Regionalized-1	5	1.2E-03	5.9E-04	9.3E-02
Regionalized-2	2	- -	- -	- -

Notes:
- - = Treatment is not considered for this alternative.

Table II-16.5-3. SRS—HW—Treatment: MEI Probability of Cancer Incidences

HW Alternatives	Number of Treatment Sites	Treatment	
		Offsite MEI Cancer Incidence Probability	Noninvolved MEI Cancer Incidence Probability
No Action	2	- -	- -
Decentralized	3	1.7E-08	7.4E-07
Regionalized-1	5	1.5E-08	6.7E-07
Regionalized-2	2	- -	- -

Notes:
MEI = Maximally Exposed Individual
- - = Treatment is not considered for this alternative.

Table II-16.5-4. SRS—HW—Treatment: Noncancer Health Risk From Chemical Exposure

HW Alternatives	Number of Treatment Sites	Treatment		
		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action	2	- -	- -	- -
Decentralized	3	2.2E-04	9.9E-03	5.3E+00
Regionalized-1	5	2.0E-04	9.0E-03	5.2E+00
Regionalized-2	2	- -	- -	- -

Notes:
MEI = Maximally Exposed Individual
- - = Treatment is not considered for this alternative.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-16.5-5. SRS—HW—Emissions in Tons per Year of Criteria Air Pollutants

HW Alternatives	Number of Treatment Sites	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	3	3 (2/1)	5 (5/0)	0	0	0	1 (0/0)	0	0	0	0	1 (1/0)	0
Regionalized - 1	5	3 (2/1)	5 (5/0)	0	0	0	1 (0/0)	0	0	0	0	1 (1/0)	0
Regionalized - 2	2	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)

Table II-16.5-6. SRS—HW—Percent of Standard/Guideline for Criteria Air Pollutants

HW Alternatives	Number of Treatment Sites	Construction					
		Percent of Tons/Year General Conformity Rule (1)					
		CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--
Decentralized	3	--	--	--	--	--	--
Regionalized-1	5	--	--	--	--	--	--
Regionalized-2	2	--	--	--	--	--	--

HW Alternatives	Number of Treatment Sites	Operations & Maintenance											
		Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	2	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	3	0	0	0	3	1	0	0	0	0	0	0	0
Regionalized-1	5	0	0	0	3	1	0	0	0	0	0	0	0
Regionalized-2	2	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) SRS is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the Regionalized-2 Alternative are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-16.5-7. SRS—HW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HW Alternatives	Number of Treatment Sites	Operations & Maintenance												
		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	2	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	--	--	0	--	--	0	0	--	--	--	--
Regionalized - 1	5	--	--	--	0	--	--	0	0	--	--	--	--
Regionalized - 2	2	--	--	--	--	--	--	--	--	--	--	--	--

HW Alternatives	Number of Treatment Sites	Operations & Maintenance									
		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	Vinyl Chloride
No Action	2	--	--	--	--	--	--	--	--	--	--
Decentralized	3	--	0	--	--	0	--	0	0	0	1
Regionalized - 1	5	--	0	--	--	0	--	0	0	0	1
Regionalized - 2	2	--	--	--	--	--	--	--	--	--	--

Notes:
Percentages <1% are shown as zeros.
-- = Emissions of certain hazardous or toxic air pollutants, including radionuclides, from HW treatment facilities are assumed to be negligible.

Table II-16.5-8. SRS—HW—Impacts on Water Resources Due to Increased Water Use

HW Alternatives	Number of Treatment Sites	Construction			Operations			
		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	2	--	--	--	--	--	--	--
Decentralized	3	516	<0.1	--	358	<0.1	--	<0.1
Regionalized-1	5	593	<0.1	--	371	<0.1	--	<0.1
Regionalized-2	2	--	--	--	--	--	--	--

Notes:
Water supplied by groundwater. Current water use = 1,600,000 gallons/day.
Wastewater discharged to the Savannah River. Average flow rate of the Savannah River = 6,463,000,000 gallons/day.
-- = Not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-16.5-9. SRS—HW—Socioeconomic Impacts for Treatment

HW Alternatives	Number of Treatment Sites	Effect of Implementation of Alternatives					
		Cost (Millions) (1)	Jobs		Income		% ROI Population Increase (2)
			Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	
No Action	2	- -	- -	- -	- -	- -	- -
Decentralized	3	24	30	0.01	0.3	0.00	0.00
Regionalized 1	5	25	31	0.01	0.3	0.00	0.00
Regionalized 2	2	- -	- -	- -	- -	- -	- -

Notes:
- - = Treatment is not considered for this alternative.
(1) In 1990 dollars.
(2) Compared to 1990 baseline.

Table II-16.5-10. SRS—HW—Infrastructure Impacts for Treatment

HW Alternatives	Number of Treatment Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	2	--	--	--	--	--	--	--	--	--	--
Decentralized	3	1	0.000	516	0.01	358	0.05	0.13	0.07	8	0
Regionalized-1	5	1	0.001	593	0.01	371	0.05	0.13	0.07	10	0
Regionalized-2	2	--	--	--	--	--	--	--	--	--	--

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
-- = Treatment is not considered for this alternative
(1) Based on 1991 Site Employment.

Table II-16.5-11. SRS—HW—Cost

HW Alternatives	Number of Treatment Sites	Total Cost (Millions) (1)	Government Cost by Life-Cycle Component (1)				Cost by Functional Area (1)	
			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment & Disposal	
							Government (2) (Millions)	Commercial (Millions)
No Action	2	3	0	0	3	0	0	3
Decentralized	3	31	2	10	15	1	28	3
Regionalized-1	5	32	2	10	16	1	29	3
Regionalized-2	2	--	--	--	--	--	--	--

Notes:
-- = Not considered for this site.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Functional Areas.
(2) Government costs equal to the sum of the life-cycle components.

II.17.0 WIPP

II.17.1 WIPP LLMW

WIPP is not one of the sites considered for management of LLMW. Therefore, Section 17.1 has been intentionally left blank.

II.17.2 WIPP LLW

WIPP is not considered for the management of LLW. Therefore, Section 17.2 has been intentionally left blank.

II.17.3 WIPP TRUW

Twelve tables immediately following portray the impacts of TRUW at WIPP. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	WIPP—TRUW—Treatment: Estimated Number of Fatalities	II-17.3-1	17-3
2.	WIPP—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-17.3-2	17-4
4.	WIPP—TRUW—Treatment: MEI Probability of Cancer Fatality	II-17.3-3	17-5
5.	WIPP—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-17.3-4	17-6
6.	WIPP—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-17.3-5	17-7
7.	WIPP—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-17.3-6	17-8
8.	WIPP—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-17.3-7	17-9
9.	WIPP—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-17.3-8	17-10
10.	WIPP—TRUW—Impacts on Water Resources Due to Increased Water Use	II-17.3-9	17-11
13.	WIPP—TRUW—Socioeconomic Impacts for Treatment	II-17.3-10	17-12
14.	WIPP—TRUW—Infrastructure Impacts for Treatment	II-17.3-11	17-13
15.	WIPP—TRUW—Cost	II-17.3-12	17-14

Table II-17.3-1. WIPP—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites			WM Worker		Offsite Population	Noninvolved Workers
	CH Treat	RH Treat	Treatment Standard	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure
No Action **	16	5	WIPP WAC	- -	- -	- -	- -
Decentralized ***	16	5	WIPP WAC	- -	- -	- -	- -
Regionalized-1	5	2	Reduce Gas	- -	- -	- -	- -
Regionalized-2	5	2	LDR	- -	- -	- -	- -
Regionalized-3	3	2	LDR	- -	- -	- -	- -
Centralized	WIPP	2	LDR	1.6E-02	4.4E-01	2.6E-01	2.1E-02

Notes:
- - = WIPP is only considered under the Centralized Alternative.
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-17.3-2. WIPP—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	WIPP	2	LDR	5.2E+02	8.9E-01	5.5E-10	5.2E-02	4.2E+01	7.2E-02	2.8E-10	4.2E-03	4.1E+01	5.7E-02	4.6E-06	2.4E-03

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-17.3-3. WIPP—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	--	--
Decentralized***	16	5	WIPP WAC	--	--
Regionalized-1	5	2	Reduce Gas	--	--
Regionalized-2	5	2	LDR	--	--
Regionalized-3	3	2	LDR	--	--
Centralized	WIPP	2	LDR	6.9E-05	8.2E-05

Notes:
-- = Treatment is not considered under this alternative
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP

Table II-17.3-4. WIPP—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite Population MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	--	--	--	--	--	--	--	--
Decentralized ***	16	5	WIPP WAC	--	--	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--	--	--
Centralized	WIPP	2	LDR	1.4E-01	2.3E-04	2.1E-13	1.4E-05	1.6E-01	2.8E-04	1.3E-12	1.6E-05

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
-- = WIPP is only considered under the Centralized Alternative.

Table II-17.3-5. WIPP—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment		
	CH Treat	RH Treat		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	--	--	--
Decentralized***	16	5	WIPP WAC	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--
Regionalized-2	5	2	LDR	--	--	--
Regionalized-3	3	2	LDR	--	--	--
Centralized	WIPP	2	LDR	4.9E-11	3.0E-10	5.2E-04

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
-- = Treatment is not considered under this alternative.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-17.3–6. WIPP—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	--	--	--	--	--	--	1 (0/1)	2 (0/2)	0	0	0	0
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	1 (0/1)	2 (0/2)	0	0	0	0
Regionalized-2	5	2	LDR	--	--	--	--	--	--	0	1 (0/1)	0	0	0	0
Regionalized-3	3	2	LDR	--	--	--	--	--	--	0	1 (0/1)	0	0	0	0
Centralized	WIPP	2	LDR	104 (55/49)	153 (143/10)	0	11 (11/0)	14 (14/0)	20 (14/6)	8 (1/7)	9 (6/3)	0	4 (4/0)	0	1 (0/1)

Notes:

Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.

CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.

(1) Values = total emissions (equipment emissions / worker vehicles emission)

(2) Values = total emissions (stationary-source emissions / mobile-source emission)

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-17.3-7. WIPP—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--
Centralized	WIPP	2	LDR	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	WIPP	2	LDR	1	15	0	25	1	0	0	0	0	2	0	0

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) WIPP is in an attainment area for all criteria pollutants, therfore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for alternatives that do not involve treatment to LDR (incineration) are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-17.3-8. WIPP—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	WIPP	2	LDR	137	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	--	--	--	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled.

Table II-17.3-9. WIPP—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	--	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--	--
Centralized	WIPP	2	LDR	41429	287.7	--	15204	105.6	--	--

Notes:
Water supplied by municipal system from City of Carlsbad. Current water use = 14,400 gallons/day.
Wastewater discharged to onsite evaporation ponds.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = WIPP is only considered under the Centralized Alternative, and Stream Flow and Waste Water Stream Flow are not considered for WIPP.

Table II-17.3-10. WIPP—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -
Decentralized***	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -
Regionalized-1	5	2	Reduce Gas	- -	- -	- -	- -	- -	- -
Regionalized-2	5	2	LDR	- -	- -	- -	- -	- -	- -
Regionalized-3	3	2	LDR	- -	- -	- -	- -	- -	- -
Centralized	WIPP	2	LDR	2074	2046	2.05	22.1	0.75	0.64

Notes:
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
- - = WIPP is only considered under the Centralized Alternative.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-17.3-11. WIPP—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP WAC	--	--	--	--	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--	--	--	--	--
Centralized	WIPP	2	LDR	8.8	0.09	41429	7.7	15204	82.18	3.5	49.96	1512	102.20

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
-- = WIPP is only considered under the Centralized Alternative.

Table II-17.3-12. WIPP—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	--	--	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	--	--	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	--	--	--	--	--	--	--	--
Regionalized-2	5	2	LDR	--	--	--	--	--	--	--	--
Regionalized-3	3	2	LDR	--	--	--	--	--	--	--	--
Centralized	WIPP	2	LDR	2346	185	832	1243	86	0	2346	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.18.0 WVDP

WVDP currently is the custodian of significant volumes of LLMW, LLW, TRUW, and HLW. Each of the waste types is treated independently in the following sections.

II.18.1 WVDP LLMW

Fourteen tables immediately following portray the impacts of LLMW at WVDP. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	WVDP—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-18.1-1	18-2
2.	WVDP—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-18.1-2	18-3
3.	WVDP—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-18.1-3	18-4
4.	WVDP—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-18.1-4	18-5
5.	WVDP—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-18.1-5	18-6
6.	WVDP—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure	II-18.1-6	18-7
7.	WVDP—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-18.1-7	18-8
8.	WVDP—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-18.1-8	18-9
9.	WVDP—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-18.1-9	18-10
10.	WVDP—LLMW—Impacts on Water Resources Due to Increased Water Use	II-18.1-10	18-11
11.	WVDP—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-18.1-11	18-12
13.	WVDP—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-18.1-12	18-13
14.	WVDP—LLMW—Infrastructure Impacts for Treatment and Disposal	II-18.1-13	18-14
15.	WVDP—LLMW—Cost	II-18.1-14	18-15

Table II-18.1-1. WVDP—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	3.1E-05	7.6E-04	1.4E-04	3.4E-07	- -	- -
Decentralized	37	16	2.5E-03	4.8E-03	2.5E-07	4.2E-10	- -	- -
Regionalized-1	11	12	2.8E-05	3.2E-03	1.7E-07	2.2E-10	- -	- -
Regionalized-2	7	6	2.8E-05	3.2E-03	1.7E-07	2.2E-10	- -	- -
Regionalized-3	7	1	2.8E-05	3.2E-03	1.7E-07	2.2E-10	- -	- -
Regionalized-4	4	6	2.9E-05	3.3E-03	1.7E-07	2.3E-10	- -	- -
Centralized	1	1	2.9E-05	3.3E-03	1.7E-07	2.3E-10	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-18.1-2. WVDP—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	2.7E-01	4.7E-04	1.5E-07	2.7E-05	6.7E-04	1.1E-06	3.0E-09	6.7E-08	7.7E-02	1.1E-04	1.4E-09	4.6E-06
Decentralized	37	16	5.0E-04	8.6E-07	5.1E-09	5.0E-08	8.4E-07	1.4E-09	1.0E-10	8.4E-11	6.2E+00	8.6E-03	1.2E-09	3.7E-04
Regionalized-1	11	12	3.4E-04	5.8E-07	4.5E-09	3.4E-08	4.4E-07	7.5E-10	8.9E-11	4.4E-11	6.9E-02	9.6E-05	1.1E-09	4.1E-06
Regionalized-2	7	6	3.4E-04	5.8E-07	4.5E-09	3.4E-08	4.4E-07	7.5E-10	8.9E-11	4.4E-11	6.9E-02	9.6E-05	1.1E-09	4.1E-06
Regionalized-3	7	1	3.4E-04	5.8E-07	4.5E-09	3.4E-08	4.4E-07	7.5E-10	8.9E-11	4.4E-11	6.9E-02	9.6E-05	1.1E-09	4.1E-06
Regionalized-4	4	6	3.5E-04	5.9E-07	4.5E-09	3.5E-08	4.6E-07	7.8E-10	9.0E-11	4.6E-11	7.3E-02	1.0E-04	1.2E-09	4.4E-06
Centralized	1	1	3.5E-04	5.9E-07	4.5E-09	3.5E-08	4.6E-07	7.8E-10	9.0E-11	4.6E-11	7.3E-02	1.0E-04	1.2E-09	4.4E-06

Notes:
T = Treatment
D = Disposal

Table II-18.1-3. WVDP—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	- -	- -	- -
Regionalized-1	11	12	- -	- -	- -
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-18.1-4. WVDP—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	2.1E-09	1.9E-09	- -
Decentralized	37	16	3.8E-12	2.4E-12	- -
Regionalized-1	11	12	2.6E-12	1.3E-12	- -
Regionalized-2	7	6	2.6E-12	1.3E-12	- -
Regionalized-3	7	1	2.6E-12	1.3E-12	- -
Regionalized-4	4	6	2.6E-12	1.3E-12	- -
Centralized	1	1	2.6E-12	1.3E-12	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-18.1-5. WVDP—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Hypothetical Farm Family Most Exposed Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	4.1E-08	7.0E-09	5.0E-12	4.1E-10	3.8E-08	6.4E-09	1.5E-11	3.8E-10	--	--	--	--
Decentralized	37	16	7.6E-09	1.3E-11	1.7E-13	7.6E-13	4.8E-09	8.1E-12	5.1E-13	4.8E-13	--	--	--	--
Regionalized-1	11	12	5.2E-09	8.8E-12	1.5E-13	5.2E-13	2.5E-09	4.3E-12	4.5E-13	2.5E-13	--	--	--	--
Regionalized-2	7	6	5.2E-09	8.8E-12	1.5E-13	5.2E-13	2.5E-09	4.3E-12	4.5E-13	2.5E-13	--	--	--	--
Regionalized-3	7	1	5.2E-09	8.8E-12	1.5E-13	5.2E-13	2.5E-09	4.3E-12	4.5E-13	2.5E-13	--	--	--	--
Regionalized-4	4	6	5.2E-09	8.9E-12	1.5E-13	5.2E-13	2.6E-09	4.4E-12	4.5E-13	2.6E-13	--	--	--	--
Centralized	1	1	5.2E-09	8.9E-12	1.5E-13	5.2E-13	2.6E-09	4.4E-12	4.5E-13	2.6E-13	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered for this alternative.

Table II-18.1-6. WVDP—LLMW—Treatment and Disposal: Noncancer Health Risk from Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	4.8E-09	1.4E-08	8.7E-08	- -
Decentralized	37	16	7.1E-11	2.1E-10	9.9E-08	- -
Regionalized-1	11	12	2.1E-11	6.2E-11	8.7E-08	- -
Regionalized-2	7	6	2.1E-11	6.2E-11	8.7E-08	- -
Regionalized-3	7	1	2.1E-11	6.2E-11	8.7E-08	- -
Regionalized-4	4	6	2.4E-11	6.9E-11	9.9E-08	- -
Centralized	1	1	2.4E-11	6.9E-11	9.9E-08	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-18.1-7. WVDP—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)	0	0	0	0	0	0
Decentralized	37	16	3 (1/2)	2 (2/0)	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-1	11	12	1 (0/1)	0	0	0	0	0	0	0	0	0	0	0
Regionalized-2	7	6	1 (0/1)	0	0	0	0	0	0	0	0	0	0	0
Regionalized-3	7	1	1 (0/1)	0	0	0	0	0	0	0	0	0	0	0
Regionalized-4	4	6	1 (0/1)	0	0	0	0	0	0	0	0	0	0	0
Centralized	1	1	1 (0/1)	0	0	0	0	0	0	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-18.1-8. WVDP—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	--	--	--	--	--
Decentralized	37	16	--	--	--	--	--	--
Regionalized-1	11	12	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	7	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) WVDP is in an attainment area for all criteria pollutants, therefore the GCR does not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-18.1-9. WVDP—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
- - = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-18.1-10. WVDP—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	229	0.3	<0.1	18	<0.1	<0.1	<0.1
Decentralized	37	16	1925	2.8	<0.1	240	0.3	<0.1	<0.1
Regionalized-1	11	12	365	0.5	<0.1	173	0.2	<0.1	<0.1
Regionalized-2	7	6	365	0.5	<0.1	173	0.2	<0.1	<0.1
Regionalized-3	7	1	365	0.5	<0.1	173	0.2	<0.1	<0.1
Regionalized-4	4	6	365	0.5	<0.1	173	0.2	<0.1	<0.1
Centralized	1	1	365	0.5	<0.1	173	0.2	<0.1	<0.1

Notes:
T = Treatment
D = Disposal
Notes: Water supplied by surface water from 2 onsite reservoirs. Current water use = 70,000 gallons/day.
Wastewater discharged to Buttermilk Creek. Average flow rate of Buttermilk Creek = 41,000,000 gallons/day.
<0.1 indicates that the percentage is less than 0.1%.

Table II-18.1-11. WVDP—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLMW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-2	7	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized	1	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

LLMW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-2	7	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Centralized	1	1	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-18.1-12. WVDP—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	23	21	0.00	0.2	0.00	0.00
Decentralized	37	16	15	17	0.00	0.2	0.00	0.00
Regionalized-1	11	12	6	7	0.00	0.1	0.00	0.00
Regionalized-2	7	6	6	7	0.00	0.1	0.00	0.00
Regionalized-3	7	1	6	7	0.00	0.1	0.00	0.00
Regionalized-4	4	6	6	7	0.00	0.1	0.00	0.00
Centralized	1	1	6	7	0.00	0.1	0.00	0.00

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline

Table II-18.1-13. WVDP—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	0.36	0.221	229	0.21	18	0.03	0.02	0.31	34	5
Decentralized	37	16	1.5	0.908	1925	1.75	240	0.34	0.26	4.03	14	2
Regionalized-1	11	12	0.65	0.393	365	0.33	173	0.25	0.03	0.54	8	1
Regionalized-2	7	6	0.65	0.393	365	0.33	173	0.25	0.03	0.54	8	1
Regionalized-3	7	1	0.65	0.393	365	0.33	173	0.25	0.03	0.54	8	1
Regionalized-4	4	6	0.65	0.393	365	0.33	173	0.25	0.03	0.55	8	1
Centralized	1	1	0.65	0.393	365	0.33	173	0.25	0.03	0.55	8	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-18.1-14. WVDP—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	26	9	11	5	1	7	19	0
Decentralized	37	16	17	2	7	6	2	7	0	10
Regionalized-1	11	12	7	2	4	1	1	7	0	0
Regionalized-2	7	6	7	2	4	1	1	7	0	0
Regionalized-3	7	1	7	2	4	1	1	7	0	0
Regionalized-4	4	6	7	2	4	1	1	7	0	0
Centralized	1	1	7	2	4	1	1	7	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.18.2 WVDP LLW

Impact Category

No.	Description	Table No.	Page No.
1.	WVDP—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-18.2-1	18-17
2.	WVDP—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-18.2-2	18-18
3.	WVDP—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-18.2-3	18-19
4.	WVDP—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-18.2-4	18-20
5.	WVDP—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-18.2-5	18-21
7.	WVDP—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-18.2-6	18-22
8.	WVDP—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-18.2-7	18-23
9.	WVDP—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-18.2-8	18-24
10.	WVDP—LLW—Impacts on Water Resources Due to Increased Water Use	II-18.2-9	18-25
11.	WVDP—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-18.2-10	18-26
13.	WVDP—LLW—Socioeconomic Impacts for Treatment and Disposal	II-18.2-11	18-27
14.	WVDP—LLW—Infrastructure Impacts for Treatment and Disposal	II-18.2-12	18-28
15.	WVDP—LLW—Cost	II-18.2-13	18-29

Table II-18.2-1. WVDP—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	1.9E-02	3.8E-02	3.5E-06	7.5E-09	- -	- -
Decentralized	- -	16	1.3E-02	4.9E-02	1.2E-06	1.5E-11	2.5E-02	6.8E-02
Regionalized-1	- -	12	1.3E-02	5.3E-02	2.1E-06	4.3E-09	- -	- -
Regionalized-2	11	12	1.3E-02	5.3E-02	2.1E-06	4.4E-09	- -	- -
Regionalized-3	- -	6	1.3E-02	5.3E-02	2.1E-06	4.3E-09	- -	- -
Regionalized-4	7	6	1.3E-02	5.3E-02	2.1E-06	4.4E-09	- -	- -
Regionalized-5	4	6	1.3E-02	5.3E-02	2.1E-06	4.4E-09	- -	- -
Regionalized-6	- -	2	1.3E-02	5.3E-02	2.1E-06	4.3E-09	- -	- -
Regionalized-7	- -	2	1.3E-02	5.3E-02	2.1E-06	4.3E-09	- -	- -
Centralized-1	- -	1	1.3E-02	5.3E-02	2.1E-06	4.3E-09	- -	- -
Centralized-2	- -	1	1.3E-02	5.3E-02	2.1E-06	4.3E-09	- -	- -
Centralized-3	7	1	1.3E-02	5.3E-02	2.1E-06	4.4E-09	- -	- -
Centralized-4	7	1	1.3E-02	5.3E-02	2.1E-06	4.4E-09	- -	- -
Centralized-5	1	1	1.3E-02	5.3E-02	2.1E-06	4.4E-09	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-18.2-2. WVDP—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	7.1E-03	1.2E-05	7.1E-07	1.5E-05	2.5E-08	1.5E-09	4.6E+01	6.5E-02	2.8E-03
Decentralized	--	16	2.5E-03	4.2E-06	2.5E-07	5.1E-06	8.7E-09	5.1E-10	3.2E+01	4.5E-02	1.9E-03
Regionalized-1	--	12	4.1E-03	7.0E-06	4.1E-07	8.6E-06	4.3E-09	8.6E-10	3.2E+01	4.5E-02	1.9E-03
Regionalized-2	11	12	4.2E-03	7.2E-06	4.2E-07	8.8E-06	1.5E-08	8.8E-10	3.2E+01	4.5E-02	1.9E-03
Regionalized-3	--	6	4.1E-03	7.0E-06	4.1E-07	8.6E-06	1.5E-08	8.6E-10	3.2E+01	4.5E-02	1.9E-03
Regionalized-4	7	6	4.2E-03	7.2E-06	4.2E-07	8.8E-06	1.5E-08	8.8E-10	3.2E+01	4.5E-02	1.9E-03
Regionalized-5	4	6	4.2E-03	7.2E-06	4.2E-07	8.8E-06	1.5E-08	8.8E-10	3.2E+01	4.5E-02	1.9E-03
Regionalized-6	--	2	4.1E-03	7.0E-06	4.1E-07	8.6E-06	1.5E-08	8.6E-10	3.2E+01	4.5E-02	1.9E-03
Regionalized-7	--	2	4.1E-03	7.0E-06	4.1E-07	8.6E-06	1.5E-08	8.6E-10	3.2E+01	4.5E-02	1.9E-03
Centralized-1	--	1	4.1E-03	7.0E-06	4.1E-07	8.6E-06	1.5E-08	8.6E-10	3.2E+01	4.5E-02	1.9E-03
Centralized-2	--	1	4.1E-03	7.0E-06	4.1E-07	8.6E-06	1.5E-08	8.6E-10	3.2E+01	4.5E-02	1.9E-03
Centralized-3	7	1	4.2E-03	7.2E-06	4.2E-07	8.8E-06	1.5E-08	8.8E-10	3.2E+01	4.5E-02	1.9E-03
Centralized-4	7	1	4.2E-03	7.2E-06	4.2E-07	8.8E-06	1.5E-08	8.8E-10	3.2E+01	4.5E-02	1.9E-03
Centralized-5	1	1	4.2E-03	7.2E-06	4.2E-07	8.8E-06	1.5E-08	8.8E-10	3.2E+01	4.5E-02	1.9E-03

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-18.2-3. WVDP—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized	- -	16	6.2E+01	8.7E-02	3.7E-03
Regionalized-1	- -	12	- -	- -	- -
Regionalized-2	11	12	- -	- -	- -
Regionalized-3	- -	6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6	- -	2	- -	- -	- -
Regionalized-7	- -	2	- -	- -	- -
Centralized-1	- -	1	- -	- -	- -
Centralized-2	- -	1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-18.2-4. WVDP—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	5.3E-11	4.2E-11	- -
Decentralized	- -	16	1.9E-11	1.5E-11	1.3E-04
Regionalized-1	- -	12	3.1E-11	2.4E-11	- -
Regionalized-2	11	12	3.1E-11	2.5E-11	- -
Regionalized-3	- -	6	3.1E-11	2.4E-11	- -
Regionalized-4	7	6	3.1E-11	2.5E-11	- -
Regionalized-5	4	6	3.1E-11	2.5E-11	- -
Regionalized-6	- -	2	3.1E-11	2.4E-11	- -
Regionalized-7	- -	2	3.1E-11	2.4E-11	- -
Centralized 1	- -	1	3.1E-11	2.4E-11	- -
Centralized 2	- -	1	3.1E-11	2.4E-11	- -
Centralized 3	7	1	3.1E-11	2.5E-11	- -
Centralized 4	7	1	3.1E-11	2.5E-11	- -
Centralized 5	1	1	3.1E-11	2.5E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-18.2-5. WVDP—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	1.1E-07	1.8E-10	1.1E-11	8.5E-08	1.4E-10	8.5E-12	--	--	--
Decentralized	--	16	3.7E-08	6.3E-11	3.7E-12	2.9E-08	4.9E-11	2.9E-12	2.7E-01	4.5E-04	2.7E-05
Regionalized-1	--	12	6.1E-08	1.0E-10	6.1E-12	4.8E-08	8.2E-11	4.8E-12	--	--	--
Regionalized-2	11	12	6.3E-08	1.1E-10	6.3E-12	5.0E-08	8.4E-11	5.0E-12	--	--	--
Regionalized-3	--	6	6.1E-08	1.0E-10	6.1E-12	4.8E-08	8.2E-11	4.8E-12	--	--	--
Regionalized-4	7	6	6.3E-08	1.1E-10	6.3E-12	5.0E-08	8.4E-11	5.0E-12	--	--	--
Regionalized-5	4	6	6.3E-08	1.1E-10	6.3E-12	5.0E-08	8.4E-11	5.0E-12	--	--	--
Regionalized-6	--	2	6.1E-08	1.0E-10	6.1E-12	4.8E-08	8.2E-11	4.8E-12	--	--	--
Regionalized-7	--	2	6.1E-08	1.0E-10	6.1E-12	4.8E-08	8.2E-11	4.8E-12	--	--	--
Centralized-1	--	1	6.1E-08	1.0E-10	6.1E-12	4.8E-08	8.2E-11	4.8E-12	--	--	--
Centralized-2	--	1	6.1E-08	1.0E-10	6.1E-12	4.8E-08	8.2E-11	4.8E-12	--	--	--
Centralized-3	7	1	6.3E-08	1.1E-10	6.3E-12	5.0E-08	8.4E-11	5.0E-12	--	--	--
Centralized-4	7	1	6.3E-08	1.1E-10	6.3E-12	5.0E-08	8.4E-11	5.0E-12	--	--	--
Centralized-5	1	1	6.3E-08	1.1E-10	6.3E-12	5.0E-08	8.4E-11	5.0E-12	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-18.2-6. WVDP—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Decentralized	- -	16	93 (59/34)	161 (155/7)	0	12 (12/0)	15 (15/0)	19 (15/4)	18 (1/17)	5 (2/3)	0	0	0	2 (0/2)
Regionalized-1	- -	12	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-2	11	12	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-3	- -	6	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-4	7	6	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-5	4	6	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-6	- -	2	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Regionalzied-7	- -	2	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Centralized-1	- -	1	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Centralized-2	- -	1	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Centralized-3	7	1	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Centralized-4	7	1	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)
Centralized-5	1	1	27 (9/18)	28 (24/4)	0	2 (2/0)	2 (2/0)	4 (2/2)	8 (0/8)	2 (0/2)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emission)
** Ten sites use existing facilities for volume reduction.

Table II-18.2-7. WVDP—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	T	D	Construction Percent of Tons/Year General Conformity Rule (1)					
			CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--
Decentralized	--	16	--	--	--	--	--	--
Regionalized-1	--	12	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--
Regionalzied-7	--	2	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--

LLW Alternatives	T	D	Operations & Maintenance Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
			CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized	--	16	1	5	0	2	0	0	--	--	--	--	--	--
Regionalized-1	--	12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-2	11	12	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-3	--	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-4	7	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-5	4	6	0	0	0	0	0	0	--	--	--	--	--	--
Regionalized-6	--	2	0	0	0	0	0	0	--	--	--	--	--	--
Regionalzied-7	--	2	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-1	--	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-2	--	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-3	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-4	7	1	0	0	0	0	0	0	--	--	--	--	--	--
Centralized-5	1	1	0	0	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide. VOC = volatile organic compounds.
NAAQS = National Ambient Air Quality Standard.
(1) WIPP is in an attainment area for all criteria pollutants, therefore the GCR do not apply.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the minimum treatment (no incineration) alternatives, and the Centralized-5 Alternatives, are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
** Ten sites use existing facilities for volume reduction.

Table II-18.2–8. WVDP—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance												
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	--	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	--	--	--	--	--	--	--	--	--	--
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-18.2-9. WVDP—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	6447	9.2	--	2588	3.7	--	<0.1
Decentralized	--	16	58800	84.0	--	5618	8.0	--	<0.1
Regionalized-1	--	12	6447	9.2	--	2588	3.7	--	<0.1
Regionalized-2	11	12	6447	9.2	--	2588	3.7	--	<0.1
Regionalized-3	--	6	6447	9.2	--	2588	3.7	--	<0.1
Regionalized-4	7	6	6447	9.2	--	2588	3.7	--	<0.1
Regionalized-5	4	6	6447	9.2	--	2588	3.7	--	<0.1
Regionalized-6	--	2	6447	9.2	--	2588	3.7	--	<0.1
Regionalized-7	--	2	6447	9.2	--	2588	3.7	--	<0.1
Centralized-1	--	1	6447	9.2	--	2588	3.7	--	<0.1
Centralized-2	--	1	6447	9.2	--	2588	3.7	--	<0.1
Centralized-3	7	1	6447	9.2	--	2588	3.7	--	<0.1
Centralized-4	7	1	6447	9.2	--	2588	3.7	--	<0.1
Centralized-5	1	1	6447	9.2	--	2588	3.7	--	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by surface water in two onsite reservoirs. Current water use = 70,000 gallons/day.
Wastewater discharged to Buttermilk Creek. Average flow rate of the creek = 41,000,000 gallons/day.
** Ten sites use existing facilities for volume reduction.
<0.1 indicates that the percentage is less than 0.1%.

Table II-18.2-10. WVDP—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 228	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 246	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 229	Th 230	Th 232	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-18.2-11. WVDP—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	Annual Income (Millions)	% Change in Annual Income	% ROI Population Increase (2)
No Action	10**	6	291	337	0.06	3.85	0.02	0.02
Decentralized	- -	16	542	628	0.11	7.16	0.04	0.05
Regionalized-1	- -	12	291	337	0.06	3.85	0.02	0.02
Regionalized-2	11	12	291	337	0.06	3.85	0.02	0.02
Regionalized-3	- -	6	291	337	0.06	3.85	0.02	0.02
Regionalized-4	7	6	291	337	0.06	3.85	0.02	0.02
Regionalized-5	4	6	291	337	0.06	3.85	0.02	0.02
Regionalized-6	- -	2	291	337	0.06	3.85	0.02	0.02
Regionalized-7	- -	2	291	337	0.06	3.85	0.02	0.02
Centralized-1	- -	1	291	337	0.06	3.85	0.02	0.02
Centralized-2	- -	1	291	337	0.06	3.85	0.02	0.02
Centralized-3	7	1	291	337	0.06	3.85	0.02	0.02
Centralized-4	7	1	291	337	0.06	3.85	0.02	0.02
Centralized-5	1	1	291	337	0.06	3.85	0.02	0.02

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for volume reduction.

Table II-18.2-12. WVDP—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Decentralized	- -	16	18	10.9	58800	53.45	5618	8.03	8.49	130	643	41
Regionalized-1	- -	12	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Regionalized-2	11	12	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Regionalized-3	- -	6	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Regionalized-4	7	6	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Regionalized-5	4	6	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Regionalized-6	- -	2	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Regionalized-7	- -	2	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Centralized-1	- -	1	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Centralized-2	- -	1	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Centralized-3	7	1	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Centralized-4	7	1	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13
Centralized-5	1	1	4.0	2.40	6447	5.86	2588	3.70	0.70	10.75	139	13

Notes:
T = Treatment
D = Disposal
** = Ten sites use existing facilities for volume reduction.
GPD = Gallons per Day
MW = Megawatts Electric

Table II-18.2-13. WVDP—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	330	27	80	210	13	330	0	0
Decentralized	- -	16	614	49	152	385	28	306	0	308
Regionalized-1	- -	12	330	27	80	210	13	330	0	0
Regionalized-2	11	12	330	27	80	210	13	330	0	0
Regionalized-3	- -	6	330	27	80	210	13	330	0	0
Regionalized-4	7	6	330	27	80	210	13	330	0	0
Regionalized-5	4	6	330	27	80	210	13	330	0	0
Regionalized-6	- -	2	330	27	80	210	13	330	0	0
Regionalized-7	- -	2	330	27	80	210	13	330	0	0
Centralized-1	- -	1	330	27	80	210	13	330	0	0
Centralized-2	- -	1	330	27	80	210	13	330	0	0
Centralized-3	7	1	330	27	80	210	13	330	0	0
Centralized-4	7	1	330	27	80	210	13	330	0	0
Centralized-5	1	1	330	27	80	210	13	330	0	0

Notes:
** Ten sites use existing facilities for volume reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.18.3 WVDP TRUW

WVDP has a small amount of TRUW which factored into the transportation analysis but did not warrant analysis of impacts onsite. Therefore, Section 18.3 has been intentionally left blank.

II.18.4 WVDP HLW

Nine of the 15 impact categories apply to HLW at WVDP. These impacts are presented in the following tables.

Impact Category No.	Description	Table No.	Page No.
1.	WVDP—HLW—Storage: Estimated Number of Fatalities	II-18.4-1	18-32
2.	WVDP—HLW—Storage: Estimated Number of Cancer Incidences and Genetic Effects	II-18.4-2	18-33
7.	WVDP—HLW—Emissions in Tons per Year of Criteria Air Pollutants	II-18.4-3	18-34
8.	WVDP—HLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-18.4-4	18-35
9.	WVDP—HLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-18.4-5	18-36
10.	WVDP—HLW—Impacts on Water Resources Due to Increased Water Use	II-18.4-6	18-37
13.	WVDP—HLW—Socioeconomic Impacts for Storage	II-18.4-7	18-38
14.	WVDP—HLW—Infrastructure Impacts for Storage	II-18.4-8	18-39
15.	WVDP—HLW—Cost	II-18.4-9	18-40

Table II-18.4-1. WVDP—HLW—Storage: Estimated Number of Fatalities

HLW Alternatives	Number of Storage Sites	WM Workers	
		Radiation Exposure	Physical Hazards
No Action	4	5.3E-02	2.3E-02
Decentralized	4	5.3E-02	2.3E-02
Regionalized-1	3	3.2E-02	1.4E-02
Regionalized-2	3	4.5E-02	1.9E-02
Centralized	1	4.5E-02	1.9E-02

Table II-18.4-2. WVDP—HLW—Storage: Estimated Number of Cancer Incidences and Genetic Effects

HLW Alternatives	Number of Storage Sites	WM Workers		
		Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	4	2.0E+02	2.8E-01	1.2E-02
Decentralized	4	1.9E+02	2.7E-01	1.2E-02
Regionalized-1	3	1.2E+02	1.7E-01	7.4E-03
Regionalized-2	3	1.7E+02	2.3E-01	1.0E-02
Centralized	1	1.7E+02	2.3E-01	1.0E-02

Table II-18.4-3. WVDP—HLW—Emissions in Tons per Year of Criteria Air Pollutants

HLW Alternatives	Number of Sites S	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	4	0	0	0	0	0	0	2 (0/2)	0	0	0	0	0
Decentralized	4	0	0	0	0	0	0	2 (0/2)	0	0	0	0	0
Regionalized-1	3	0	0	0	0	0	0	2 (0/2)	0	0	0	0	0
Regionalized-2	3	0	0	0	0	0	0	2 (0/2)	0	0	0	0	0
Centralized	1	0	0	0	0	0	0	2 (0/2)	0	0	0	0	0

Notes:
S = Storage
Data is based on repository beginning to accept HLW canisters in 2015.
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)

Table II-18.4-4. WVDP—HLW—Percent of Standard/Guideline for Criteria Air Pollutants

HLW Alternatives	Number of Sites	Construction					
		Percent of Tons/Year General Conformity Rule (1)					
	S	CO	NO2	Pb	PM10	SO2	VOC
No Action	4	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--
Regionalized - 1	3	--	--	--	--	--	--
Regionalized - 2	3	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--

HLW Alternatives	Number of Sites	Operations & Maintenance										
		Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)				
	S	CO (4)	NO2 (4)	Pb (4)	PM10 (4)	SO2 (4)	VOC (4)	CO	NO2	Pb	PM10	SO2
No Action	4	--	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 1	3	--	--	--	--	--	--	--	--	--	--	--
Regionalized - 2	3	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--	--

Notes:
S = Storage
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) WVDP is in an attainment area for all criteria pollutants, therfore the GCR does not apply.
(2) Stationary-source emissions from HLW storage facilities are assumed to be negligible.
(3) Stationary-source emissions from HLW storage facilities are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.

Table II-18.4-5. WVDP—HLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

HLW Alternatives	Number of Sites S	Operations & Maintenance											
		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	4	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--	--	--

HLW Alternatives	Number of Sites S	Operations & Maintenance									
		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	Vinyl Chloride
No Action	4	--	--	--	--	--	--	--	--	--	--
Decentralized	4	--	--	--	--	--	--	--	--	--	--
Regionalized-1	3	--	--	--	--	--	--	--	--	--	--
Regionalized-2	3	--	--	--	--	--	--	--	--	--	--
Centralized	1	--	--	--	--	--	--	--	--	--	--

Notes:
S = Storage
- - = Emissions of hazardous and toxic air pollutants, including radionuclides, from HLW storage facilities are assumed to be negligible.

Table II-18.4-6. WVDP—HLW—Impacts on Water Resources Due to Increased Water Use

HLW Alternatives	Number of Sites	Construction			Operations			
	S	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	4	- -	- -	- -	1,000	1.4	<0.1	<0.1
Decentralized	4	- -	- -	- -	1,000	1.4	<0.1	<0.1
Regionalized-1	3	- -	- -	- -	1,000	1.4	<0.1	<0.1
Regionalized-2	3	- -	- -	- -	1,000	1.4	<0.1	<0.1
Centralized	1	- -	- -	- -	1,000	1.4	<0.1	<0.1

Notes:
S = Storage
Water supplied by surface water from 2 onsite reservoirs. Current water use = 70,000 gallons/day.
Wastewater discharged to Buttermilk Creek. Average flow rate of Buttermilk Creek = 41,000,000 gallons/day.
Data is based on repository beginning to accept HLW canisters in 2015.
- - = Construction is not considered at WVDP.
<0.1 indicates that the percentage is less than 0.1%.

Table II-18.4–7. WVDP—HLW—Socioeconomic Impacts for Storage

HLW Alternatives	S	Effect of Implementation of Alternatives					
			Jobs		Income		
		Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	4	19	21	0.00	0.2	0.00	0.00
Decentralized	4	19	21	0.00	0.2	0.00	0.00
Regionalized-1	3	27	30	0.01	0.3	0.00	0.00
Regionalized-2	3	27	30	0.01	0.3	0.00	0.00
Centralized	1	27	30	0.01	0.3	0.00	0.00

Notes:
S = Storage
(1) In 1990 dollars. The economic multiplies analysis only was applied to costs through 2015.
(2) Compared to 1990 baseline.

Table II-18.4-8. WVDP—HLW—Infrastructure Impacts for Storage

HLW Alternatives	Number of Sites	Effect of Implementation of Alternatives									
		Land Use		Water		Waste Water		Power		Employment (FTE)	
	S	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Construction Employment	% of Current Employment (1)
No Action	4	- -	- -	1,000	0.9	1,000	1.4	0.04	0.54	- -	- -
Decentralized	4	- -	- -	1,000	0.9	1,000	1.4	0.04	0.54	- -	- -
Regionalized-1	3	- -	- -	1,000	0.9	1,000	1.4	0.04	0.54	- -	- -
Regionalized-2	3	- -	- -	1,000	0.9	1,000	1.4	0.04	0.54	- -	- -
Centralized	1	- -	- -	1,000	0.9	1,000	1.4	0.04	0.54	- -	- -

Notes:
S = Storage
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1991 Site Employment.
- - = Construction is not considered at WVDP.

Table II-18.4-9. WVDP—HLW—Cost

HLW Alternatives	Number of Sites	Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)		Cost by Functional Area (1)	
	S		Construction (Millions) (2)	Operations & Maintenance (3) (Millions)	Storage (Millions)	Handling (Millions)
No Action	4	30	10	20	12	18
Decentralized	4	29	10	19	11	18
Regionalized-1	3	29	10	19	11	18
Regionalized-2	3	29	10	19	11	18
Centralized	1	29	10	19	11	18
Centralized Delayed Acceptance	1	29	10	19	11	18

Notes:
S = Storage
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of Life Cycle Components = Sum of Functional Areas.
(2) Construction costs are for the interim storage facilities.
(3) Operations and maintenance costs include operation and maintenance of the interim storage facilities, and the handling of canisters (unloading/loading of canisters into or out of the interim storage facilities).

U.S. Department of Energy
Office of Environmental Management

ENTERED

Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage and Disposal of Radioactive and Hazardous Waste

Volume III of V

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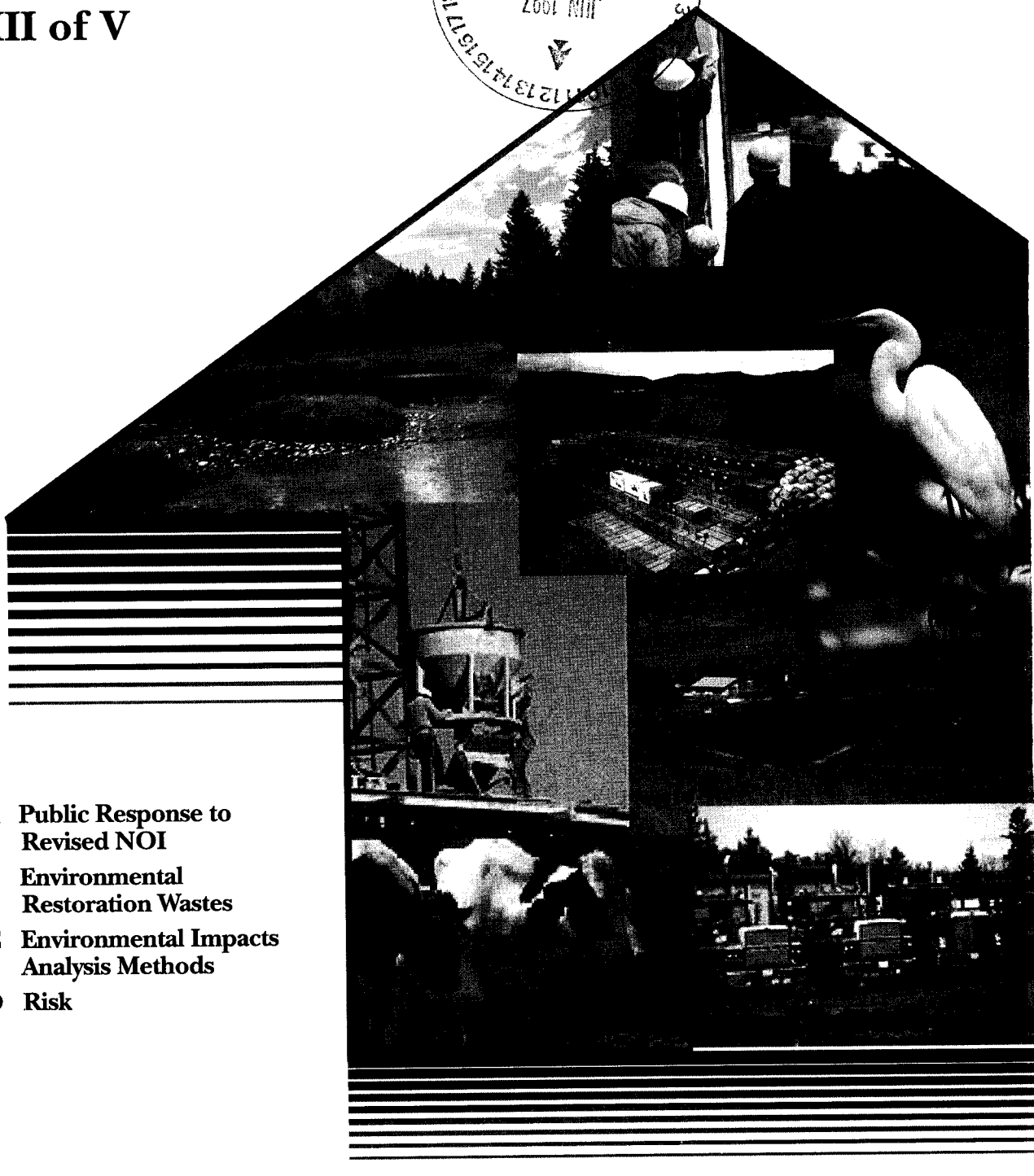

Appendix A Public Response to Revised NOI

Appendix B Environmental Restoration Wastes

Appendix C Environmental Impacts Analysis Methods

Appendix D Risk

DOE/EIS-0200-F

FINAL
WASTE MANAGEMENT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
for
Managing Treatment, Storage, and Disposal of
Radioactive and Hazardous Waste

Volume III of V

Appendices A–D

U.S. Department of Energy
Office of Environmental Management
1000 Independence Ave.
Washington, DC 20585

Appendix A

Public Comments to DOE's Proposed Revisions to the Scope of the WM PEIS

U.S. Department of Energy
Waste Management Programmatic Environmental Impact Statement

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Attachment 2 Federal Register Notice, January 24, 1995 (60 FR 4607) A2-1
Attachment 3 Federal Register Notice, March 16, 1995 (60 FR 14275) A3-1
Attachment 4 Natural Resources Defense Council's Comments on the Department of Energy's Proposed Modification in Scope of the Environmental Restoration and Waste Management Programmatic Environmental Impact Statement A4-1

Acronyms

The following is a list of acronyms used in this appendix.

BEMR	Baseline Environmental Management Report
CERCLA	Comprehensive Environmental Response; Compensation and Liability Act
DOE	U.S. Department of Energy
NEPA	National Environmental Policy Act
NOI	Notice of Intent
PEIS	programmatic environmental impact statement
WM	Waste Management

APPENDIX A
Public Comments to DOE's Proposed Revisions to the Scope of the WM PEIS

On June 27, 1989, twenty-two citizens' groups, led by the Natural Resources Defense Council, filed suit to compel the U.S. Department of Energy (DOE) to prepare a programmatic environmental impact statement (PEIS) on proposals for the cleanup and modernization of the nuclear weapons production complex. Consequently, on January 12, 1990, the Secretary of Energy decided to prepare two programmatic environmental impact statements, one on the modernization of the nuclear weapons complex and the other on the Five-year Environmental Restoration and Waste Management Plan. Accordingly, on October 22, 1990, DOE issued a Notice of Intent (NOI) (55 FR 42633) to prepare the Environmental Restoration (ER) and Waste Management (WM) Programmatic Environmental Impact Statement (see Attachment 1). In the NOI, the Department identified the proposed action as follows: "to formulate and implement an integrated environmental restoration and waste management program in a safe and environmentally sound manner and in compliance with applicable laws, regulations and standards." The NOI identified two separate sets of alternatives to be evaluated, one for environmental restoration and one for waste management.

The public scoping period on the PEIS extended from October 22, 1990, to February 19, 1991. Beginning on December 3, 1990, the Department held 23 scoping meetings at various locations across the country to ensure adequate opportunity for participation by the public and other government agencies. During the public comment period, over 1,200 people provided approximately 7,000 comments, either by participating in the meetings or by submitting materials and letters. Most concerns were related to the public perception of the Department and to environmental, health, and safety issues.

To record the results of the public scoping meetings and to serve as a plan for preparing the PEIS, a Draft Implementation Plan was prepared and made publicly available on February 4, 1992 (57 FR 4193). The Draft Implementation Plan summarized the comments received during the public scoping meetings and identified those issues, as suggested by the comments, that would be considered in preparing the PEIS. A public comment period on the Draft Implementation Plan extended from February 4, 1992, until April 24, 1992. During this time, six regional public workshops were held.

The Final Implementation Plan was completed in January 1994 and made available to the public (59 FR 7990, February 17, 1994). It addressed comments received during the public scoping meetings and those received on the Draft Implementation Plan as well.

Subsequently, the Department attempted to meaningfully analyze the environmental restoration alternatives that it originally defined in the Final Implementation Plan but concluded, after considerable effort, that it would not be appropriate to make programmatic decisions regarding cleanup strategies that would be applicable to all of the Department's sites.

Accordingly, the Department announced on January 24, 1995 (60 FR 4607), an opportunity for public comment on its proposal to shift the focus and change the title of the PEIS (see Attachment 2). The proposed modification would eliminate the environmental restoration alternatives and modify the proposed action. On March 16, 1995, (60 FR 14275) in response to a request from the public, the Department announced an extension of the public comment period on the proposed scope to April 10, 1995 (see Attachment 3). In both announcements, the Department stated that the draft PEIS would contain an appendix summarizing comments received during the resulting public comment period.

On April 10, 1995, the Natural Resources Defense Council (NRDC) filed a public comment in response to the notices of opportunity on the proposed modification to the scope and title of the PEIS. The NRDC's comments were the only ones DOE received.

The NRDC's letter (see Attachment 4) referred to the prior litigation between the Natural Resources Defense Council and the Department of Energy and stated that the Department indicated that its cleanup and waste management activities constituted actions that fall within the meaning of the National Environmental Policy Act (NEPA) and are thus subject to review. The letter also stated that the Department, during the course of litigation, committed to preparing a PEIS that included environmental restoration.

The NRDC cited several issues that it believes warrant full analysis and public participation, including those pertaining to standards; the scope and pace of the cleanup program; land use restrictions in setting cleanup levels; inter- and intra-facility priorities in light of budget constraints; and public participation in the decision process for cleanup. Further, NRDC noted that as a matter of policy, the Department does not perform reviews under NEPA for actions taken pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The Department agrees that there are issues with regard to the cleanup program for which a national perspective and public discussion are appropriate. DOE is considering some enhanced public participation to obtain input on such national environmental restoration issues. The Department believes that there are suitable analytical tools and venues available other than the PEIS, to address the issues raised in the Council's letter. These are discussed below.

As the Department noted in the *Federal Register*, the fundamental reasoning behind its decision to refocus the scope of the EIS was that cleanup decisions must reflect site-specific cleanup conditions commensurate with the regulatory framework under CERCLA and the Resource Conservation and Recovery Act. The site-specific nature of cleanup is inconsistent with programmatic initiatives that would be implemented nationwide. In other words, for environmental restoration, there is not a proposed program that requires evaluation of programmatic alternatives. Consequently, a PEIS is not an appropriate vehicle for analysis.

Arriving at cleanup decisions on a site-specific basis does not preclude public involvement in such decisions, nor does it alter the Department's commitments and requirements to complete appropriate reviews under NEPA. On the contrary, this permits the necessary specific reviews, considerations, and deliberations for cleanup actions, including considerations of land use issues, to be reached properly with the approval of state and federal regulators and with the direct involvement of the local community.

In addition, with regard to using land use restrictions in setting cleanup levels, the Department has embarked on an extensive initiative to gain an understanding of the long-term future site uses, which is essential to effective planning and decision making for a myriad of Departmental activities. Specifically, this initiative will provide a basis for decision making and for site development and comprehensive planning. Each of the Department's major sites is developing future land use preferences with significant involvement of interested and affected stakeholders.

The Department's Office of Environmental Management (EM) actively seeks the involvement of regulators and other stakeholders in establishing priorities and developing budgets. EM designed a process to give regulators and stakeholders a meaningful voice in developing site priorities, which are then used to develop a budget. The goal of this collaborative effort is to plan what could and could not be done with available resources to try to achieve an optimum balance among priorities within a site, and to some extent, among sites. This process results in a reprioritizing of activities and modification of schedules to ensure that the program will be as effective and cost-efficient as possible. As part of this open decision-making process, national meetings are held with regulators and stakeholders to discuss national priorities and cross-cutting

issues as well as any changes to field budget submissions. The pace as well as the scope of the program, therefore, is taken into consideration and reflected in the priorities and the budget.

The role of site-specific advisory boards and other means of public participation in the decision-making process for cleanup is of critical concern to the Department. The Department has established several advisory boards at its major sites. The boards, which are one means for involving the public, have negotiated their roles and responsibilities. Moreover, agendas are left to the boards to determine in conjunction with the regulators and the Department. The boards are informed of ongoing cleanup activities and issues, including land use planning, budget planning and development, and priority setting, and are invited into the decision-making process.

In the Fiscal Year 1994 National Defense Authorization Acts, Congress directed the Department to provide a life-cycle cost estimate for the program, delineated by specific projects and activities. The *Baseline Environmental Management Report* (BEMR), first issued in 1995 and updated in 1996, systematically analyzed potential life-cycle costs of meeting legal commitments as well as addressing other issues related to the management of hazardous and radioactive materials and waste within DOE The report provided cost estimates associated with various programwide alternatives given differing land use assumptions, residual contamination standards funding and schedule changes, waste treatment, storage and disposal options, and potential technology improvements. This report is a valuable analytical tool for exploring cost consequences of potential options.

In addition, the document *Risks and the Risk Debate: Searching for Common Ground "The First Step"* (DOE, 1995a), when considered with the *Baseline Environmental Management Report* (DOE, 1996) as well as other analyses, helps to provide a foundation of technical, environmental, financial, and social analysis needed to inform the national debate on a number of issues, including those raised in the Council's letter. The purpose of the analysis, prepared in response to direction from the Energy and Water Subcommittee of the Committee on Appropriations, was to help the Department develop a mechanism for establishing priorities among competing cleanup requirements.

After careful consideration of the NRDC's comments, and given these various opportunities for discussion and the analytical tools available for informed debate on national issues, the Department determined that these activities and processes are useful to the public and should continue. Consequently, DOE has begun a "National Dialogue" initiative to provide a means for continuing comprehensive discussions with government officials, regulatory authorities, and other interested organizations and publics regarding the

major materials, waste, and cleanup decisions DOE needs to make. This dialogue includes public participation and input into environmental restoration issues. Nonetheless, the Department decided that the scope of the PEIS should be modified as proposed to consider management of the Department's radiological and hazardous wastes and sites at which the wastes could be managed in the future. This approach is consistent with the alternatives outlined for waste management in the Final Implementation Plan.

Appendix A
References

U.S. Department of Energy. 1995a. *Risks and the Risk Debate: Searching for Common Ground "The First Step," Volumes I and II.* June draft. Washington, DC: Office of Environmental Management.

U.S. Department of Energy. 1996. *The 1996 Baseline Environmental Management Report [BEMR].* DOE/EM-0290. June. Washington, DC: Office of Environmental Management.

Attachment 1
(to WM PEIS Appendix A)

Federal Register Notice
(Volume 55, Number 204, Monday October 22, 1990)
[55 FR 42633]

Department of Energy
"Intent to Prepare a Programmatic Environmental Impact Statement on the Department of Energy's Proposed Integrated Environmental Restoration and Waste Management Program, and to Conduct Public Scoping Meetings"

Federal Register / Vol. 55, No. 204 / Monday, October 22, 1990 / Notices 42633

DEPARTMENT OF ENERGY

Intent To Prepare a Programmatic Environmental Impact Statement on the Department of Energy's Proposed Integrated Environmental Restoration and Waste Management Program, and To Conduct Public Scoping Meetings

AGENCY: U.S. Department of Energy (DOE).

ACTION: Notice of intent (NOI) to prepare a programmatic environmental impact statement (PEIS).

SUMMARY: The Department of Energy announces its intent to prepare a PEIS pursuant to the National Environmental Policy Act of 1969 (NEPA) [42 U.S.C. 4321, *et seq.*], as amended, and to conduct a series of public scoping meetings nationwide. The PEIS will assess the potential environmental consequences of alternatives for implementing an integrated environmental restoration and waste management program

The purpose of DOE's proposed integrated environmental restoration and waste management program is to provide a broad, systematic approach to addressing cleanup activities and waste management practices. The Department is committed to ensuring that potential risks to human health and the environment from the cleanup of contamination resulting from past operations and from future waste management activities are at safe levels. DOE is further committed to full compliance with environmental regulations and to a goal of completing environmental restoration by 2019.

INVITATION TO COMMENT: To ensure that the full range of issues related to this proposal are addressed, comments on the proposed scope of the PEIS are invited from all interested parties. Written comments to assist DOE in identifying significant environmental issues and defining the appropriate scope of the PEIS should be directed to Mr. Wisenbaker at the address indicated below. Agencies, organizations, and the general public also are invited to present oral comments pertinent to the preparation of the PEIS at the public scoping meetings to be held nationwide, as described below. Written and oral comments will be given equal weight.

Following the completion of the public scoping process, a PEIS Implementation Plan will be issued for public comment. The Implementation Plan will record the results of the scoping process and define the alternatives and issues to be evaluated in the PEIS. DOE intends to

complete the draft PEIS in early 1992. Its availability will be announced in the Federal Register, and public comments again will be solicited. Comments on the draft PEIS will be considered in preparing the final PEIS, scheduled for 1993.

DATES: The public scoping period will continue until February 19, 1991. Written comments should be postmarked by February 19, 1991 to assure consideration. Comments received after that date will be considered to the extent practicable. The public scoping meetings will begin in December 1990. The dates and locations of the meetings will be announced in a subsequent Federal Register notice and in local public notices in advance of the planned meetings.

ADDRESSES AND FURTHER INFORMATION: Written comments on the scope of the PEIS, questions concerning the program, and requests for copies of the draft PEIS should be directed to: Mr. W. E. Wisenbaker, Acting Director, Division of Program Support, Office of Environmental Restoration (EM–43), U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585, (202) 353–2950.

For further information on the DOE NEPA process please contact: Ms. Carol M. Borgstrom, Director, Office of NEPA Oversight (EH–25), U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585, (202) 586–4600.

PUBLIC SCOPING MEETINGS: Public scoping meetings will be held in the following cities beginning in December 1990. The dates and locations of these meetings will be published in a subsequent Federal Register notice. This information will also be announced in local public notices before the planned meetings.

Oakland, California
Denver, Colorado
Washington, DC
Tampa, Florida
Atlanta, Georgia
Boise, Idaho
Idaho Falls, Idaho
Chicago, Illinois
Paducah, Kentucky
St. Louis, Missouri
Las Vegas, Nevada
Princeton, New Jersey
Albuquerque, New Mexico
Newburgh, New York
Cincinnati, Ohio
Columbus, Ohio
Portland, Oregon
Columbia, South Carolina
Oak Ridge, Tennessee
Amarillo, Texas
Richland, Washington
Seattle, Washington
Spokane, Washington

SUPPLEMENTARY INFORMATION:

Background. In November 1989, the Secretary of Energy established the DOE Office of Environmental Restoration and Waste Management (EM) for the purpose of consolidating the Department's environmental restoration and waste management activities. In January 1990, the Secretary determined that DOE will prepare an Environmental Impact Statement on a newly proposed integrated environmental restoration and waste management program.

Some of the waste management practices that DOE and its predecessor agencies once considered safe and prudent under then existing requirements and guidelines have resulted in the need for remediation under applicable current Federal and state requirements and guidelines. DOE's environmental restoration activities include the assessment and physical cleanup of contamination at DOE installations and other properties. Environmental restoration activities also include the decontamination and decommissioning (D&D) of DOE's surplus facilities. These facilities and properties may have contamination from radioactive, hazardous, or mixed (radioactive and hazardous) waste. As decisions are made for the handling of contamination at various sites and facilities, new wastes will be generated that will require management.

DOE's waste management operations include the treatment, storage, transportation, and disposal of wastes generated by ongoing nuclear energy, energy research, and defense activities; by environmental restoration activities; and by other sources. These wastes include: high-level radioactive waste (HLW); low-level radioactive waste (LLW); transuranic waste (TRU); mixed waste (MW); greater-than-Class C waste (GTCC) waste; and hazardous waste.

The Affected Installations. DOE's environmental restoration and waste management activities occur throughout the U.S. The largest number of facilities that require environmental restoration or that generate or store the largest volumes of radioactive, hazardous, and mixed waste are located at these installations: Hanford Reservation (Washington); Savannah River Site (South Carolina); Oak Ridge Reservation (Tennessee); Rocky Flats Plant (Colorado); Feed Materials Production Center, Mound Plant and Portsmouth Gaseous Diffusion Plant (Ohio); Idaho National Engineering Laboratory (Idaho); Lawrence Livermore National Laboratory (California); Argonne National Laboratory (Illinois); Paducah Gaseous Diffusion Plant (Kentucky); Nevada Test Site (Nevada); Los Alamos National Laboratory and Sandia National Laboratory (New Mexico); and Pantex Plant (Texas). The Appendix contains a listing of DOE locations where current environmental restoration and waste management activities occur that DOE believes are within the scope of this PEIS. Additional sites may be added in the course of the development of the PEIS.

The Regulatory Framework. Federal laws of major importance to DOE's environmental restoration and waste management activities include, among others, the Atomic Energy Act of 1954 (42 U.S.C. 2011, *et seq.*), as amended; the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 U.S.C. 9601, *et seq.*), as amended; and the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901, *et seq.*), as amended. The Atomic Energy Act requires the management, processing, and utilization of radioactive materials in a manner that protects the public health and the environment. CERCLA requires responses to releases or threatened releases of hazardous substances into the environment and establishes a process to clean up abandoned or uncontrolled hazardous waste sites which may endanger public health or the environment. RCRA requires management of waste currently being generated, including the treatment, storage, transportation, and disposal of hazardous waste, and cleanup of hazardous waste releases from past and present operations that pose a threat to human health and the environment. It is DOE's policy to apply NEPA to its waste management and cleanup activities. To minimize delay and duplication of effort in meeting these responsibilities, DOE is supplementing, where necessary, and integrating the procedural documentation and public participation requirements for CERCLA and RCRA to facilitate compliance with NEPA requirements (DOE Order 5400.4, Comprehensive Environmental Response, Compensation, and Liability Act Requirements).

DOE environmental restoration and waste management activities are subject to other applicable Federal and state requirements and to enforceable agreements. Additionally, certain Federal statutes require DOE to undertake specific environmental restoration and waste management activities. For example, under Title I of the Uranium Mill Tailings Radiation Control Act, DOE must remediate inactive uranium milling sites in accordance with Environmental

Protection Agency standards (40 CFR part 192) established for that purpose.

Wastes are categorized in accordance with Federal statutes and regulations and DOE Orders. High-level waste is defined in the Nuclear Waste Policy Act of 1982 (42 U.S.C. 10101(12)). Low-level, transuranic, and radioactive mixed wastes are defined in DOE Order 5820.2A (Radioactive Waste Management). Hazardous wastes are those wastes that are defined as hazardous by U.S. Environmental Protection Agency regulations implementing RCRA (40 CFR Part 261) and by applicable state regulations.

Current Practices for Waste Management. To date, DOE's waste management operations have focused on site-by-site treatment, storage, transportation, and disposal of waste. Transuranic, low-level, hazardous, and radioactive mixed waste are generated at many DOE installations; only a few installations generate high-level waste.

DOE generates or stores high-level waste at four installations: the Savannah River Site, the Hanford Reservation, the Idaho National Engineering Laboratory, and the West Valley Demonstration Project. To date, high-level waste has undergone only limited treatment. DOE intends to immobilize the waste in a stable, solid form acceptable for disposal in a geologic repository. Under current law, only one potential repository site (at Yucca Mountain, Nevada) for this waste is currently being characterized.

Most TRU waste has been generated at DOE's Rocky Flats Plant in Golden, Colorado. Transuranic waste is currently stored at several facilities including the Rocky Flats Plant, the Idaho National Engineering Laboratory, the Hanford Reservation, the Oak Ridge Reservation, the Nevada Test Site, Los Alamos National Laboratory, and the Savannah River Site. The Idaho National Engineering Laboratory has the largest management program for this waste. The Department is currently evaluating the Waste Isolation Pilot Plant in Carlsbad, New Mexico, as a potential disposal site for TRU waste.

Low-level waste requires relatively minimal treatment. Although in some instances other methods may be used, DOE currently disposes of the majority of its LLW in near-surface facilities, including installations at the Savannah River Site, the Oak Ridge Reservation, the Nevada Test Site, the Hanford Reservation, Los Alamos National Laboratory, and the Idaho National Engineering Laboratory.

DOE Order 5820.2A (Radioactive Waste Management) requires that the DOE waste equivalent to commercially generated Greater-than-Class C (GTCC) waste be handled as a special case by each site. The Department is also responsible for disposal of commercially generated GTCC waste. DOE has developed a three-part strategy for managing this waste. The first phase would provide a storage facility for those generators that cannot continue to store the waste. The second phase would provide a central storage facility for all commercially generated GTCC waste.

The final phase would transfer the stored waste to a high-level waste repository or provide for the development of a separate GTCC disposal facility.

For hazardous waste, DOE's near-term objective is to treat the waste as it is generated, thereby minimizing the need for storage capacity. DOE disposes of treated hazardous waste in permitted DOE or commercial facilities.

Mixed wastes are generated at many DOE installations. Mixed waste may include high-level waste, transuranic waste, and low-level waste. DOE stores these wastes until they can be treated and disposed of in permitted facilities. The Department currently treats a small amount of MW by thermal destruction to eliminate some hazardous components. In addition, DOE treats some low-level MW by solidification.

The PEIS will address these practices and any reasonable alternatives that are amenable to environmental analysis. (See Scope of PEIS, below)

Current Practices for Environmental Restoration. DOE will continue to seek, to the extent possible, to negotiate a comprehensive Federal Facilities Agreement with the Environmental Protection Agency (EPA) and the involved state to cover its remediation activities at an installation. Such agreements establish technical requirements and schedules for characterization, feasibility assessment and cleanup at each of the affected sites, and delineate the roles and responsibilities of each party to the agreement, to comply with the requirements of Section 120 of CERCLA. DOE is in the early stages of site assessment and characterization at many facilities. These initial activities are being reviewed in compliance with NEPA. DOE has determined that these early remediation activities are normally categorically excluded under its NEPA guidelines (55 FR 37174, September 7, 1990).

Decontamination and decommissioning activities have several objectives: (1) To maintain facilities awaiting additional D&D activities in a manner that protects workers, the public, and the environment; (2) to decontaminate facilities intended for reuse; and (3) decommission other facilities in accordance with requirements set forth in an approved environmental compliance plan. Currently, D&D activities are planned and executed on a site-by-site basis.

The PEIS will address these practices and any reasonable alternatives amenable to environmental analysis.

Need for an Integrated Environmental Restoration and Waste Management Program. The fundamental goal of DOE's Office of Environmental Restoration and Waste Management is to ensure that potential risks to human health and to the environment posed by wastes under its jurisdiction are at safe levels. To help achieve this goal, DOE proposes to conduct an integrated environmental restoration and waste management program.

Historically, DOE environmental restoration and waste management operations have been conducted on a site-by-site basis. This practice has led to differing approaches to cleanup and waste management among DOE sites. DOE's recent consolidation of waste program responsibilities (environmental restoration and waste management) provides the opportunity to establish a systematic approach to programmatic requirements and practices.

Remediation and D & D activities result in large amounts of waste that will require management, in addition to the wastes generated from production, research, and other activities. Because environmental restoration activities will be a significant source of waste, cleanup and waste management activities are closely related. The resolution of certain key issues, such as future land-usability objectives, will determine the amount, type, and timing of environmental restoration waste being introduced into the waste management part of the system. Land-usability policy relates to cleanup standards and the degree of reliance on institutional controls for long-term health and environmental protection.

PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT: On January 12, 1990, the Secretary of Energy determined that a PEIS should be prepared for DOE's newly proposed integrated environmental restoration and waste management program. The Secretary stated that preparation of this PEIS will ensure that a comprehensive and cumulative environmental analysis of waste management proposals and alternatives will be available to DOE decisionmakers and the public.

The PEIS will assess broad programmatic issues and integrated approaches to DOE's environmental restoration and waste management activities. DOE aims, to the extent this is feasible, for the PEIS to provide the primary environmental basis for selecting waste management methods and technologies and the locations at which they would be implemented. However, DOE does not intend the PEIS to assess impacts related to alternative choices of locations within a site. Such detailed decisions would be based on site-specific NEPA documents tiered to this PEIS.

PRELIMINARY DESCRIPTION OF ALTERNATIVES: *Scope of PEIS.* DOE solicits public input on all aspects of the proposed program described in this notice. DOE plans to structure this PEIS in two sections to facilitate public review and comments. One section of the PEIS will focus on key environmental restoration issues. The second section will analyze reasonably foreseeable potential impacts associated with various waste management alternatives within the integrated program.

As discussed previously, current environmental restoration and waste management practices for which reasonable alternatives that are amenable to environmental analysis can be identified are within the scope of the PEIS. Under the Nuclear Waste Policy Act of 1982 (42 U.S.C. 10101, *et seq.*), as amended, DOE currently plans to dispose of high-level waste resulting from Departmental activities in a repository to be developed for spent fuel from commercial nuclear utilities. In addition, under section 213(a) of the Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980 (42 U.S.C. 7272, *et seq.*), as amended, the Department plans to demonstrate the disposal of defense transuranic waste at the Waste Isolation Pilot Plant in Carlsbad, New Mexico. These decisions will not be revisited in the programmatic EIS. In addition, there is a national program, under Congressional direction, to address the management of commercial nuclear reactor spent fuel. The activities associated with that program will be considered in separate NEPA documentation and not in this PEIS. Commercial LLW is not the Department's responsibility and therefore is outside the scope of the PEIS. Uranium Mill Tailings Remedial Action Program (UMTRAP) tailings cleanup and disposal activities are within DOE's purview, but are expected to be close to completion prior to the issuance of the Record of Decision and will not be considered in the PEIS. The groundwater remediation activities associated with UMTRAP are just beginning, however, and therefore are within the scope of this PEIS.

Proposed action. The proposed action is to formulate and implement an integrated Environmental Restoration and Waste Management Program in a safe and environmentally sound manner, and in compliance with applicable laws, regulations and standards. Alternative approaches are discussed below.

Environmental Restoration Analysis: NEPA requires DOE to analyze reasonable alternatives to its proposed actions. DOE realizes that in the current environmental restoration decisionmaking framework for remediation activities there are statutory and regulatory requirements that must be fulfilled. DOE will continue to follow established processes in conducting ongoing environmental restoration activities.

For example, the framework Congress established under CERCLA for remedial actions imposes a strong preference for permanent remedies that comply with all applicable and appropriate requirements established under environmental laws. Consequently, DOE's overall environmental restoration efforts have focused on cleaning up sites adequately for unrestricted future use. The framework also requires that cleanup requirements and remedies be selected site-specifically. This produces final decisions made both discretely and diversely.

DOE believes, however, that there are important national issues that it should analyze in carrying out its responsibilities. These issues include, but are not limited to, (1) the degree to which DOE should rely on proven technologies in contrast to making strong resource commitments to developing innovative technologies; (2) the manner in which DOE should manage wastes until adequate treatment and disposal capacity is available; (3) whether DOE's installations should invariably be cleaned up for unrestricted use; and (4) the environmental basis for deciding cleanup priorities.

DOE seeks to develop and analyze programmatic alternatives that bear on these issues. DOE believes that important information on the costs and benefits of alternative program management strategies could thereby be obtained. DOE is especially interested in receiving public comments on these issues.

Decontamination and decommissioning activities are not subject to the decisionmaking framework that governs remediation activities. DOE proposes, therefore, to approach all D&D activities in an integrated, systematic fashion.

Waste Management Analysis: Waste treatment, storage, transportation, and disposal alternatives primarily depend on the waste category (such as radioactive, hazardous, or radioactive mixed waste). Alternatives will reflect centralized, regional, or installation-specific strategies. The analysis would provide environmental information for deciding which waste management capabilities should be established centrally, regionally, or at each site. Transportation of waste and the potential associated impacts will also be evaluated.

No Action. This alternative would continue present practices. DOE would not adopt and integrated environmental restoration and waste management program. DOE would continue to operate its environmental restoration activities and its waste operations as discrete site-specific actions. If site requirements dictate the need for offsite or new facilities, management decisions would be made on a project specific basis.

DOE would maintain existing facilities for waste management operations. New waste management activities, projects, and technological development would be considered case-by-case.

IDENTIFICATION OF ENVIRONMENTAL ISSUES: The following environmental issues have been identified for analysis in the PEIS. This list is presented to facilitate discussion on the scope of the PEIS and is not intended to be all-inclusive or to predetermine the scope. Therefore, DOE invites comments on these and additional issues relevant to this PEIS.

(1) The potential impacts (both beneficial and adverse) to worker health, public health, and the environment under various alternatives for environmental restoration and waste management.

(2) The potential impacts to workers, public health, and the environment under various alternatives from routine transportation of wastes and potential transportation accidents.

(3) The development of needed technologies and methods for environmental restoration and waste management and the potential impacts (both beneficial and adverse) from their implementation.

(4) Any obstacles to achieving full compliance with all applicable federal, state, and local environmental statutes, regulations, and requirements.

(5) The socioeconomic impacts of alternatives for dispersed, regional, and centralized waste management.

(6) The potential impacts of applying various land-usability strategies to the cleanup of DOE installations and sites.

RELATIONSHIP TO OTHER ACTIONS: *Five-Year Plan.* DOE issued a Five-Year Plan for Environmental Restoration and Waste Management (DOE/S-0070) in August 1989 that was subsequently revised, updated, and reissued (DOE/S-0078P) in June 1990. The Plan summarizes current DOE practices and identifies short- and long-term goals. The activities described are for the near-term (e.g., remediation of seepage basins at the Savannah River Site, and radioactive storage upgrades at the Kansas City Plant). Only general objectives, criteria, and guidance, in addition to those set in applicable environmental regulations and statutes, are specified for implementing environmental restoration and waste management activities on a long-term basis. For example, the Plan states that the majority of solid low-level waste generally will continue to be disposed of using shallow land burial, but recognizes that this may not be suitable for all locations. The Plan also states DOE's general intent that facilities and sites be returned to a condition suitable for unrestricted use, but recognizes that in-place remedies may sometimes be preferred.

The Five-Year Plan is not a proposal within the context of NEPA. Rather, it is preliminary to the Environmental Restoration and Waste Management PEIS in which DOE will evaluate integrating its long-term environmental restoration and waste management activities. The PEIS will specifically address the long-term goals and issues generally summarized in the Five-Year Plan.

As the Plan states, completion of the PEIS process may result in changes in specific programs, which would be reflected in future editions of the Plan.

Environmental Restoration and Waste Management Configuration Study. The Environmental Restoration and Waste Management Configuration Study is a strategic planning study for the long-term (the next 25 years). The study will support the definition of waste system configuration alternatives in this PEIS. DOE intends to issue the draft configuration study concurrently with the draft PEIS for public information and use in reviewing the draft PEIS.

Many factors influence the configuration and updating of DOE's waste management operations, including: (1) Increasingly strict environmental, safety, and health standards and requirements; (2) facilities dating from the late 1940s to the middle 1960s becoming obsolete; (3) increasing costs to maintain and upgrade these facilities; (4) difficulties in managing widely dispersed waste storage facilities in different environmental settings; (5) potential changes in the locations, volumes, and types of waste to be managed, after consideration of a PEIS on reconfiguring (modernizing) the nuclear weapons complex; (6) availability of improved technologies; (7) population growth near once-remote facilities such as areas near Rocky Flats, Colorado, Fernald, Ohio, Oak Ridge, Tennessee, and Livermore, California, which has led to local demands for restricting DOE operations; and (8) transition from waste accumulation and storage to waste treatment and disposal.

PEIS for the Nuclear Weapons Complex (NWC). In concert with the decision to prepare this PEIS, the Secretary decided that a separate PEIS on DOE's proposal to modernize (reconfigure) the nuclear weapons complex will also be prepared. The reconfiguration of the nuclear weapons complex would affect DOE's program for environmental restoration and waste management because it would change the locations, volumes, and types of waste to be managed. The environmental restoration and waste management PEIS, therefore, will take into account, to the extent practical, the materials generated in the preparation of the NWC PEIS. Separate statements are being prepared, however, because the programs are driven by distinct missions, requirements, and schedules. If the PEIS on the NWC is not issued first, DOE will prepare a supplement to the Environmental Restoration and waste management PEIS, if appropriate.

PUBLIC SCOPING MEETINGS AND INVITATION TO COMMENT: DOE is committed to providing opportunities for the involvement of interested individuals and groups in this and other DOE planning activities.

DOE will conduct a series of public scoping meetings nationwide and invites all interested people to attend and to present oral comments concerning: (1) the scope of the PEIS, (2) the issues that should be addressed, and (3) the alternative integrated approaches to be analyzed in the PEIS. DOE also invites written comments.

Oral and written comments will be given equal consideration. Instructions for submitting written comments are given above. People desiring to speak at the public scoping meetings should submit their requests to do so to the contact persons to be designated in a subsequent **Federal Register** notice. Oral presentation requests for each meeting should be received by DOE at least two days before the meeting.

The meetings will be chaired by a presiding officer. They will not be conducted as evidentiary hearings. Speakers will not be cross-examined, although the DOE representatives present may ask them clarifying questions.

To ensure everyone an adequate opportunity to speak, five minutes will be allotted for each speaker. Depending on the number of persons requesting to speak, the presiding officer may allow more time for speakers representing multiple parties or organizations. Persons wishing to speak on behalf of organizations should identify the organization in their request. Persons who have not submitted a timely request to speak may register at the meetings, and will be called on to speak if time permits. Written comments also will be accepted at the meetings, and speakers are encouraged to provide written versions of their oral comments for the record.

The public scoping meetings will begin in December 1990. Detailed information on the meetings will be provided in a subsequent **Federal Register** notice. This information will also be announced in local public notices before the planned meetings.

DOE will make a transcript of each meeting. Copies will be made available for inspection at the DOE Freedom of Information Reading Room (Room 1E-190), Forrestal Building, 1000 Independence Avenue SW., Washington, DC 20585, during business hours, Monday through Friday and in local DOE reading rooms. Locations of local reading rooms will be provided in the subsequent **Federal Register** notice regarding the scoping meetings.

RELATED NEPA DOCUMENTATION: DOE expects to prepare additional NEPA documents for implementing programmatic and facility-specific decisions based upon this PEIS. These generally site-specific documents will analyze future technology and siting alternatives for implementing DOE's environmetnal restoration and waste management activities. Their analyses will address such local concerns as floodplains and wetlands, historic and archaeological sites, land use, and threatened and endangered species. The PEIS will examine these issues only to the degree necessary for selection of an integrated program.

Interim Actions. DOE may need to conduct many diverse and discrete site-

specific environmental restoration and waste management activities while the PEIS is being prepared. Many of these activities are required by Federal and state regulatory agencies under environmental compliance agreements and some are required by court decrees. DOE will have to determine case-by-case whether site-specific actions may proceed before the PEIS is completed. This will be done in accordance with all applicable requirements, including the test for interim actions found in Council on Environmental Quality's NEPA Regulations (40 CFR 1506.1(c)).

Other. DOE has prepared, or is currently preparing, NEPA documents for many of DOE's site-specific actions. Examples of some major relevant waste management NEPA documents are listed below:

1. Final Environmental Impact Statement, Disposal of Hanford Defense High-level, Transuranic and Tank Wastes, Hanford Site, Richland, Washington. DOE/EIS-0113, December 1987. U.S. Department of Energy, Washington, DC.
2. Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection, Savannah River Plant, Aiken, South Carolina. DOE/EIS-0120, December 1987. U.S. Department of Energy, Washington, DC.
3. Final Supplemental Environmental Impact Statement, Waste Isolation Pilot Plant, DOE/EIS-0026-FS, January 1990. U.S. Department of Energy, Washington, DC.
4. Draft Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, DOE/EIS-0119d, March 1989. U.S. Department of Energy, Washington, DC.

These documents, the Five-Year Plan (DOE/S-0078P), transcripts from the public scoping meetings (when they become available), and other related documents will be available for inspection at DOE Freedom of Information Reading Rooms.

Issued in Washington, DC, this 15th day of October 1990.

Peter N. Brush,

Acting Assistant Secretary, Environment, Safety and Health.

Appendix: Locations of Activities Embraced by the PEIS

Name	Location
Amchitka Island	Amchitka Island, AK.
Lawrence Berkeley Laboratory.	Berkeley, CA.
University of California	Berkeley, CA.
Atomics International	Canoga Park, CA.
Laboratory for Energy-Related Health Research.	Davis, CA.
Sandia National Laboratory-Livermore.	Livermore, CA.
Lawrence Livermore Laboratory	Livermore, CA.
Bayo Canyon	Los Alamos, CA.
Stanford Linear Accelerator Center.	Palo Alto, CA.
General Atomics	San Diego, CA.
Energy Technology Engineering Center.	Santa Susana, CA.
General Electric Vallecitos Nuclear Center.	Vallecitos, CA.
Rocky Flats Plant	Golden, CO.
Grand Junciton Project Office.	Grand Junction, CO.
Project Rulison Site	Grand Valley, CO.
Project RioBlanco Site	Rifle, CO.
Seymour Speciality Wire	Seymour, CT.
Pinellas Plant	St. Petersburg, FL.
Kauai Test Facility	Kauai, HI.
Ames Laboratory	Ames, IA.
Idaho National Engineering Laboratory	Idaho Falls, ID.
Argonne National Laboratory—West.	Idaho Falls, ID.
Argonne National Laboratory—East.	Chicago, IL.
National Guard Armory	Chicago, IL.
Palos Forest	Chicago, IL.
Fermi National Accelerator Laboratory.	Batavia, IL.
University of Chicago	Chicago, IL.
Johnston Atoll	Johnston Atoll.
Paducah Gaseous Diffusion Plant.	Paducah, KY
Ventron, Beverly	Beverly, MA.
Shpack Landfill	Norton, MA.
W.R. Grace & Co.	Curtis Bay, MD.
General Motors	Adrian, MI.
Hazelwood (Latty Avenue)	Hazelwood, MO.
Kansas City Plant	Kansas City, MO.
St. Louis Airport Storage Site	St. Louis, MO.
Mallinckrodt, Inc.	St. Louis, MO.
St. Louis Airport Storage Site Vicinity Properties.	St. Louis, MO.
Weldon Spring Site Remedial Action Project.	St. Charles, MO.
Tatum Dome	Tatum Dome, MS.
Component Development & Integration Facility	Butte, MT
Hallam Nuclear Power Facility	Lincoln, NE.
Du Pont & Company	Deepwater, NJ.
Kellex/Pierpont	Jersey City, NJ.
Maywood	Maywood, NJ.
Middlesex Landfill	Middlesex, NJ.
Middlesex Sampling Plant	Middlesex, NJ.
New Brunswick Laboratory	New Brunswick, NJ.
Princeton Plasma Physics Laboratory.	Princeton, NJ.
Wayne/Pequannock	Wayne/Pequannock, NJ.
Inhalation Toxicology Research Institute.	Albuquerque, NM.
Sandia National Laboratory—Albuquerque.	Albuquerque, NM.
Ross Aviation	Albuquerque, NM.
Project GNOME Site	Carlsbad, NM.
Waste Isolation Pilot Plant	Carlsbad, NM.
Project GASSBUGGY Site	Farmington, NM.
Los Alamos National Laboratory.	Los Alamos, NM.
Acid/Pueblo Canyon	Los Alamos, NM.
Chupadera Mesa	White Sands Missile Range, NM.
Central Nevada Test Area	Central Nevada Test Area, NV.
Project Shoal Site	Fallon, NV.
Nevada Test Site	Las Vegas, NV
Tonopah Test Range	Nellis Air Force Base, NV.
Colonie	Colonie, NY.
Niagara Falls Storage Site Vicinity Properties.	Lewiston, NY
Niagara Falls Storage Site	Niagara Falls, NY
Ashland Oil Co. #2	Tonawanda, NY
Linde Air Products	Tonawanda, NY.
Seaway Industrial Park	Tonawanda, NY.
Ashland Oil Co. #1	Tonawanda, NY.
Brookhaven National Laboratory.	Upton, Long Island, NY.
West Valley Demonstration Project.	West Valley, NY.
Reactive Metals Inc	Ashtabula, OH.
Battelle Columbus Laboratories.	Columbus, OH.
Feed Materials Production Center.	Fernald, OH.
Mound Laboratory	Miamisburg, OH.
Piqua Nuclear Power Facility	Piqua, OH.
Portsmouth Gaseous Diffusion Plant.	Portsmouth, OH.
Albany Metallurgical Research Center.	Albany, OR.
Universal Cyclops	Aliquippa, PA.
Center for Energy and Environmental Research.	Mayaguez, PR.
Savannah River Site	Aiken, SC.
Oak Ridge National Laboratory	Oak Ridge, TN.
Oak Ridge Gaseous Diffusion Plant.	Oak Ridge, TN.
Y-12 Plant	Oak Ridge, TN.
Pantex Plant	Amarillo, TX.
Hanford Reservation	Richland, WA.
24 Site Covered under Title I of the Uranium Mill Tailings Radiation Control Act.	Various Locations.

Attachment 2
(to WM PEIS Appendix A)

Federal Register Notice
(Volume 60, Number 15, Tuesday January 24, 1995)
[60 FR 4607]

Department of Energy
"Environmental Restoration and Waste Management; Programmatic Environmental Impact Statement"

Federal Register / Vol. 60, No. 15 / Tuesday, January 24, 1995 / Notices 4607

DEPARTMENT OF ENERGY

Environmental Restoration and Waste Management; Programmatic Environmental Impact Statement

AGENCY: U.S. Department of Energy

ACTION: Notice of opportunity for public comment.

SUMMARY: The Department of Energy is giving the public the opportunity to comment on proposed modifications to the title and scope of the Environmental Restoration and Waste Management Programmatic Environmental Impact Statement. The Department proposes to modify the scope and name of the Environmental Restoration and Waste Management Programmatic Environmental Impact Statement (PEIS).

The proposed action would focus primarily on the evaluation and analysis of waste management issues confronting the Department and would be renamed the Waste Management Programmatic Environmental Impact Statement.

DATES: To ensure that the public's concerns and views are fully considered, DOE is providing a 45-day written comment period that will extend until March 10, 1995, to comment on the proposed modification to the Programmatic Environmental Impact Statement.

ADDRESSES AND FURTHER INFORMATION: Written comments and requests for further information on the Environmental Restoration and Waste Management Programmatic Environmental Impact Statement should be directed to: James A. Turi, Office of Waste Management (EM-33), U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585-0002, (301) 903-7147.

For information on the Department's National Environmental Policy Act process, contact: Carol M. Borgstrom, Director, Office of NEPA Oversight (EH-25), U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585, (202) 586-4600 or leave a message at 1-800-472-2756.

SUPPLEMENTARY INFORMATION: On October 22, 1990, the Department of Energy issued a Notice of Intent to prepare the Environmental Restoration and Waste Management Programmatic Environmental Impact Statement (PEIS) (55 FR 42633). In the Notice of Intent and in an Implementation Plan issued in January 1994, the Department identified the proposed action as follows: "to formulate and implement an integrated environmental restoration and waste management program in a safe and environmentally sound manner and in compliance with applicable laws, regulations and standards." The Notice of Intent and the Implementation Plan identified two separate sets of alternatives to be evaluated, for environmental restoration and for waste management.

The Department attempted to meaningfully analyze the environmental restoration alternatives that it originally defined as part of the "proposed action." After considerable effort, the Department has concluded that it would not be appropriate to make programmatic decisions regarding cleanup strategies that would be applicable to all of the Department's sites. The fundamental reasoning behind the Department's conclusion is that cleanup decisions should reflect site-specific conditions, and, in any event, can only be reached with the approval of state and federal regulators and the involvement of the public. It would be inconsistent with the site-specific nature of cleanup decisions, therefore, to make these decisions under this PEIS that would be implemented nationwide.

Accordingly, the Department proposes to eliminate the analysis of environmental restoration alternatives and to modify the proposed action. As modified, the PEIS would consider how to manage the subject wastes and analyze alternative sites at which the wastes could be managed in the future. The PEIS would focus its programmatic evaluations on waste management facilities, and would henceforth be known as the "Waste Management Programmatic Environmental Impact Statement." As previously set forth in the Implementation Plan, the PEIS would evaluate decentralized, regional, and centralized approaches for storage of high-level waste; treatment and storage of transuranic waste; treatment and disposal of low-level and low level mixed waste; and treatment of hazardous waste. Waste generated by restoration activities in the future that must be managed as part of the Department's program to manage all of its wastes would be considered in the PEIS's projected waste inventories. The draft PEIS is currently scheduled for publication in late spring of 1995.

In the October 22, 1990, Notice of Intent in the Federal Register, the Department of Energy discussed the preparation of a Programmatic Environmental Impact Statement based on formulating and implementing an integrated environmental restoration and waste management program in a safe and environmentally sound manner and in compliance with applicable requirements. The Notice of Intent stated that the purpose of the integrated environmental restoration and waste management program was to provide a broad, systematic approach to addressing site cleanup and waste management. Although the proposed action was defined in terms of integrating environmental restoration and waste management, the description of the alternatives in the Implementation Plan set forth separate sets of alternatives for environmental restoration and waste management.

When the Department published the Notice of Intent in 1990, there were important national issues regarding the direction of its environmental restoration program that could be meaningfully evaluated in the PEIS. These issues focused primarily on the level and extent of cleanup of the Department's facilities. The Department continues to believe that cleanup of its sites involves important issues such as land use, public health, worker risks, and cleanup standards. The Department has concluded, however, that programmatic decisions regarding environmental restoration cannot be made because these decisions should reflect the particular conditions at each site, and require the approval of state regulators and the involvement of stakeholders. The Department believes that the proposed action originally considered in the PEIS should be modified by eliminating the analysis of environmental restoration alternatives. In view of this modification the PEIS would be renamed the "Waste Management Programmatic Environmental Impact Statement."

The modified proposed action would focus on the evaluation and analysis of waste management issues confronting the Department and would incorporate potential impacts of environmental restoration on the management of wastes. The Department believes the proposed action as modified will identify and analyze waste management issues and activities for which the Department is responsible. A summary of the comments received in response to this notice will be contained in an appendix to the draft Waste Management Programmatic Environmental Impact Statement. Comments previously received during the public comment process on the scope of the PEIS that are still relevant in light of the proposed modification to the PEIS, and the issues raised by such comments, would be evaluated as discussed in the Implementation Plan. Comments on the scope of the PEIS that are relevant to other analyses being conducted in connection with site-specific environmental restoration at DOE's sites will be considered in the preparation of those analyses.

Issued in Washington, D.C., on January 18, 1995.

Thomas P. Grumbly,
Assistant Secretary for Environmental Management.

[FR Doc. 95-1754 Filed 1-23-95; 8:45 am]

BILLING CODE 6450-01-P

Attachment 3
(to WM PEIS Appendix A)

Federal Register Notice
(Volume 60, Thursday March 16, 1995)
[60 FR 14275]

Department of Energy
"Extension of Public Comment Period for The Environmental Management Programmatic Environmental Impact Statement"

Federal Register / Vol. 60, No. 51 / Thursday, March 16, 1995 / Notices 14275

DEPARTMENT OF ENERGY

Extension of Public Comment Period for the Environmental Management Programmatic Environmental Impact Statement

AGENCY: U.S. Department of Energy.

ACTION: Extension of public comment period.

SUMMARY: On October 22, 1990, the Department of Energy issued a Notice of Intent to prepare the Environmental Restoration and Waste Management Programmatic Environmental Impact Statement (PEIS). (55 FR 42633). In the Notice of Intent and in an Implementation Plan issued in January 1994, the Department identified the proposed action as follows: "to formulate and implement an integrated environmental restoration and waste management program in a safe and environmentally sound manner and in compliance with applicable laws, regulations and standards." A notice was issued on January 24, 1995, inviting the public to provide written comments on a proposed modification to the scope and name of the PEIS. (60 FR 4607). In the notice, the Department proposed to modify the proposed action to eliminate the analysis of environmental restoration alternatives. As modified, the PEIS would consider how to manage certain types of radioactive and hazardous waste, and analyze alternative sites at which the wastes could be managed in the future. The PEIS would focus its programmatic evaluations on waste management facilities, and would henceforth be known as the "Waste Management Programmatic Environmental Impact Statement."

INVITATION TO COMMENT: In response to a request from the public, the Department is extending for 30 days, until April 10, 1995, the written comment period for the proposed modification to the Programmatic Environmental Impact Statement. A summary of the comments received in response to this notice will be contained in an appendix to the draft Waste Management Programmatic Environmental Impact Statement.

ADDRESSES AND FURTHER INFORMATION: Written comments and requests for further information on the Programmatic Environmental Impact Statement should be directed to: James A. Turi, Office of Waste Management (EM-33), U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585-0002, (301) 903-7147.

For information on the Department's National Environmental Policy Act process, contact: Carol M. Borgstrom, Director, Office of NEPA Policy and Assistance (EH-42), U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585, (202) 586-4600 or leave a message at 1-800-472-2756.

Issued in Washington, D.C., this 10th day of March 1995.

Thomas P. Grumbly,
Assistant Secretary for Environmental Management.

[FR Doc. 95-6520 Filed 3-15-95; 8:45 am]

BILLING CODE 6450-01-P

Attachment 4
(to WM PEIS Appendix A)

Natural Resources Defense Council's (NRDC's) Comments on the Department of Energy's (DOE's) Proposed Modification in Scope of the Environmental Restoration and Waste Management Programmatic Environmental Impact Statement (Letter: Andrew P. Caputo [NRDC] to James A. Turi [DOE], April 10, 1995)

Natural Resources
Defense Council

1350 New York Ave., N.W.
Washington, DC 20005
202 783-7800
Fax 202 783-5917

April 10, 1995

James A. Turi
Office of Waste Management (EM-33)
U.S. Department of Energy
1000 Independence Avenue SW
Washington, D.C. 20585-0002

Dear Mr. Turi:

The Natural Resources Defense Council ("NRDC"), lead plaintiff in NRDC v. Watkins, Civ. No. 89-1835-SS (D.D.C.) (stipulation filed Oct. 22, 1990), files the following comments on the Department of Energy's proposed modification in scope of the Environmental Restoration and Waste Management Programmatic Environmental Impact Statement. Notice of the proposed modification was published in the Federal Register at 60 Fed. Reg. 4,607 (Jan. 24, 1995), and the comment period was extended to today pursuant to a notice published at 60 Fed. Reg. 14,275 (March 16, 1995).

NRDC opposes the proposed modification for both legal and policy reasons. As a legal matter, the National Environmental Policy Act ("NEPA") requires the Energy Department to prepare a programmatic environmental impact statement ("EIS") on its program of environmental restoration activities, for all of the reasons explained in the submissions by NRDC leading up to and during the above-cited litigation. Moreover, during this litigation the Department specifically conceded that its program of environmental restoration and waste management constitutes "'a group of concerted actions' within the meaning of NEPA,"[1] which triggers a duty to prepare a programmatic EIS pursuant to 40 C.F.R. § 1508.18(b)(3). Finally, the Department committed to prepare such a document in the course of the NRDC v. Watkins litigation.

The case for a programmatic EIS on the environmental restoration program is just as strong from a policy perspective as it is from a legal perspective. While it is certainly true that "cleanup decisions should reflect site-specific conditions," 60 Fed. Reg. at 4,608, it is

[1] Memorandum from James D. Watkins, Secretary, DOE, to Leo P. Duffy, Director, Office of Environmental Restoration and Waste Management, DOE, Jan. 12, 1990.

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equally true that there are a number of important program-level issues relating to the environmental restoration program that demand a full, prospective, program-level analysis with full public participation. These issues include the scope and pace of the environmental restoration program in light of budgetary and other constraints; the choice between using uniform cleanup standards or site-specific cleanup standards as part of the program; the programmatic implications of using land-use restrictions in setting cleanup levels; issues of inter- and intra-facility priority setting, particularly in a situation of budget scarcity; and the programmatic role of site-specific advisory boards and other avenues for public participation in making cleanup decisions. A programmatic analysis of these and other important issues in the environmental restoration program has become even more important in recent months and years, in light of such developments as departmental discussions concerning land-use considerations in the cleanup process, the findings of the Baseline Environmental Management Report, and budget developments.

The need for a program-level analysis of the environmental restoration program is enhanced by the fact that the Department, as a matter of policy, does not perform NEPA compliance on site-specific environmental restoration actions taken pursuant to the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"). Thus, a program-level EIS seems the only NEPA analysis available to citizens on many of the important issues facing the environmental restoration program. Moreover, no alternative to the NEPA process currently exists for analyzing these issues in a programmatic, prospective manner with full public participation.

Sincerely,

Andrew Caputo

Andrew P. Caputo
Attorney

cc: Assistant Secretary Thomas P. Grumbly

Appendix B

Environmental Restoration Wastes

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Acronyms and Abbreviations

The following is a list of the acronyms and abbreviations (including units of measure) used in this appendix.

Ames	Ames Laboratory
ANL-E	Argonne National Laboratory-East
BCL	Battelle Columbus Laboratories
BEMR	*Baseline Environmental Management Report*
BNL	Brookhaven National Laboratory
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERDF	Environmental Restoration Disposal Facility
FEMP	Fernald Environmental Management Project
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	fiscal year
GA	General Atomics
GE	General Electric Vallecitos Nuclear Center
Hanford	Hanford Site
INEL	Idaho National Engineering Laboratory
ITRI	Inhalation Toxicology Research Institute
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LEHR	Laboratory for Energy-Related Health Research
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
m^3	cubic meter(s)
Mound	Mound Plant
NEPA	National Environmental Policy Act
NTS	Nevada Test Site

ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OU	operable unit
Pantex	Pantex Plant
PGDP	Paducah Gaseous Diffusion Plant
PORTS	Portsmouth Gaseous Diffusion Plant
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RMI	Reactive Metals, Inc.
SNL-NM	Sandia National Laboratories, New Mexico
SPRU	Separations Process Research Unit
SRS	Savannah River Site
TRUW	transuranic waste
WIPP	Waste Isolation Pilot Plant
WM	waste management
WM PEIS	Waste Management Programmatic Environmental Impact Statement
WVDP	West Valley Demonstration Project
Y-12	Y-12 Plant

APPENDIX B
Environmental Restoration Wastes

Certain wastes generated during environmental restoration (ER) activities will be transferred to the Waste Management (WM) Program. The current information available about the ER transferred waste is limited to volumetric estimates by site and waste type (i.e., low-level waste, low-level mixed waste, and transuranic waste. The radiological profiles, chemical contaminant concentrations, and the treatment categories of the individual ER transferred waste streams have not yet been determined to the extent necessary to allow for an evaluation of the potential environmental and human health impacts that would result from management of these ER transferred wastes. Therefore, in this appendix, the assessment as to how the addition of ER transferred wastes may affect WM PEIS alternatives is limited to a qualitative discussion about the potential for affecting WM facility capacities. This discussion is based on the comparison between the expected volumes of ER transferred waste and the volumes of the WM waste at each site. Such analysis, while not of the same scope as the impacts assessment done for WM wastes, is useful to identify those sites and alternatives that could be affected by the addition of ER transferred wastes. When the radiological and chemical contaminant concentration and the treatment categories of ER transferred waste are better known, DOE may be required to assess the impacts of managing ER transferred waste on a site-specific or project basis.

B.1 Introduction

The term "environmental restoration" (ER) refers to the remediation of contaminated media at U.S. Department of Energy (DOE) sites in order to reduce risks and allow sites to be used for other purposes. Depending on the particular site and contaminated media, remediation can occur in place without removal, or the contaminated media may be removed from the environment, generating wastes that would require further treatment or disposal. The majority of the wastes generated during remediation will be managed outside of the alternatives evaluated in the Waste Management Programmatic Environmental Impact Statement (WM PEIS). However, a certain subset of the remediation wastes will be sent for treatment or disposal at waste management (WM) facilities.

This appendix provides estimates of the total amounts of low-level waste (LLW), low-level mixed waste (LLMW), and transuranic waste (TRUW) that are expected to be generated during remediation, as well as estimates of the amounts of these wastes that may be managed by the WM Program. In this appendix, the term "ER transferred wastes" is used to designate those wastes generated by ER that will be transferred to the WM Program. This appendix compares the estimated volumes of ER transferred waste to the volumes of WM wastes analyzed in the WM PEIS and also discusses how the ER transferred wastes may affect the

treatment and disposal capacities of WM facilities. The purpose of the analysis is to identify those WM PEIS alternatives, if any, that could be affected by the addition of ER transferred wastes. This appendix also identifies possible strategies that can be used to accommodate the increased loading of the ER transferred wastes to the WM Program.

Finally, this appendix discusses the assumptions and uncertainties involved in (1) estimating the amount of ER transferred wastes and (2) estimating the effects that ER transferred waste would have on the alternatives in the WM PEIS.

B.2 DOE Environmental Restoration Program

One legacy of the Nuclear Weapons Program is environmental contamination at the sites where research, development, testing, and production of nuclear weapons took place. The Environmental Restoration Program was established to address contaminated media at these sites. The ER Program performs a wide range of activities such as stabilizing contaminated soil, treating groundwater, decommissioning process buildings (including nuclear reactors and chemical separations plants), and exhuming buried drums of waste.

The extent to which a site is "cleaned up" will depend largely on regulatory requirements and decisions regarding future land use. For many sites, the process of evaluating possible uses in the future has just begun. The general process concerning site cleanup actions is laid out by statutes, including the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC Section 9601 *et seq.*) and the Resource Conservation and Recovery Act (RCRA) (42 USC Section 6905 *et seq.*). The process involves discussions among DOE, regulatory agencies, and local stakeholders. Decisions are implemented at specific sites through formal agreements among DOE, the U.S. Environmental Protection Agency (EPA), and the host state. The process involves several steps. First, a site or portion of a site is characterized to identify contaminants, determine the nature and extent of contamination, and assess potential threats to public health and the environment. Concurrent with characterization, a detailed analysis is performed to quantify risk and evaluate remedial alternatives. A remedy can be implemented quickly, as expedited response actions designed to mitigate conditions that present immediate and significant risks to the environment or human health, or can be performed as part of long-term cleanup.

B.3 Remediation Alternatives and ER Transferred Wastes

The treatment and disposition of wastes generated from site restoration activities can be done under either the DOE ER or WM Programs. Environmental restoration wastes transferred to the responsibility of the DOE WM Program for treatment and disposal are called "ER transferred wastes." The highlighted areas in Figure B.3-1 indicate the ER transferred wastes that are analyzed in this appendix.

Remediation activities are dependent on proposed land uses for each site and can be grouped into two general categories: containment or removal. In the first category, containment, *in situ* remediation and access control serve to reduce the risks by managing contaminated media in their current locations. The second category, *ex situ* remediation, involves removal of the contaminated media, which are then treated and sent for disposal (Figure B.3-1). *In situ* containment remedies (such as capping a landfill or entombing buildings) generate relatively small volumes of ER transferred waste. Typically, remedies using *in situ* technologies, where the contaminated media would remain in place, are coupled with decisions that restrict future site land use.

At those sites where future land-use plans call for less restricted access, it is more likely that remediation would involve removal of contaminated media. Typically, contaminated media that are excavated or facilities that are dismantled will undergo some type of treatment that would generate either a final waste form ready for disposal or a waste stream that will require additional treatment before disposal. In some cases, contaminated media can be removed and sent directly for disposal.

The extent to which ER transferred wastes will use WM facilities is site-specific and depends on such factors as the particular remediation activities at each site and on decisions regarding ER at the site. For example, at the Hanford Site (Hanford), the vast majority of wastes generated during remediation activities are destined for disposal in the Environmental Restoration Disposal Facility (ERDF) (DOE, 1996b). The ERDF is a dedicated disposal facility for ER wastes. Accordingly, Hanford is unlikely to transfer large amounts of ER waste to WM facilities. At sites without dedicated ER facilities, much (or all) of the wastes generated during remediation might become ER transferred waste and would be managed under the alternatives evaluated in the WM PEIS.

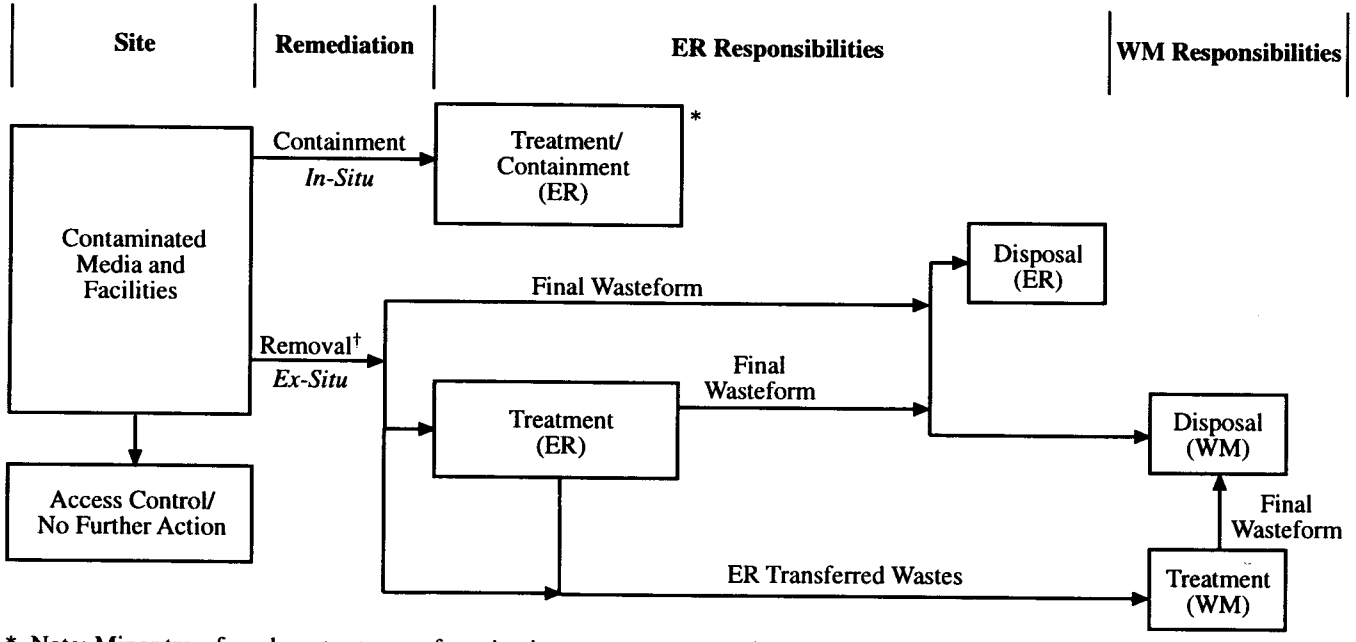

Figure B.3–1. General Remediation Scheme for Contaminated Media and ER Wastes.

B.4 Need to Proceed With Waste Management Decisions Without Assessment of Impacts From ER Transferred Waste

DOE believes that decisions about which sites should host WM treatment, storage, or disposal activities must be made now to make rapid progress toward improving DOE's management of its wastes. Although some ER waste could be transferred for treatment or disposal in WM facilities, possibly influencing the size or siting for these facilities, it was not possible to analyze the potential impacts of managing ER transferred waste in the WM PEIS because there are large uncertainties about ER waste (see Section B.9). DOE believes, however, that the sites for WM facilities must be selected soon. There is a minimum requirement for the siting and sizing of WM facilities based wholly on the locations and quantities of WM wastes and that would remain valid regardless of future ER waste treatment or disposal requirements. When there is better knowledge about the volumes and composition of ER wastes, it is possible that additional WM treatment or disposal capabilities may be needed, which may necessitate further site-specific National Environmental Policy Act (NEPA) analyses. However, these site-specific evaluations would not change the need for the initial set of sites identified to host WM treatment, storage, or disposal activities.

As DOE conducted its analyses of both the ER and WM Programs, it became evident that analyses leading to nationwide programmatic proposals for the ER Program were not appropriate. The Department felt that decisions related to ER were not suited to a national-level analysis but instead should be focused at the site level and reflect site-specific conditions. The ER activities at each site would be best developed on the basis of factors such as the proposed land use, the nature of the contaminated media, the technical solutions available, and local regulatory priorities. Evaluations conducted at the site and local level would be more effective in considering these elements and developing appropriate remediative responses. In contrast, many WM Program decisions are more appropriately addressed at the national level. The nature of WM waste and the requirements for its treatment and disposal are more certain; wastes are either already in storage or will be generated from ongoing processes that are well understood. It is possible and appropriate to develop treatment or disposal capabilities at one or more sites to handle these wastes because the nature and timing of treatment and disposal requirements across many sites are better known. A national-level analysis and programmatic decisions would therefore provide better solutions for the WM Program (see Section 1.7.1).

Consequently, in the *Federal Register* of January 24, 1995, DOE announced that the scope of the WM PEIS would be limited to a programmatic analysis regarding how and where DOE would treat, store, and dispose of its WM waste. The 1995 announcement and the response by the public are contained in Appendix A.

In making decisions about sites that will host WM treatment, storage, or disposal facilities, DOE will consider many criteria. For example, the WM PEIS shows that there is a tradeoff between the impacts resulting from the transport of wastes and the impacts (e.g., health risks and costs) that result from site-specific waste management actions under each alternative. The Decentralized Alternatives minimize transportation risks and associated impacts (such as physical trauma from accidents) but increase the site-specific impacts associated with construction and operation of WM facilities at many sites. The Centralized Alternatives have the greatest transportation impacts and increase the impacts at the chosen central site but decrease the nationwide site-specific impacts and decrease overall costs. The transportation and site-specific impacts associated with the Regionalized Alternatives fall in between those of the Decentralized and Centralized Alternatives. Decisions on which sites will host WM facilities will consider such transportation and site-specific tradeoffs. Sites may be selected to host WM facilities on the basis of a variety of factors, including (1) minimizing the transportation of large quantities of waste, (2) effectively using existing management capabilities, or (3) taking advantage of site-specific conditions (e.g., favorable geology).

When there is sufficient information to evaluate ER transferred wastes, DOE will need to further assess its options. For example, if ER transferred waste is located at a site that already is selected to have certain WM facility capabilities, DOE would have to determine whether the site facilities should manage the additional waste and whether additional NEPA analysis would be required to examine the impacts resulting from the addition of the ER transferred wastes. If the ER transferred waste is present at a site not selected for a WM facility, DOE would evaluate whether new WM capabilities should be added to the site or whether the wastes should be transported to a site with the capability to manage the waste. Any additional NEPA evaluations are likely to be project- or site-specific and would consider how the ER activities and ER transferred waste at one site should be managed, given the existence of a set of WM facilities with varying capacities and capabilities, as well as commercial waste treatment and disposal capabilities. The future evaluation of options for managing ER transferred wastes will be facilitated by having more operating experience at the WM facilities and improved knowledge of costs, effectiveness, and environmental effects.

The following sections of Appendix B provide general information on the estimated volumes of ER wastes.

B.5 Estimated Volumes of Contaminated Media and ER Transferred Wastes

DOE has prepared projections of the volumes of contaminated media and the waste that may be generated by remedial activities. The information on ER waste volume presented in this appendix is updated from data in *The Current and Planned Low-Level Waste Disposal Capacity Report, Revision 0* (DOE, 1996a). Additional information about the amounts of contaminated media and facilities at DOE sites is contained in *The 1996 Baseline Environmental Management Report* (BEMR) (DOE, 1996b). The BEMR looked at more than 10,000 contaminated sites and facilities and applied generic "base case" (the base case is detailed in the Summary and Volume 1 of the BEMR) criteria, such as potential site land use and the technical feasibility of processing certain media, to identify possible remedial actions and to estimate the volume of waste that might be generated.

For DOE sites addressed in this appendix, the total volume of radioactively contaminated media is approximately 58 million cubic meters (m^3). Tables B.5–1 through B.5–3 present the anticipated disposition and volumes of LLW, LLMW, and TRUW, respectively, from ER.

DOE does not expect to generate any high-level waste by remedial activities. Hazardous waste generated during remediation would be sent to offsite commercial facilities for final disposition and thus is not analyzed in this section.

Environmental restoration activities are site-specific. Of the total volume of contaminated media, approximately 36,000,000 cubic meters would be managed without physically removing or excavating the media, either through access controls or *in situ* treatment or both. Of this volume, approximately 11,000,000 cubic meters are media for which an appropriate response may be access control alone (where public access to the area is restricted either through land deeds or a barrier such as a fence and posted warnings). At some sites (e.g., LANL), some of the contaminated media may require no further action. The other 25,000,000 cubic meters would be managed by *in situ* treatment and containment technologies such as capping.

Approximately 8,500,000 cubic meters would be removed and managed in planned ER facilities that would only handle LLW and LLMW generated by onsite remediation. An additional 1,600,000 cubic meters of LLW and LLMW would be removed and sent to commercial facilities for disposal (e.g., DOE currently sends some waste to the Envirocare facility in Utah; other commercial disposal facilities will be considered

Table B.5-1. Planned Disposition of LLW From Environmental Restoration Actions

DOE Sites Analyzed in the WM PEIS		Estimated Volume for Each Type of Response Action[a] (m^3)						TOTAL by Site
		Ex Situ, Managed by ER	*Ex Situ*, Transferred to WM	*Ex Situ*, Commercial Disposal	*In Situ* Treatment or Containment	Access Controls Only and/or No Further Action	Not Yet Determined	
ANL-E		0	8,700	20	0	0	0	8,800
BNL		0	400	120,000	0	0	0	120,000
FEMP		1,800,000	180,000	480,000	0	0	5,800	2,500,000
Hanford		3,900,000	700	0	20,000,000	0	0	24,000,000
INEL		420,000	140,000	0	79,000	0	0	640,000
LLNL		0	0	0	0	0	0	0
LANL		0	15,000	0	200,000	8,900,000	110,000	9,300,000
NTS		0	1,100,000	0	1,200	0	0	1,100,000
ORR		30,000	9,800	850,000	51,000	0	0	940,000
Pantex		54	0	0	0	0	0	0
PGDP		770,000	150	0	0	56	0	770,000
PORTS		730,000	190	0	0	0	0	730,000
RFETS		61,000	36,000	0	0	0	0	96,000
SNL-NM		0	36,000	0	0	14,000	0	50,000
SRS		0	400,000	0	310,000	1,800	1,800,000	2,500,000
WVDP		0	0	0	0	0	0	0
Other Sites	Chicago Offsite	0	0	15,000	0	0	0	15,000
	FUSRAP	260,000	0	16,000	0	0	2,200	270,000
	Mound	0	3,100	120,000	0	0	0	120,000
	Nevada Offsite	0	0	0	26,000	0	0	26,000
	RMI	0	30,000	0	0	0	0	30,000
	Others	1,400	24,000	1,000	0	0	0	26,000
	Subtotal	260,000	57,000	150,000	26,000	0	2,200	500,000
TOTAL		8,000,000	1,900,000	1,600,000	21,000,000	8,900,000	1,900,000	
							GRAND TOTAL	**= 43,000,000**

Notes: Projected actions assume the "base case" scenario as described in *The 1996 Baseline Environmental Management Report* (DOE, 1996b). The actions are for nonliquid contaminated media and facilities; they exclude groundwater because of the high level of uncertainty in estimating volumes. For *ex situ* response actions, a relatively small quantity of waste that is already in storage is also included in the estimated volumes.

[a] Volumes are in cubic meters rounded to two significant figures; therefore totals may not sum exactly.

Source: May 1996 approved version of the "Environmental Restoration Core Database" (DOE, 1996c).

Table B.5–2. Planned Disposition of LLMW From Environmental Restoration Actions

DOE Sites Analyzed in the WM PEIS		Estimated Volumes for Each Type of Response Action[a] (m^3)						TOTAL by Site
		Ex Situ, Managed by ER	*Ex Situ*, Transferred to WM	*Ex Situ*, Commercial Disposal	*In Situ* Treatment or Containment	Access Controls Only and/or No Further Action	Not Yet Determined	
ANL-E		160	0.4	0	140,000	0	0	140,000
BNL		3,200	0	16,000	0	0	0	19,000
FEMP		0	2,200	2,400	0	0	0	4,600
Hanford		220	100	0	0	0	0	320
INEL		100,000	0	65	99,000	0	0	200,000
LLNL		0	0	0	0	0	0	0
LANL		0	0	980	0	500,000	0	500,000
NTS		0	50	0	0	0	0	50
ORR		0	3,900	0	0	450,000	1,900	460,000
Pantex		0	0	0	0	0	0	0
PGDP		210,000	0	0	0	240,000	0	450,000
PORTS		380	0	0	0	270,000	0	270,000
RFETS		140,000	42,000	0	9,900	180,000	0	380,000
SNL-NM		0	0	1,700	0	2,600	0	4,300
SRS		0	150,000	0	3,900,000	0	6,600,000	11,000,000
WVDP		0	0	0	0	0	0	0
Other Sites	FUSRAP	7,200	0	12,000	0	0	0	19,000
	LBL	0	0	0	42,000	0	0	42,000
	Nevada Offsite	0	0	0	11,000	0	0	11,000
	Other	96	4,400	520	0	0	0	5,000
	Subtotal	7,300	4,400	12,000	54,000	0	0	78,000
TOTAL		470,000	200,000	34,000	4,200,000	1,600,000	6,600,000	
							GRAND TOTAL =	**13,000,000**

Notes: Projected actions assume the "base case" scenario as described in *The 1996 Baseline Environmental Management Report* (DOE, 1996b). The actions are for nonliquid contaminated media and facilities; they exclude groundwater because of the high level of uncertainty in estimating volumes. For *ex situ* response actions, a relatively small quantity of waste that is already in storage is also included in the estimated volumes.

[a] Volumes are in cubic meters rounded to two significant figures; therefore totals may not sum exactly.

Source: May 1996 approved version of the "Environmental Restoration Core Database" (DOE, 1996c).

Table B.5–3. Planned Disposition of TRUW From Environmental Restoration Actions

DOE Sites Analyzed in the WM PEIS		Estimated Volumes for Each Type of Response Action[a] (m^3)					
		Ex Situ, Managed by ER	*Ex Situ*, Transferred to WM	*In Situ* Treatment or Containment	Access Controls Only and/or No Further Action	Not Yet Determined	TOTAL by Site
ANL-E		0	190	0	0	0	190
BNL		0	0	0	0	0	0
FEMP		0	0	0	0	0	0
Hanford		0	1,800	0	0	84	1,900
INEL		0	9,700	0	0	0	9,700
LLNL		0	0	0	0	0	0
LANL		0	0	4,400	0	0	4,400
NTS		0	0	0	0	0	0
ORR	ORNL	12	1,400	130	0	0	1,600
	Y-12	0	50	0	0	0	50
	Subtotal	12	1,500	130	0	0	1,600
Pantex		0	0	0	0	0	0
PGDP		7	0	0	0	0	7
PORTS		0	0	0	0	0	0
RFETS		0	1,900	0	0	3,000	4,900
SNL-NM		0	0	0	4,000	0	4,000
SRS		0	65,000	0	0	0	65,000
WVDP		0	0	0	0	0	0
Other Sites	BCL	0	95	0	0	0	95
	GE	20	0	0	0	0	20
	SPRU	0	36	0	0	0	36
	Subtotal	20	130	0	0	0	150
TOTAL		39	80,000	4,500	4,000	3,100	
							GRAND TOTAL = 91,000

Note: Projected actions assume the "base case" scenario as described in *The 1996 Baseline Environmental Management Report* (DOE, 1996b). The actions are for nonliquid contaminated media and facilities; they exclude groundwater because of the high level of uncertainty in estimating volumes. For *ex situ* response actions, a relatively small quantity of waste that is already in storage is also included in the estimated volumes.

[a] Volumes are in cubic meters rounded to two significant figures; therefore totals may not sum exactly.

Source: May 1996 approved version of the "Environmental Restoration Core Database" (DOE, 1996c).

as they become available). At certain sites, approximately 2,200,000 cubic meters of LLW, LLMW, and TRUW will be removed and transferred to the WM Program for final treatment or disposal. It is these "transferred" wastes that are addressed in this appendix. Finally, because some sites (1) have not yet developed an ER strategy, (2) do not yet have sufficient data to estimate the volume of contaminated media, or (3) disposition only fractions of certain media, the dispositions of some 8,500,000 cubic meters of contaminated media are not yet determined.

Some site-specific ER activities are described below (Source: 1996 BEMR [DOE, 1996b]).

Argonne National Laboratory-East (ANL-E). Environmental restoration activities at ANL-E are conducted under RCRA corrective action guidelines. There are several types of ER projects scheduled at ANL-E. "Treatment site projects" include soil, groundwater, and sediment media. Up to 70% of these areas are assumed to require no further action. "Solid waste storage and disposal projects" cover the investigation and remediation of contamination resulting from landfills, disposal wells, and leaking underground storage tanks. Additional projects are the Mixed Waste Storage and Disposal Sites (317/319 Areas) Project and decommissioning activities at the Facilities Conversion, Reactor Facilities, and Support Facilities operable units.

Future ER activities at ANL-E are estimated to generate about 8,800 cubic meters of LLW, almost all of which is expected to be transferred to WM facilities. Approximately 140,000 cubic meters of LLMW is expected to be addressed by the ER Program at ANL-E; very little of this waste is anticipated to enter into the WM system because current planning assumptions are that *in situ* treatment or containment technologies would be used to stabilize these areas of contamination. DOE anticipates that all of the TRUW that will be generated by ER activities at ANL-E (approximately 190 cubic meters) will be transferred to WM facilities.

Brookhaven National Laboratory (BNL). The ER Program at BNL is conducted under an RCRA/CERCLA Interagency Agreement between the EPA and the New York Department of Environmental Conservation. Groundwater is the principal contaminated medium at BNL. The current planning assumptions are that the BNL ER Program would transfer small quantities of its waste to WM for limited treatment (i.e., volume reduction and stabilization) prior to shipment off site for disposal. The majority of LLW and LLMW generated by ER activities is planned to be sent to offsite commercial facilities for treatment or disposal. Only 400 cubic meters of ER transferred LLW would be sent to WM facilities out of 120,000 cubic meters of LLW generated by remedial actions. No LLMW is expected to be sent to WM.

Fernald Environmental Management Project (FEMP). Remedies have been selected for all of the five operable units (OUs) at FEMP under the CERCLA process. For the OU 1 waste pits, the remedy includes removal, treatment (as necessary), and offsite disposal at a permitted commercial disposal facility. DOE anticipates that wastes that do not meet the waste acceptance criteria for the commercial facility would be shipped to the Nevada Test Site (NTS). Operable Unit 4 consists of two earthen-bermed concrete silos (Silos 1 and 2) containing K-65 residues, which are high-specific-activity, radium-bearing wastes; one concrete silo containing metal oxides (Silo 3); and one unused concrete silo. The selected remedy for OU 4 involves removal, vitrification, and offsite disposal of the materials in Silos 1, 2, and 3 at NTS. The majority of the wastes from the remaining OUs will be disposed of in an onsite disposal cell. Wastes that do not meet the acceptance criteria of the onsite disposal facility would be shipped off site for disposal at commercial facilities.

Up to 180,000 cubic meters of LLW and 2,200 cubic meters of LLMW are expected to be transferred to the WM Program. An estimated 1,800,000 cubic meters of LLW are planned to be managed onsite, while 480,000 cubic meters are anticipated to be shipped to a commercial disposal facility. Approximately 2,400 cubic meters of LLMW are planned to be shipped to a commercial facility.

Hanford Site. Environmental restoration activities at Hanford are conducted under the authority of the Tri-Party Agreement among the DOE, EPA, and the Washington State Department of Ecology. The Hanford Site has numerous areas with contaminated surface and subsurface soils and has several large plumes of contaminated groundwater. The ER activities also cover the decontamination and decommissioning of up to 800 buildings. The vast majority of the LLW and LLMW generated during ER activities would be managed within the ER Program. Excluding the wastes that would be treated *in situ*, the majority of the waste would be disposed in the Environmental Restoration Disposal Facility.

The ER Program at Hanford will manage approximately 24,000,000 cubic meters of LLW and 320 cubic meters of LLMW. Of these amounts, only 700 cubic meters of LLW and 100 cubic meters of LLMW are expected to be transferred to the WM Program. Approximately 1,800 cubic meters of TRUW would be transferred to the WM Program out of a total of 1,900 cubic meters.

Idaho National Engineering Laboratory (INEL). The ER Program at INEL operates within the framework of the Federal Facility Agreement/Consent Order signed in 1991 by the DOE, EPA, and the State of Idaho. The INEL has 98 OUs grouped into 10 waste areas. Waste Area Groups 8 and 9 cover the Argonne National Laboratory-West and the Naval Reactor Facility sites, respectively. Wastes generated

during remediation will be sent to either the ER Program or WM Program for final treatment and disposal. Since fiscal year (FY) 1986, a total of 381 potentially contaminated area or sites have been identified at INEL.

Approximately 140,000 cubic meters of LLW would be transferred to the WM Program out of 640,000 cubic meters of LLW generated by site remediation. All 200,000 cubic meters of LLMW would be managed within the ER Program. All 9,700 cubic meters of TRUW generated by remediation would be managed by the WM Program.

Lawrence Livermore National Laboratory (LLNL). Environmental restoration activities at the LLNL Main Site and Site 300 are conducted as two distinct projects and are governed by separate Federal Facility Agreements among the DOE, EPA, and the California Environmental Protection Agency Department of Toxic Substance Control and Regional Water Quality Control Boards. Assessments at the Main Site have focused on determining the extent of groundwater contamination and, as necessary, implementing cleanup actions that deal with the following three issues: capturing the western offsite plume, capturing the southern offsite plume, and interior source control and mass removal. Site 300 activities have included assessing the extent of both onsite and offsite soil and groundwater contamination, with treatment of trichloroethylene-contaminated groundwater beginning in 1991. Additional cleanup actions are currently planned at LLNL, some of which will continue to generate hazardous wastes that would be shipped to offsite commercial facilities. No LLW, LLMW, or TRUW is projected to be generated as a result of these cleanup actions.

Los Alamos National Laboratory (LANL). Environmental restoration at LANL is designed to meet the requirements of the facility's RCRA operating permit. The 2,100 potentially contaminated areas at LANL are grouped into six field units. As of FY 1995, one hundred of the areas had been remediated, with no further action proposed for up to 900 sites.

About 15,000 cubic meters of LLW generated from ER projects would be transferred to WM facilities for treatment or disposal. An estimated 980 cubic meters of LLMW would be sent off site for commercial treatment and disposal. All 9,700 cubic meters of TRUW generated by site cleanup would be transferred for disposal within the WM Program. Plans are to address the remaining media contaminated with LLW or LLMW by using *in situ* treatment or containment technologies. In addition, a large number of sites, containing almost 9,000,000 cubic meters of contaminated media, have been proposed for no further action.

Nevada Test Site (NTS). Environmental restoration at NTS is conducted according to RCRA guidelines under a Federal Facility Agreement and Consent Order. There are approximately 2,400 corrective action sites within the NTS and Tonopah Test Range that require some level of investigation and possible remediation under the ER Program. The sites have been grouped into three categories: (1) industrial sites, which include all sites used in support of testing operations; (2) soil sites, which include all surface and shallow subsurface soil contamination resulting from nuclear tests; and (3) underground test areas, which are sites that were impacted by underground testing of nuclear devices. From a waste generation standpoint, cleanup of the soil sites, which would involve excavation and bulk disposal of contaminated soil in an appropriate subsidence crater, represents the largest potential volume of ER generated wastes at NTS. As an interim action, DOE and the State of Nevada have negotiated a radionuclide concentration action level of 200 picocuries per gram, which would result in approximately 1,100,000 cubic meters of LLW that would be transferred into the WM Program for disposal. One of the major assumptions used to estimate the future waste contribution from these activities is that the final cleanup action level for plutonium would be near the 200-picocurie-per-gram level.

Oak Ridge Reservation (ORR). The ER Program at ORR is conducted under a 1992 Federal Facility Agreement and covers the K-25 Site, the Oak Ridge National Laboratory (ORNL), and the Y-12 Plant (Y-12). The K-25 Site has numerous solid waste management units and contaminated buildings. At ORNL, there are approximately 350 sites contaminated with radioactivity or hazardous chemicals. The sites are grouped into 20 waste area groupings, 13 of which are identified as potential sources of contamination. Areas of potential contamination at Y-12 are consolidated into three hydrologic, geographic units. Because of the large number of contaminated sites or buildings, remedial actions at ORR are site-specific and depend on the location and type of contaminated media, as well as the sources of contamination. For the most part, large volumes of radioactively contaminated soils and facilities to be decommissioned would be stabilized in place.

At ORR, the ER Program would manage approximately 940,000 cubic meters of LLW, 460,000 cubic meters of LLMW, and 3,100 cubic meters of TRUW. Approximately 9,800 cubic meters of LLW, 3,900 cubic meters of LLMW, and 2,900 cubic meters of TRUW are expected to be transferred to the WM Program.

Paducah Gaseous Diffusion Plant (PGDP). At PGDP, the DOE has retained responsibility for ER and related WM activities, and the United States Enrichment Corporation has assumed operation of the production portion of the plant. Most investigation and remediation activities at the site are subject to RCRA

and CERCLA regulations. There are 204 potential release sites (solid waste management units) grouped into 28 waste area groupings that are being addressed by the ER Program. Two groundwater contamination plumes are known to extend beyond the boundaries of the plant (a northwest plume and a northeast plume); both have been the subject of considerable ER activity. In addition, the ER Program is planning for the eventual decommissioning activities, which will be undertaken once the uranium enrichment processing facilities are no longer needed.

Current ER planning assumptions are that 770,000 cubic meters of LLW would be generated by the remedial and decommissioning activities, almost all of which is expected to be handled by the ER Program, either using offsite disposal facilities or through construction of an onsite disposal facility. Only 150 cubic meters of LLW is currently planned to be transferred to the WM system. At present, 240,000 cubic meters of LLMW is anticipated to remain on site, in an area with long-term institutional controls. Another 210,000 cubic meters of LLMW is expected to be generated and dispositioned by using either commercial facilities or possibly an onsite engineered disposal cell. Approximately 7 cubic meters of TRUW is estimated to be generated during remedial action and decommissioning activities and is expected to be managed by the ER Program, with possible future shipment to WIPP.

Pantex Plant. The ER Program at Pantex addresses 144 solid waste management units and 114 potential release sites that have been grouped into 15 OUs for investigation and cleanup. RCRA Facility Investigations have been initiated for all OUs. Activities to date have resulted in no adverse environmental impacts based on the RCRA and NEPA reviews and evaluations performed on a project-specific level. Future cleanup activities are expected to be of a similar nature, with a gradual decrease in intensity as more sites reach closure. The ER work is expected to generate 54 cubic meters of LLW. Beginning in FY 1997, the WM Program will assume responsibility for characterization, packaging, treatment, storage, and disposal of the relatively small volume of LLW generated by ER activities.

Portsmouth Gaseous Diffusion Plant (PORTS). At PORTS, the DOE has retained responsibility for ER and related WM activities, and the United States Enrichment Corporation has assumed operation of the production portion of the plant. Environmental restoration activities at PORTS are done under RCRA guidelines. Assessments conducted as part of the RCRA corrective action process have found that soil and groundwater underlying portions of the plant are contaminated with various solvents. The groundwater contamination appears to be limited to the shallow aquifer, which is not used for drinking water, and remains within the boundaries of the plant. Remedial actions have been completed at several sites, and

additional actions are ongoing or are currently in the planning stages. The ER Program is planning for the eventual decommissioning activities that will be undertaken once the uranium enrichment processes are no longer needed.

The majority of the LLW and LLMW expected to be generated in the future at PORTS would come from decommissioning activities. It is assumed that the gaseous diffusion facilities would be removed to ground level, and several low-profile disposal mounds would be located where the former structures stood. Consequently, a total of about 730,000 cubic meters of LLW and 270,000 cubic meters of LLMW are slated to be managed under the ER Program. These wastes are not scheduled to be transferred to WM facilities.

Rocky Flats Environmental Technology Site (RFETS). Environmental restoration activities at RFETS are conducted under an interagency agreement among DOE and Federal and State stakeholders. There are 16 OUs contaminated with hazardous and radioactive substances. The OUs include ponds, creeks, reservoirs, holding pads, trenches, storage pads, and ground surfaces and belowground areas. Several contaminated sites (OU 3) lie off site of the RFETS. In addition, the decommissioning of more than 400 structures is planned for the site. Contaminated media include soils, surface water, groundwater, sediments, and debris. Remedial actions planned for the site would utilize new and currently operating waste treatment facilities, including a soil-washing facility, a wastewater treatment facility, and a disposal facility.

The majority of the wastes generated during ER activities (61,000 cubic meters of LLW and over 320,000 cubic meters of LLMW) would be managed on site by the ER Program. Of this total, approximately 190,000 cubic meters of LLMW is expected to be managed via *in situ* containment or access controls. A Corrective Action Management Unit is expected to be ready in FY 1997 to dispose of LLW and LLMW soil and debris. This unit will be designed to meet RCRA performance standards. An additional 36,000 cubic meters of LLW, 42,000 cubic meters of LLMW, and 1,900 cubic meters of TRUW are expected to be transferred to WM facilities.

Sandia National Laboratories, New Mexico (SNL-NM). The ER Program at SNL-NM is being conducted under the authority of RCRA. Beginning in FY 1995, SNL-NM no longer divided the site up into OUs for purposes of ER activities. According to the 1996 BEMR, SNL-NM expects to establish a Corrective Action Management Unit under RCRA to dispose of hazardous wastes. For LLW, the current strategy is to ship such waste off site to NTS after using volume-reduction technologies to the extent practicable. LLMW is

expected to be treated on site and then disposed of as hazardous waste in the Corrective Action Management Unit or as LLW at NTS.

All 36,000 cubic meters of contaminated LLW media removed at the site would be transferred to the WM Program. An additional 14,000 cubic meters of contaminated media would be managed in place using access controls.

Savannah River Site (SRS). The ER Program at SRS is governed by a variety of regulatory requirements, including State and Federal laws, interagency agreements, and various settlement and consent decrees. Under CERCLA, in 1993, the DOE, EPA, and the South Carolina Department of Health and Environmental Control entered into a Federal Facility Agreement. Some remedial actions at inactive waste units have been conducted under the authority of the site's 1987 RCRA permit. At SRS, there are over 1,000 facilities potentially contaminated with hazardous and radioactive materials. Contaminant migration from some of the structures has resulted in groundwater contamination. The potential migration of contaminants is a public health concern. More than 90 areas of potential contamination are currently being characterized or remediated. An additional 478 areas are undergoing preliminary evaluation. An estimated 25% of these areas are expected to require a complete assessment and remediation.

Current SRS estimates are that approximately 400,000 cubic meters of ER generated LLW will have transferred to WM, out of a total 2,500,000 cubic meters of LLW generated by remedial actions at SRS. An additional 150,000 cubic meters of LLMW is expected to be transferred to the WM Program. Approximately 4,000,000 cubic meters of LLMW would be managed within the ER Program. All of the 65,000 cubic meters of TRUW generated by remediation would be transferred to the WM Program. The disposition of up to 8,400,000 cubic meters of ER media has not yet been determined.

West Valley Demonstration Project (WVDP). All wastes at WVDP are managed within the WM Program.

B.6 Estimated ER Transferred Waste Loads

Estimates of ER transferred waste are derived from the base case criteria as outlined in the BEMR (DOE, 1996b). Future site land-use decisions are a crucial factor in determining the base case remedial actions at

a site and the amount of transferred waste that will be produced during ER activities. Land-use choices can range from "restricted," where the area will be subject to restrictive access controls, to "unrestricted," where the public will have full access to the site. Unrestricted use options are also known as "greenfield" access.

Table B.6–1 provides a summary, by waste type, of the ER transferred wastes and the corresponding WM waste. Hazardous waste generated during ER is not included because such waste will most likely be sent off site for commercial treatment. The data are site-specific for the ER transferred waste totals. Some of the ER transferred wastes may be in a stable form that would only require disposal at WM facilities. These stabilized wastes would only affect disposal facilities, not WM treatment facilities.

B.7 Potential Effects of ER Transferred Waste Inputs to the WM PEIS Analyses

In this appendix, the relative volumes of ER transferred wastes are compared with WM waste volumes to determine whether there may be effects on the WM alternatives. Where facility capacity allows, the treatment of ER transferred waste would be conducted during the planned 10-year treatment time frame; and, if capacity is limited, treatment of ER transferred waste might continue for as much as 20 years beyond the WM treatment period (see Section B.8). In this appendix, potential effects of overloading on site treatment facility capacity are noted for those waste types, sites, and alternatives where the ER transferred waste load is equal to or greater than 100% of the volume of the comparable WM inputs. This level represents a doubling of the waste loading to the affected WM facility.

For sites where the volume of ER transferred waste is greater than 100% of the corresponding volume of WM waste, the additional waste loads could be managed by either utilizing up to 30 years of WM facilities' operating capacity or by increasing the capacity of the facilities. Volumes of ER waste that are less than 100% of comparable WM wastes could most likely be handled by utilizing the longer operational period and thus would not require increasing the facilities' capacity. If additional facility capacity were required, future NEPA analyses could evaluate the impacts of increasing WM facility capacity.

Tables B.7–1 through B.7–3 show a comparison, by site, between the expected volumes of ER transferred waste and the volumes of WM waste for each alternative. The tables also show the percentage ratio between the ER and WM wastes. As shown in Tables B.7–1 through B.7–3, the volume of ER transferred wastes

Table B.6-1. Total Site Volumes (m^3) of WM Wastes and ER Transferred Wastes[a]

	LLW		LLMW		TRUW	
Site	ER Transferred	WM	ER Transferred	WM	ER Transferred[b]	WM
ANL-E	8,700	6,700	0.4	160	190	1,300
BNL	400	5,600	0	190	0	0
FEMP	180,000	0[c]	2,200	2,600	0	0
Hanford	700	89,000	100	36,000	1,800	50,000
INEL	140,000	105,000	0	35,000	9,700	39,000
LANL	15,000	150,000	0	2,800	0	11,000
LLNL	0	3,200	0	4,300	0	1,700
NTS	1,100,000	1,700	50	3,000	0	610
ORR	9,800	270,000	3,900	59,000	1,500	2,700
Pantex	54	2,700	0	690	0	0
PGDP	150	50,000	0	600	0	14
PORTS	190	97,000	0	33,000	0	0
RFETS	36,000	41,000	42,000	21,000	1,900	6,200
SNL-NM	36,000	2,500	0	100	0	0
SRS	400,000	510,000	150,000	20,000	65,000	17,000
WVDP	0	42,000	0	55	0	0.5
Others[d]	57,000	130,000	4,400	1,000	130	1,500
Total	1,900,000	1,500,000	200,000	220,000	80,000	132,000

[a] May 1996 Approved Version of the "Environmental Restoration Core Database" (DOE, 1996c).
[b] Includes mixed TRUW.
[c] All FEMP LLW considered as ER.
[d] Others include Mound, RMI, LBL, Ames, BCL, ITRI, GA, GE, and LEHR.

may exceed 100% of the comparable WM wastes at ANL-E, NTS, FEMP, INEL, and SNL-NM for LLW; at RFETS and SRS for LLMW; and at SRS for TRUW.

Table B.7-4 shows, for each treatment alternative and waste type, the number of sites that would be affected by the addition of ER transferred waste. Overall, the addition of the ER waste would affect less than 25% of the treatment sites for most alternatives. The only effect on a Centralized Alternative would be for LLW, due to the large amount of LLW projected for NTS.

However, since it is likely that the bulk of the ER transferred LLW at NTS (primarily consisting of soils) would be treated on site using minimal treatment, the effects of this large waste load on the treatment facilities' LLW Regionalized and Centralized Alternatives would be minimized. In a similar fashion, the

Table B.7–1. Comparison of Total Volumes of ER Transferred LLW to WM LLW by Alternative

Site	Decentralized (Minimal Treatment Only at All Sites)			Centralized 3 and 4 (Treatment at 7 Sites)			Centralized 5 (Treatment at 1 Site)		
	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM
ANL-E	8,700	6,700	130%	--[a]	--	--	--	--	--
BNL	400	5,600	7%	--	--	--	--	--	--
FEMP	180,000	0	NA[b]	--	--	--	--	--	--
Hanford	700	89,000	<1%	700	95,000	<1%	1,900,000	1,500,000	136%[d]
INEL	140,000	105,000	130%	1,200,000	107,000	11×[c,d]	--	--	--
LANL	15,000	150,000	10%	51,000	150,000	32%	--	--	--
LLNL	0	3,200	0%	--	--	--	--	--	--
NTS	1,100,000	1,700	650×[c]	--	--	--	--	--	--
ORR	9,800	270,000	4%	10,000	300,000	3%	--	--	--
PGDP	150	50,000	<1%	--	--	--	--	--	--
Pantex	54	2,700	2%	--	--	--	--	--	--
PORTS	190	97,000	<1%	220,000	290,000	76%	--	--	--
RFETS	36,000	41,000	88%	36,000	41,000	88%	--	--	--
SNL-NM[e]	36,000	2,500	14×[c]	--	--	--	--	--	--
SRS	400,00	510,000	78%	400,000	515,000	78%	--	--	--
WVDP	0	42,000	0%	--	--	--	--	--	--
Other	57,000	130,000	41%	--	--	--	--	--	--

Table B.7-1. Comparison of Total Volumes of ER Transferred LLW to WM LLW by Alternative—Continued

Site	Regionalized 2 (Treatment at 11 Sites)			Regionalized 4 (Treatment at 7 Sites)			Regionalized 5 (Treatment at 4 Sites)		
	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM
ANL-E	--	--	--	--	--	--	--	--	--
BNL	--	--	--	--	--	--	--	--	--
FEMP	190,000	46,000	410%	--	--	--	--	--	--
Hanford	700	89,000	<1%	700	96,000	<1%	700	96,000	<1%
INEL	1,200,000	107,000	11×[c]	1,200,000	107,000	11×[c,d]	1,300,000	300,000	430%
LANL	51,000	150,000	32%	51,000	150,000	32%	--	--	--
LLNL	0	8,000	0%	--	--	--	--	--	--
NTS	--	--	--	--	--	--	--	--	--
ORR	9,800	270,000	4%	10,000	320,000	3%	230,000	600,000	38%
PGDP	150	50,000	<1%	--	--	--	--	--	--
Pantex	0	2,700	<1%	--	--	--	--	--	--
PORTS	30,000	230,000	13%	220,000	280,000	76%	--	--	--
RFETS	36,000	41,000	88%	36,000	41,000	88%	--	--	--
SNL-NM[e]	--	--	--	--	--	--	--	--	--
SRS	400,000	510,000	78%	400,000	510,000	78%	400,000	516,000	78%
WVDP	--	--	--	--	--	--	--	--	--
Other	--	--	--	--	--	--	--	--	--

Note: Waste volumes in total cubic meters.
[a] Not a treatment site under the alternative.
[b] All LLW at FEMP is ER waste.
[c] For clarity, factor increase is used instead of %.
[d] Under some alternatives, actual onsite ER transferred waste loads at INEL and Hanford would be reduced by use of minimal treatment onsite at NTS and SNL-NM.
[e] Includes ITRI.

Table B.7-2. Comparison of Total Volumes of ER Transferred LLMW to WM LLMW by Alternative

Site	Decentralized (Treatment at 16 Sites)			Regionalized 1 (Treatment at 11 Sites)			Regionalized 2 and 3 (Treatment at 7 Sites)		
	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM
ANL-E	0.4	160	<1%	--[a]	--	--	--	--	--
BNL	0	190	0%	--	--	--	--	--	--
FEMP	2,200	2,600	85%	2,200	2,800	79%	--	--	--
Hanford	100	36,000	<1%	100	36,000	<1%	100	41,000	<1%
INEL	0	35,000	0%	50	38,000	<1%	50	38,000	<1%
LANL	0	2,800	0%	0	2,900	0%	0	3,500	0%
LLNL	0	4,300	0%	0	4,700	0%	--	--	--
NTS	50	3,000	2%	--	--	--	--	--	--
ORR	3,900	59,000	7%	3,900	59,000	7%	3,900	60,000	7%
PGDP	0	600	0%	0	600	0%	--	--	--
Pantex	0	690	0%	0	690	0%	--	--	--
PORTS	0	33,000	0%	0	33,000	0%	2,200	36,000	6%
RFETS	42,000	21,000	200%	42,000	21,000	200%	42,000	21,000	200%
SNL-NM	0	100	0%	--	--	--	--	--	--
SRS	150,000	20,000	750%	150,000	20,000	750%	150,000	20,000	750%
WVDP	0	55	0%	--	--	--	--	--	--
Other	4,400	1,000	--	4,400	--	--	--	--	--

Table B.7–2. Comparison of Total Volumes of ER Transferred LLMW to WM LLMW by Alternative—Continued

Site	Regionalized 4 (Treatment at 7 Sites)			Centralized (Treatment at 1 Site)		
	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM
ANL-E	--	--	--	--	--	--
BNL	--	--	--	--	--	--
FEMP	--	--	--	--	--	--
Hanford	100	41,000	--	200,000	220,000	91%
INEL	42,000	62,000	68%	--	--	--
LANL	--	--	--	--	--	--
LLNL	--	--	--	--	--	--
NTS	--	--	--	--	--	--
ORR	5,100	96,000	5%	--	--	--
PGDP	--	--	--	--	--	--
Pantex	--	--	--	--	--	--
PORTS	--	--	--	--	--	--
RFETS	--	--	--	--	--	--
SNL-NM	--	--	--	--	--	--
SRS	150,000	20,000	750%	--	--	--
WVDP	--	--	--	--	--	--
Other	--	--	--	--	--	--

Note: Waste volumes in total cubic meters.
[a] Not a treatment site under the alternative.

Table B.7-3. Comparison of Total Volumes of ER Transferred TRUW to WM TRUW by Alternative

Site	Decentralized (Treatment at 16 Sites)			Regionalized 1 and 2 (Treatment at 6 Sites)			Regionalized 3 (Treatment at 4 Sites)			Centralized (Treatment at 1 Site)		
	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM	ER (m^3)	WM (m^3)	ER as % of WM
ANL-E	190	1,300	15%	--[a]	--	--	--	--	--	--	--	--
BNL	0	0	--	--	--	--	--	--	--	--	--	--
FEMP	0	0	--	--	--	--	--	--	--	--	--	--
Hanford	1,800	50,000	4%	1,800	50,000	4%	1,800	50,000	4%	--	--	--
INEL	9,700	39,000	25%	9,700	39,000	25%	12,000	56,000	21%	--	--	--
LANL	0	11,000	0%	0	11,000	0%	--	--	--	--	--	--
LLNL	0	1,700	0%	--	--	--	--	--	--	--	--	--
NTS	0	610	0%	--	--	--	--	--	--	--	--	--
ORR	1,500	2,700	56%	1,700	2,700	56%	1,700	2,700	63%	--	--	--
PGDP	0	14	0%	--	--	--	--	--	--	--	--	--
Pantex	0	0	--	--	--	--	--	--	--	--	--	--
PORTS	0	0	--	--	--	--	--	--	--	--	--	--
RFETS	1,900	6,200	31%	1,900	6,200	31%	--	--	--	--	--	--
SNL-NM	0	0	--	--	--	--	--	--	--	--	--	--
SRS	65,000	17,000	390%	65,000	18,000	360%	65,000	18,000	360%	--	--	--
WVDP	0	0	--	--	--	--	--	--	--	--	--	--
WIPP	--	--	--	--	--	--	--	--	--	80,000	130,000	62%

Note: Waste volumes in total cubic meters.
[a] Not a treatment site under the alternative.

Table B.7-4. Number of Sites Potentially Affected by the Addition of ER Transferred Wastes by Alternative

Waste Type	Decentralized: All Sites Treat	Regionalized: 11 Sites Treat	Regionalized: 7 Sites Treat	Regionalized: 6 Sites Treat	Regionalized: 4 Sites Treat	Centralized: 1 Site Treats
LLW	4/16 [a]	1/11	1/7	NA[b]	1/7	1/1
LLMW	2/16	2/11	2/7	NA	1/4	0/1
TRUW	1/10	NA	NA	1/6	1/4	0/1

[a] Indicates the number of WM treatment sites where the volume of ER transferred waste ≥ 100% of the WM waste volume, compared with the total number of treatment sites.
[b] Not applicable.

potential impacts on the Regionalized Alternatives for LLMW and TRUW are also due to large waste inputs from one or two sites (i.e., RFETS and SRS for LLMW and SRS for TRUW) rather than to substantial ER inputs at a large number of sites. Again, the site-specific treatment capacities could be expanded to accommodate the increased loading resulting from the addition of ER waste. There would be no effects to the Centralized Alternative for LLMW and TRUW.

B.8 Assumptions

The estimates of the volumes of ER transferred wastes that would be managed in WM facilities and the effects of such wastes on WM PEIS alternatives were based on several assumptions:

- All of the waste identified as ER transferred wastes would, in fact, be transferred to the WM Program.
- Although the proportional distribution of wastes may differ, ER transferred wastes are assumed to fall into the same treatability groups as the WM waste for each waste type and can therefore be processed in WM treatment plants.
- The majority of the ER wastes generated over the 75-year period evaluated in the BEMR (DOE, 1996b) would actually be produced between 2003 and 2033.
- ER transferred wastes would be sent to the WM Program during site remediation. The ER transferred wastes may be sent gradually during the remediation activities or all at once, depending on the specific ER operations.
- If shipped to other sites for treatment or disposal, ER transferred wastes would follow the same transport configuration as WM wastes.

- Once there is sufficient information to characterize ER transferred wastes, they would fall within the waste treatment categories already identified in characterizing WM wastes. In other words, it is unlikely that there would be a novel category of ER transferred waste that would be unlike any of the treatment categories of WM waste.
- All wastes identified as ER transferred wastes in this appendix would require some type of treatment, although the type of treatment cannot be determined until the wastes are characterized.
- Current ER data combine both TRUW and mixed TRUW. It is expected that the majority of transuranic-contaminated media will be TRUW.
- All ER transferred waste is likely to be contact-handled.
- Although plans to manage contaminated media are proceeding independent of the WM Program, excess WM facility capacity can be used for ER transferred wastes; after the planned 10-year facility operations period for WM wastes, as much as 20 years of additional operational treatment capacity of these facilities would be available to treat ER transferred wastes and newly generated WM wastes.
- The radiological activity of ER transferred waste would be lower than the activity of corresponding WM wastes.
- The ER transferred waste estimates do not include waste volumes for which no feasible remedial technology is available; these volumes were therefore not included in the base case (e.g., underground soils at nuclear test sites, major contaminated aquifers).
- Hazardous waste would be treated and disposed of at commercial facilities to the maximum extent practical.
- The majority of ER transferred LLW would require only minimal treatment to meet health and safety requirements prior to disposal. Minimal treatment (i.e., packaging) would be done at the site generating the waste.

B.9 Uncertainties

Determination of the effects that the addition of ER transferred wastes would have on the capabilities of WM facilities and on the alternatives evaluated in the WM PEIS depends on many factors. Major considerations include assumptions on future site land use and remedial actions, changes in WM technologies, the radiological composition and activity of ER transferred wastes, and changes in the characterization of contaminated media and facilities at DOE sites. The uncertainties inherent in estimating

the effects of ER wastes on WM facilities may affect final decisions on WM PEIS alternatives. The following factors contribute to the uncertainties:

- The adoption of alternate land uses than those assumed in the BEMR may alter the amounts of ER transferred waste. More restrictive access policies at each site and across the DOE complex would result in lower amounts of ER transferred waste going to WM facilities. Conversely, the adoption of less restrictive access policies would likely increase the volume of waste generated by ER actions. This could, in turn, increase the amount of ER transferred waste. For example, current BEMR projections estimate up to a 77% increase in costs for the most unrestricted greenfield uses. This scenario would be expected to create a comparable increase in the ER waste loads. However, adoption of the most unrestricted land use is unlikely. The choice of land uses between restricted and unrestricted uses would result in only minor changes in expected cleanup costs and, by extension, waste volumes (see 1996 BEMR [DOE, 1996b]: Table 9 and Figure 11, Executive Summary).
- Future ER decisions at each site could alter the amount of ER transferred wastes that would be sent to WM facilities for final disposition. If DOE decides that more sites will have their own ER management facilities, the result would be lower amounts of ER waste that would be transferred to WM facilities.
- Effects are also dependent on the volume of ER transferred wastes that require treatment and disposal, compared with those that will require disposal only. As considered here, all ER transferred wastes are assumed to require some treatment; however, it is likely that a sizable amount of the ER transferred waste load would require only disposal at WM facilities. The current ER data do not separate those ER transferred wastes that require treatment and disposal from wastes that would require only disposal. The final treatment and disposal volumes will only be determined when the contaminated media are removed.
- Because the ER transferred wastes would be shipped as generated during site cleanup, the volume that would be delivered to WM facilities at any given time is uncertain. If a site's wastes were generated early in remedial operations, all or a substantial portion of the estimated ER transferred waste might be sent to WM facilities in a relatively short time. Large loadings of ER transferred waste may have greater effects on WM waste storage facilities than on treatment and disposal facilities because even if a facility has adequate capacity to accommodate additional waste loading within the 30-year time frame, there may not be sufficient storage capacity to hold the wastes until they can be processed.
- This appendix only identifies the potential volumetric effects of sending ER transferred waste to WM treatment facilities. Because current data do not characterize the radiological composition or activity concentration of this waste, the additional contaminant emissions resulting from the treatment of ER waste and the subsequent additional impacts on human health and the environment cannot be directly quantified. However, because the radiological activities and chemical contaminant concentrations of ER

transferred waste are expected to be lower than those for the corresponding WM wastes, the direct impacts on human health and the environment from treating ER transferred wastes would likely be lower than those for processing similar volumes of WM wastes. The ultimate effects of the treatment of ER transferred wastes can only be determined when a site's contaminated media are removed and characterized prior to treatment.

- This appendix assumes that all of the ER transferred waste would be sent for treatment in WM facilities. However, future decisions may direct some of the ER transferred waste to commercial facilities. This would lessen the potential effects of ER transferred wastes on WM facilities.
- Because the exact radiological and chemical composition of the ER transferred waste is not yet known, it is possible that as more data about waste composition become available, the type categorization of ER transferred wastes could change. For example, the presence or absence of hazardous chemicals in the waste could alter the distribution between LLW and LLMW. Similarly, more detailed information about the levels of alpha-radionuclide activities in ER transferred waste could change the distribution between TRUW and LLW or LLMW.
- Although ER transferred wastes are expected to fall into the waste treatment categories already identified for WM wastes, the proportional distribution of the ER wastes among the treatment categories may not be the same as the distribution for WM wastes at a site. The ER transferred wastes can only be placed into specific treatment categories after determination of their chemical, radiological, and physical characteristics. Since such characterization can only be done after the ER wastes are generated, there is uncertainty in the amounts of ER transferred waste and in the treatment that they will require.

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Appendix C

Environmental Impacts Analysis Methods

Appendix C in the Final WM PEIS contains material formerly found in Appendix I in the Draft WM PEIS.

U.S. Department of Energy
Waste Management Programmatic Environmental Impact Statement

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Acronyms and Abbreviations

The following is a list of acronyms and abbreviations (including units of measure) used in this appendix.

Acronyms

AAL	ambient allowable limit
AAQS	Ambient Air Quality Standards
ACHP	Advisory Council on Historic Preservation
AGDSP	aboveground disposal module
ANL-E	Argonne National Laboratory-East
AQCR	Air Quality Control Region
ARARs	Applicable or Relevant and Appropriate Requirements
BEA	Bureau of Economic Analysis
BHDSP	borehole disposal
BNL	Brookhaven National Laboratory
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	chlorofluorocarbons
CH	contact-handled
CISV	canister storage vault
CPI	consumer price index
D&D	decontamination and decommissioning
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
FEMP	Fernald Environmental Management Project
FTE	full-time equivalent
GCR	General Conformity Rule

HAPs	hazardous air pollutants
HI	hazard index
HLW	high-level waste
HW	hazardous waste
INEL	Idaho National Engineering Laboratory
I-O	input-output system
LANL	Los Alamos National Laboratory
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
MEI	maximally exposed individual
MDVS	modular dry vault storage
NAAQS	National Ambient Air Quality Standards
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
O&M	operations and maintenance
ODS	ozone-depleting substance
ORR	Oak Ridge Reservation
PCBs	polychlorinated biphenyls
PGDP	Paducah Gaseous Diffusion Plant
PLCC	program life-cycle cost
PORTS	Portsmouth Gaseous Diffusion Plant
PPI	producer price index
PSD	prevention of significant deterioration
RFETS	Rocky Flats Environmental Technology Site
RH	remote-handled
RIMS	Regional Input-Output Modeling System
ROI	region of influence

SEL	significant emission level
SHOP	State Historic Preservation Officer
SIDSP	silo disposal module
SLDSP	shallow land disposal module
SNL-NM	Sandia National Laboratories-New Mexico
SRS	Savannah River Site
STOSI	silo storage module
TAP	toxic air pollutant
TRUW	transuranic waste
VMT	vehicle mile traveled
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WM	waste management
WMFCI	Waste Management Facility Cost Information
WM PEIS	Waste Management Programmatic Environmental Impact Statement
WVDP	West Valley Demonstration Project

Abbreviations

BTU	British thermal unit
CO	carbon monoxide
gpd	gallons per day
L	liter
μg	microgram
m^3	cubic meter
mg	milligram
mph	miles per hour
mrad	millirad
mrem	millirem
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
pCi	picocurie
PM_{10}	particulate matter equal to or less than 10 micrometers in diameter
SO_2	sulfur dioxide
yr	year

APPENDIX C
Environmental Impacts Analysis Methods

The Waste Management Programmatic Environmental Impact Statement (WM PEIS) environmental impacts analysis was accomplished using an engineering analysis of generic designs developed for the treatment, storage, and disposal facilities required to manage each waste type at the sites, and estimates of transportation requirements. Outputs from the engineering analysis were estimates of resource requirements, environmental discharges, and costs. These outputs were used as inputs to evaluate human health risk, environmental, socioeconomic, and cultural resources, and impacts at the sites and along the transportation corridors, and were the basis for discussions of environmental justice issues.

C.1 WM PEIS Environmental Impacts Analysis Approach

The environmental resources for which detailed impacts analysis methods are presented in this appendix include:

- ***Cost***
- ***Air Quality***
- ***Water Resources***
- ***Ecological Resources***
- ***Economic Resources***
- ***Population Impacts***
- ***Environmental Justice***
- ***Land Use***
- ***Infrastructure***
- ***Cultural Resources***

The environmental impacts for the five waste types were evaluated using an analytical process consisting of three phases for the waste management alternatives. This three-phased approach was applied as applicable in the analysis of treatment, transportation, storage, and disposal activities for each of the waste types at the 17 major U.S. Department of Energy (DOE) sites. The three phases, as shown in Figure C.1-1, were: (1) a Generic Design Engineering Analysis Input Phase; (2) an Engineering Analysis Output Phase; and (3) an Environmental Impacts Analysis Phase. It should be noted that in addition to the relationships indicated in Figure C.1-1, there are significant interrelationships between areas identified in the "Environmental Impact Analysis" phase. For example, facility discharges are directly linked to human health effects. Health risk effects in turn form the basis for the environmental justice analysis. The details of these relationships are presented in the remainder of this appendix.

Engineering Analysis Using a Generic Design. In the first phase, DOE made assumptions regarding waste loads for the five waste types. These assumptions related to the volume of waste currently in inventory and anticipated from future operations of DOE facilities and to its physical (gaseous, liquid, solid), chemical, and radiological characteristics. DOE then routed these estimated waste loads among specified DOE sites

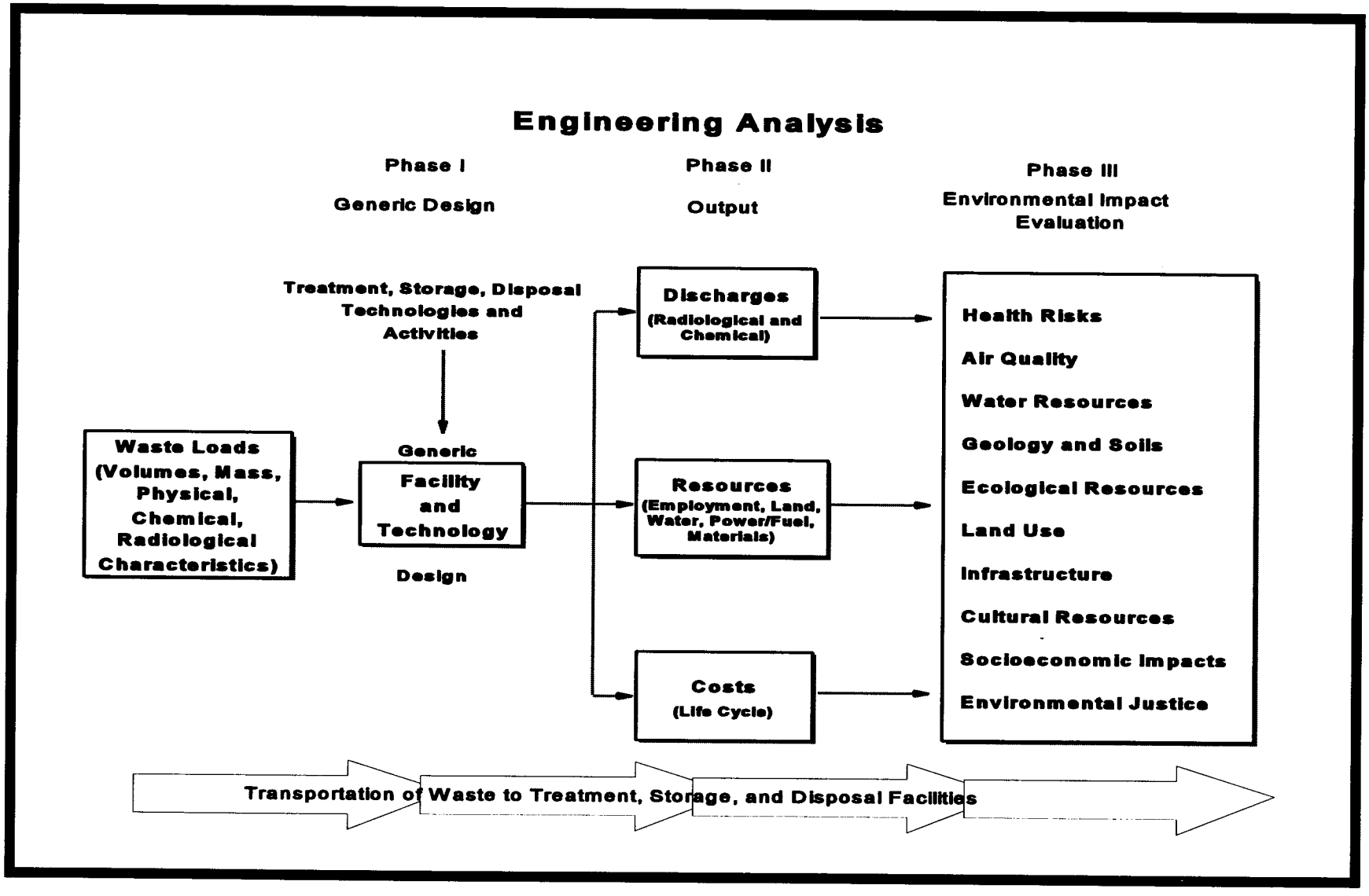

Figure C.1–1. WM PEIS Analytical Relationships.

according to certain criteria based on the closest site with appropriate treatment capabilities as defined for each of the waste management alternatives to determine how much waste would be handled at each site under each alternative. DOE also developed a generic design of the waste management processes and facilities and selected one technology option for purposes of analysis. The facilities considered and the technology chosen for each waste type, and the rationale for that selection, are described more fully in the waste-type chapters.

Engineering Analysis Output. In the second phase, the waste loads allocated to each site under each alternative were generically "processed" through a mathematical model of the generic waste management (WM) facility design, and estimates of outputs were obtained for the amounts and rates of radiological and chemical effluents released to the environment, volume and rates of resources required or consumed, numbers of full-time equivalent (FTE) workers required, and costs to build, operate, maintain, decontaminate and decommission the WM facilities.

Environmental Impact Evaluation. In the third phase, the effluents, resources, and costs became the input for evaluation of environmental and socioeconomic impacts, and human health risks.

C.2 Phase I: Engineering Analysis Using a Generic Design

C.2.1 Waste Loads

Waste Volumes. The WM Programmatic Environmental Impact Statement (PEIS) impact and cost analyses used DOE and U.S. Environmental Protection Agency (EPA) databases for waste inventories and generation rates. However, these databases are constantly upgraded, and a cutoff date was established for the data to allow the analyses to proceed.

Sources of data for each of the waste types are listed below and described in detail in the waste type chapters (Chapter 6–10) and Appendix I:

- **Low-level mixed waste (LLMW)**—The *Mixed Waste Inventory Report* (DOE, 1994) was used for all LLMW inventories and generation rates, except for Colonie, ETEC, and RFETS, whose generation

rates and inventories come from late 1994 site estimates, and ANL-E and NTS, whose generation rates and inventories come from the *Mixed Waste Inventory Summary Report* (DOE, 1995a).

- **Low-level waste (LLW)**—The *Integrated Data Base for 1992* (DOE, 1992) was used for generation rates and inventories of stored waste except for BNL, NTS, ORR, Pantex, and WVDP, whose generation rates and inventories come from the updated *Integrated Data Base Report - 1994* (DOE, 1995d). The Waste Management Information System (ORNL, 1992) was consulted for data not available in the Integrated Data Base.
- **Transuranic waste (TRUW)**—The *Integrated Data Base for 1992* (DOE, 1992) and the *Interim Mixed Waste Inventory Report* (DOE, 1993a) were used for TRUW inventories and generation rates except for Hanford and SRS. SRS generation rates and inventories come from the updated *Mixed Waste Inventory Summary Report* (DOE, 1995a), while Hanford's come from the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report* (BIR-2) for 1995 (DOE, 1995e).
- **High-level waste (HLW)**—Site-specific plans and NEPA documents for Hanford, INEL, SRS, and WVDP were used for HLW volume and canister production rates.
- **Hazardous waste (HW)**—The EPA Information System biennial and annual reports (EPA, 1991a) were used for HW generation rates. Offsite shipments to commercial treatment were derived from DOE fiscal year 1992 HW shipping manifests.

It is DOE policy that sites employ pollution prevention practices to reduce the amount of waste generated. The databases from which estimates of annual generation were obtained did not fully consider pollution prevention efforts. Possible impacts of pollution prevention are discussed in Appendix G.

The waste loads analyzed in this PEIS do not include wastes that may be generated as a result of environmental restoration (ER) activities. The anticipated ER waste loads are described in the waste-type chapters (Chapters 6–10) on a site-by-site basis, and compared to the anticipated WM waste loads at those sites. It is not anticipated that HLW will be generated through ER activities. These chapters also contain a qualitative discussion of the extent to which ER waste loads could affect the conclusions regarding environmental impacts.

Treatability Groups. While this PEIS covers five waste types, those wastes are not homogenous and are derived from thousands of different waste streams. Thus, the wastes were combined into treatability groups for purposes of developing treatment system designs. Each treatability group is identified with one or more of the five waste types considered in the PEIS and a treatment method, where appropriate, that EPA

recognizes as meeting the requirements of the Resource Conservation and Recovery Act (RCRA) (42 USC 6901 *et seq.*). For the PEIS analyses, the physical structure of the waste was used for the initial sort for treatability. At the most basic level of analysis, all waste can be grouped into six physical categories using common engineering criteria design parameters, which also served as the initial set of treatability categories:

- **Aqueous liquids**—Primarily water with organic content less than 1% (such as wastewater)
- **Organic liquids**—Liquids and slurries with organic content greater than 1% (such as solvents)
- **Organic and inorganic sludge and particulates**—Solid and semi-solid material other than debris (such as sludge from treatment plants, resins, and solids less than 2.5-inch diameter particle size)
- **Soils**—Contaminated soils (such as contaminated earth requiring remediation)
- **Debris**—Solid material exceeding 2.5-inch diameter particle size that is either (1) manufactured, or (2) plant or animal matter, or (3) discarded natural or geological material (such as cobblestones)
- **Other**—Special waste streams (such as batteries, laboratory packs, reactive metals, and toxic metals, which include mercury, lead, and beryllium)

Four waste types use this basic framework analysis: LLMW, LLW, TRUW, and HW. For purposes of the PEIS analysis, HLW, also in the above treatability categories, is assumed to have been treated (vitrified). The PEIS only addresses the environmental consequences of storing and transporting vitrified HLW.

Radiological and Chemical Composition. DOE used standard radiological profiles for each site and made assumptions about the concentration of contaminants in each treatability group based on available data. Hazardous constituents were apportioned to the treatability groups on the basis of the most prevalent hazardous chemicals using an average composition for all DOE sites. The assumptions for both radioactive and hazardous constituents are waste-type specific and are addressed in more detail in the waste-type chapters.

C.2.2 WM TECHNOLOGIES

Various technologies are used to sort and handle waste, reduce waste volume, destroy organic chemicals in waste, remove toxic metals from waste, treat hazardous characteristics to render them nonhazardous, recover and recycle materials, and stabilize and package waste for disposal. The facilities that use these technologies must be designed to accommodate the various physical and chemical forms and the radioactive and chemical characteristics discussed in previous sections. Existing, generic technologies necessary to meet

the treatment, storage, and disposal requirements for each waste type were identified and sized to meet anticipated waste volume needs. For analytical purposes, and to facilitate utilization in any system at any site, the waste management technologies were grouped into **common functions** (front-end support such as administrative and laboratory services; receiving, inspecting, dumping, and sorting the waste; maintenance of facilities; and certification and shipping of the waste), **pretreatment** (shredding and compaction), **primary treatment** (incineration, special processing, neutralization, deactivation, aqueous waste treatment, lead recovery, and mercury separation and recovery), **secondary treatment and stabilization** (polymer stabilization, grout stabilization, packaging, and vitrification of secondary processing residues), **storage** (administration, receiving and inspection, contact-handled storage, and remote-handled silo storage), and **disposal** (administration, receiving and inspection, shallow land disposal, engineered vault disposal, silo disposal, and borehole disposal). The technologies used in the WM PEIS were chosen for analytical purposes only; the Records of Decision based on the WM PEIS will not select technologies.

Existing, rather than advanced, technologies were used for the analysis because (1) the applicability of advanced technologies is more problematic, (2) impacts would more likely be bounded using existing technologies, and (3) the type of technology would be unlikely to determine the preferred alternative. However, advanced technologies will be considered in project-specific National Environmental Policy Act (NEPA) reviews expected to tier off from this programmatic review.

C.2.3 WM FACILITIES

Treatment, transportation, storage, and disposal "modules" were developed to represent every component required for waste management. Each module was assumed to contain several types of equipment, each able to perform a step needed in the waste management process.

Individual modules were linked together for each treatability group and were adjusted for the chemical and physical type of waste. This method was used so that impacts could be compared among sites, with each site assumed to be using the identical array of linked modules. Any variation in impacts would then result from site-specific environmental differences. This approach also allowed an examination of the changes in impacts resulting from changes in the linked modules.

Typically the type of facility considered was a building structure (i.e., a "fixed" facility at a given site). The analysis also considered the possible use of mobile treatment facilities that could be moved from site to site for treatment of the very small amounts of waste that exist at a number of the sites considered.

The generic design of the WM facility, consisting of these treatment, storage, transportation, and disposal modules, enabled the calculation of land utilization, worker-years, resource consumption (i.e., water and electricity), pollutant discharges, and costs for the treatment, storage, transportation, and disposal of each waste type. The engineering features of the generic facility and the waste loads "processed" through the generic facility formed the basis for the risk and environmental impacts analysis.

For purposes of analysis, the following assumptions were made regarding the construction and operation of the waste management facilities:

- The facilities were assumed to be built over a 10-year period and operated over a 10-year period to process inventories accumulated over a 20-year period. This was the basic assumption for LLW, LLMW, TRUW, and HW. This assumption was made prior to the analysis of facility costs required for the treatment, storage, and disposal of the various wastes. This assumption of similar operating conditions was made in order to allow the possible consolidation of facilities. Consolidation was not required in the PEIS, but would be attempted when facility requirements were being reviewed for justification of facility construction or for site-specific EISs.
- The facilities were assumed to operate 240 days per year with three 8-hour shifts.
- Except for HLW, a 20-year period of analysis is generally used for each waste type. Storage requirements for HLW under the No Action Alternative were assumed to be indeterminate in length, but in excess of this 20-year period. For this analysis, 30 years was assumed to be the longest period for which reasonable estimates of the HLW No Action Alternative could be made.

Although the WM PEIS only analyzes the environmental impacts from the operation of the WM facilities for 10 years, it is possible that the facilities could operate for up to 30 years. During this additional 20-year operating period, additional WM wastes or ER wastes could be processed. DOE believes that most of the impacts of operating the WM facilities for an additional 20 years would be similar to the impacts of operating these facilities for the 10 years analyzed in the WM PEIS. DOE believes this for the following reasons:

- The 10-year period of operations analyzed in the WM PEIS includes processing wastes accumulated for 20 years (i.e., waste accumulated during 10 years of construction and 10 years of operations) in

addition to any wastes in storage. Therefore the feed rate into the WM facilities would be expected to bound the feed rate during the latter 20 years of operations.

- Many of the impacts analyzed in the WM PEIS were analyzed on a daily or annual basis. For example, infrastructure impacts were analyzed for resource use in gallons of water per day, gallons of wastewater per day, and megawatts of power per year. Resource use during operation of the facilities for an additional 20 years is unlikely to exceed these rates of resource use and therefore is unlikely to exceed the environmental impacts predicted in the WM PEIS.
- Some impacts in the WM PEIS, such as human health risk to the offsite population, were analyzed for the entire 10-year operations period. DOE expects that the impacts during the additional 20 years of operations would be no more than twice the impacts predicted in the WM PEIS. For example, if the WM PEIS predicted a population health risk of 1 in 1 million (see Chapters 6 through 11 for actual risk estimates), the additional health risk of operating the facilities for 20 more years would be no more than 2 in 1 million, with a total health risk for 30 years of operations of 3 in 1 million.

This assumes that the characteristics of the waste processed during the additional 20-year operating period are similar to the characteristics of the wastes analyzed in the WM PEIS. If the characteristics of the wastes processed during the latter 20 years of operations are found in the future to be appreciably different from the characteristics of the waste analyzed in the WM PEIS, additional environmental documentation could be prepared to support continued operations.

C.2.4 ALTERNATIVES

In the PEIS, an alternative identifies the configuration of sites for treating, storing, or disposing of a specific waste type. Depending on the waste type, certain of these activities may not be analyzed in this PEIS. The categories of alternatives analyzed in this PEIS for each waste type are a No Action Alternative, Decentralized Alternative, Regionalized Alternative, and Centralized Alternative. These alternatives are described below:

- **No Action Alternative**—These alternatives would involve using only currently existing or approved WM facilities at DOE sites or commercial vendors.
- **Decentralized Alternative**—These alternatives would result in leaving waste at the site where it is currently stored or where it will be generated, treated, or disposed in the future. Unlike the No Action alternatives, the Decentralized Alternatives may require the siting, construction, and operation of new

facilities or the modification of existing facilities. Under the Decentralized Alternatives, the WM facilities would be located at a larger number of sites than under the Regionalized or Centralized Alternatives.

- **Regionalized Alternatives**—These alternatives would result in transporting waste to various numbers of sites (fewer than the number of sites considered for the Decentralized Alternative, but greater than the number of sites considered for the Centralized Alternatives). Generally, those sites that now have the largest volumes of a given waste type were considered as regional sites for treatment, storage, or disposal.
- **Centralized Alternative**—These alternatives would result in transporting wastes to one or two sites for treatment, storage, or disposal. As was the case with the Regionalized Alternatives, the sites that have the largest volumes of a given waste type were considered as sites for centralized treatment, storage, or disposal.

These four categories of alternatives encompass the range of reasonable alternatives available to DOE for siting of WM facilities. However, under each category of alternative, there are many possible combinations for the location of treatment, storage, and disposal facilities. To narrow these combinations to a feasible number for analysis, DOE selected particular site combinations for analysis under each category.

The alternatives were developed and defined based on waste type origin and character, volumes and locations within the DOE complex, existing facilities and capabilities, and specialized treatment and disposal requirements. DOE determined where the largest waste volumes are located and where transportation requirements would be minimized. Treatment, storage, or disposal facilities were analyzed at those sites. For example, if seven sites were to be considered under a Regionalized Alternative, then the seven sites with the largest volume of that type of waste became candidate sites for the analysis. Another Regionalized Alternative for the waste type being analyzed may evaluate management at three sites; in that situation, the three sites with the largest volume of that type of waste were considered as candidate sites. Existing capacity, transportation, and other factors were also considered in developing alternatives. As shown in Table C.2–1, a combined total of 36 alternatives were evaluated for the five waste types. The waste-type chapters (Chapters 6–10) contain more information on the alternatives analyzed in the WM PEIS.

Table C.2-1. Number of Alternatives Analyzed in the PEIS

Alternatives	LLMW	LLW	TRUW	HLW[a]	HW	Total
No Action	1	1	1	1	1	5
Decentralized	1	1	1	1	1	5
Regionalized	4	7	3	2	2	18
Centralized	1	5	1	1	0	8
Total	7	14	6	5	4	36

[a] HLW alternatives are analyzed in terms of both final disposal beginning in 2015 and final disposal beginning at some later date.

C.2.5 TRANSPORTATION

Transportation is an integral component of the alternatives being considered for the management of each type of waste in the PEIS. The magnitude of the transportation related activities varies with each alternative, ranging from minimal transportation under the Decentralized Alternatives to significant transportation under some of the Centralized Alernatives.

The transportation assessment included the onsite and offsite transportation of radioactive waste. Offsite transportation refers to transporting waste between distinct sites, including parts of the routes that may be within the boundaries of the origin and destination sites. Onsite transportation was evaluated for one sample site: Hanford.

The transportation linkages among generator, treatment, and disposal sites depend on the type of waste and are defined explicitly for each alternative under consideration. For the PEIS, representative offsite truck and rail routes were determined for all possible pairs of origin and destination sites. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines.

The representative truck routes were determined by using the routing model HIGHWAY 3.1 (ORNL, 1993a). INTERLINE 5.0 (ORNL, 1993b) was used to determine the rail routes. For truck and rail transportation, the route characteristics most important to the assessment included the total shipping distance between each origin and destination pair and the fraction of travel in rural, suburban, and urban areas. Because the routes were determined for the purposes of impact assessment, they are not simply representative of the actual routes that would be used to transport waste in the future.

For the offsite transportation assessment, each specific alternative is defined as a set of pairs (origin and destination) representing shipping linkages among generator, treatment, and disposal sites. The number of origin-destination pairs varies among alternatives, ranging from a small number for the Decentralized Alternatives, to many pairs for the Centralized Alternatives. The sites that would not have the capability to dispose of wastes would ship their wastes to a sites that does. Appendix E contains more detailed information on the transportation analysis.

C.3 Phase II: Engineering Analysis Outputs

The engineering features of the generic facility and the waste loads "processed" through the facility formed the basis for the estimates of resources required, effluents released, and cost. The resources required and effluents emitted were used to estimate environmental impacts from construction and operation of the WM facilities.

Resource Use. The Waste Management Facility Cost Information (WMFCI) methodology model was used to estimate the resources required for construction and operations of each WM facility. The resources included labor (number of FTEs), land, water, electrical energy, fuel (natural gas, diesel oil, and coal), chemicals, concrete, carbon steel, and stainless steel. A description of the engineering analysis used to estimate the resources used is provided in this section.

Facility Environmental Discharges. Once the generic designs and the volumes and characteristics of the waste and the model throughput requirements were specified, the WASTE_MGMT model was used to estimate discharges from the treatment, storage, and disposal modules (Argonne National Laboratory [ANL], 1996c). DOE estimated the radiological and chemical components in air and water effluents from processing the waste, and the chemical components in air effluents from the burning of fuel during the operations period. Section C.4.2 of this Appendix identifies the airborne emissions used in the analysis of air quality impacts. Discharges were assumed to be 90% from point sources and 10% from fugitive releases (ANL, 1996c). Section C.4.3 provides the estimates of releases from LLMW and LLW disposal units into groundwater that were used in evaluating water quality impacts.

Facility and Transportation Costs. The WMFCI methodology was also used to estimate life-cycle facility costs. Total cost of each alternative include the sum of the treatment, storage, disposal, and transportation costs, and in some instances, special costs. Examples of special costs include the Oak Ridge Reservation

"B&C Pond sludge" treatment and disposal actions. Section C.3.2 describes the details of the engineering cost estimation procedures.

C.3.1 RESOURCE USE

The resource use data-estimating process for LLMW, LLW, TRUW, and HW (part of the WMFCI methodology) used the mass/volume throughput to quantify resource consumption for each WM module. Supplemental methodologies provided resource estimates for modular throughputs which were bounded by WMFCI estimates. Samples of tabular presentations of resource use data accompany the discussions. Tabular details are provided (INEL, 1996). The resource use data-estimating process for HLW used regression formulas developed by ANL (ANL, 1996b).

C.3.1.1 Modular Estimating Approach

The resource consumption estimated for each module was dictated by a series of allocation rules. These rules were applied to each module to obtain resource quantities for the module size selected. The resource categories were selected before the actual analysis of any alternatives. During the impacts analysis process, it was determined that several resource categories were not directly needed in the analysis. However, the allocation rules for resources for all facilities are discussed.

C.3.1.1.1 *Construction Resource Use*

The following assumptions were common to developing the resource use parameters for construction activities.

A construction year was defined as 252 workdays, thus allowing time for holidays and weekends. Each workweek is assumed to be 40 hours and composed of five 8-hour days. An FTE (full-time equivalent) employee represents one person working full-time for one construction year, one shift per day.

Most modules were assigned a 2-year construction period, representing the total time assumed from the startup to end of construction activity. A 3-year period was assigned to modules requiring installation of

more complex equipment or special construction. The time needed to construct each module was included in tables in the resource use computer code. It was assumed that multiple modules will be placed within a single building. The time required to finish the entire plant is controlled by the interface requirements and staggered delivery schedules normally experienced during construction of a multipurpose facility. On any given site, construction of all required modules was assumed to take three to four years.

Many of the resource use parameters for construction were based on an estimate derived for construction of a generic treatment plant. A 120,000-square-foot generic plant and 3-year construction period were assumed (INEL, 1994).

The module area was a key parameter used in calculating the construction material quantities required. In the construction data tables of the resource use computer program, each construction material quantity is specified in terms of units per square foot. The area was used as a multiplier to calculate the total construction material quantities. The module area was determined from the plant area calculation presented later in this section. All buildings were assumed to be rectangular with a length-to-width ratio of 4:1.

Additional allocation rules for construction socioeconomic resource data included electrical energy, electrical load, fuel, water, laydown area, plant area, parking area, peak employment, and annual costs. Allocation rules for concrete, carbon steel, stainless steel, chemicals, and type of skills which were not used in evaluating environmental impacts are presented in the Environmental Impacts Technical Report (DOE, 1996a).

The resource use parameters for construction are as follows.

Electrical Energy (in megawatt-hours). This value represents the total amount of electrical energy consumed during construction.

Estimate Basis: Electrical energy was calculated by multiplying the connected electrical load, by the hours of use. The hours of use were based on a standard construction year (252 days). The average capacity was assumed to be 65%, which was determined by estimating the electrical energy consumed for construction of the generic treatment facility described above.

The typical allocation of electrical energy during construction was assumed to be 0.017 kilowatts per square foot for all types of facility modules.

Electrical Load (in kilowatts). This is an estimate of the connected electrical sources required during construction.

Estimate Basis: The electrical load factors for treatment and administration modules were based on the estimates developed for the generic treatment facility described above. The electrical load factor for each module was calculated in kilowatts per square foot of plant area. Total electrical load was obtained by multiplying the module area by 0.017 kilowatts per square foot for all types of facility modules.

Disposal modules with significantly less construction activity, such as the above-ground disposal module (AGDSP), silo disposal module (SIDSP), and silo storage module (STOSI), had an electrical load factor assumed to be approximately 20% of that of treatment modules. Modules such as shallow land disposal module (SLDSP), which do not include a plant with concrete and metal works, were assumed to have an electrical load factor of only 8%. Borehole disposal (BHDSP) was assumed to be constructed without electricity.

Fuel (in gallons). Fuel oil, gasoline, and propane are included in this parameter. In addition, an allowance of 840 gallons per FTE was assumed to account for fuel used by each employee on the job site and fuel required for travel to and from work.

Estimate Basis: The fuel factor for construction equipment was based on the fuel consumption estimate for the generic treatment facility described above. A consumption rate in gallons per square foot of plant area per year of construction was derived. A significantly lower value was estimated for the disposal modules. The fuel consumed by construction equipment for each module was obtained by multiplying by the module's area. Fuel consumption during construction for all modules was computed as the module area times 2.35 gallons per square foot of area.

Fuel consumption by construction employees was estimated by assuming that the workers will travel a 50-mile round trip to the construction site each day of a construction year. A fuel consumption rate of 15 miles per gallon was assumed. This gives 840 gallons per workyear (FTE) for all modules.

Water (in gallons). Estimates for water use include the water consumed during construction activities, potable water consumed by employees, and process water.

Estimate Basis: The estimate for the amount of water consumed during construction was based on the generic treatment facility estimate described above. The average use of water for dust control, equipment washdown, concrete water, and general cleaning of work areas was determined on a per square foot of plant area basis. A value equal to half of this estimate was used for all disposal and storage modules, based on the fact that fewer construction activities are included with these modules. Total water used for these activities was obtained by multiplying the quantity needed per square foot by the module's area.

The generic treatment facility estimate was also used to derive the amount of water used by a construction worker per year. The resulting yearly water usage factor was 3,400 gallons per FTE. General construction requirements were 27.5 gallons per square foot of area per year for all modules.

Laydown Area (in acres). The construction laydown area includes the area for each plant module plus that used for equipment and material storage.

Estimate Basis: The laydown area was estimated by adding a 25-foot-wide buffer to all four sides of the area required for each module. The laydown area for the site was obtained by adding the laydown areas for all modules composing the facility. A length-to-width ratio of 4:1 was assumed for all modules and the buildings containing the modules. The plant area was taken from the calculation below.

Plant Area (in acres). The plant area was obtained by summing the area requirements of the individual modules that constitute the facility. Each module's area was obtained by utilizing a relationship that relates the space required to the module's throughput capacity.

Estimate Basis: Three different module sizes were used to baseline the cost rollup and resource use data for most modules. Only two were used in a limited number of cases. The area required by any module was obtained by calculating a regression curve relating the three baseline sizes to their throughput capacity. The area needed for any other module was then obtained from this curve, based on the throughput capacity of the module in question. A scaling factor was applied in instances where the throughput capacity of the module in question was outside the range of the baseline facilities.

Parking Area (in acres). The parking area was obtained by allocating 400 square feet of space to 85% of the number of workers constituting peak employment.

Estimate Basis: A total individual parking area of 400 square feet was assumed, which includes space for both parking and maneuvering. The number of parking spaces required was based on the peak number of FTEs needed for construction. Parking space was assigned to 85% of this number, assuming that 15% will carpool. Unload/offload was assumed to take place in the laydown area.

Peak Employment (in FTEs). Peak employment is defined as the maximum number of construction employees that will be on the site on any workday during the entire construction period.

Estimate Basis: The total number of construction FTEs was obtained from the cost rollup data. The total number of FTEs divided by the construction period (in years) provided the average annual FTEs. Peak employment was estimated as 1.41 (i.e., the square root of 2) times the average number of FTEs per year.

Annual Costs (in $\times$1,000). Each of the various average annual construction cost items is divided among labor, material, or equipment categories.

Estimate Basis: The percentage of labor, materials, and equipment involved in the cost item breakdown was based on previously designed and constructed structures involving similar facilities. This cost information was taken from the cost rollup data.

C.3.1.1.2 *Operations Socioeconomic Resource Use*

The following assumptions were common to developing resource use parameters for facility operations.

An FTE employee represented one person working one shift per day for 252 days per year. Yearly plant operation was taken to be 4,032 hours assuming three 8-hour shifts daily, 240 days per year, with the plant available 70% of the time. The difference between an FTE-year and an operational year allows for the time when an employee may be working but the facility is not operating.

All socioeconomic parameters given for facility operations were annualized.

The module area were also an important factor in calculating operational resource use data. The calculation for module area used in this section is the same as that employed in the construction section.

Additional allocation rules for operations socioeconomic resource data include the following for electrical energy; electrical load; fuel, natural gas or liquid propane gas; fuel, liquid; water; total disturbed area; plant area; total number of worker years; hours per week for labor; operation and maintenance (O&M) labor; operations costs; and maintenance costs.

The resource use parameters for facility operations are as follows.

Electrical Energy (in megawatt-hours). This value represents the total electrical energy consumed during plant operations for one year.

Estimate Basis: Electrical energy was calculated by multiplying the connected electrical load by the hours of use. It was assumed that the equipment will operate half the time the plant is available. The "hotel load" (i.e., the electricity required for people), in watts per square foot, was multiplied by the module area (from below). Both were multiplied by the hours of use per year. The plant is assumed to operate 4,032 hours per year. This assumes three shifts per day, 240 days per year, with the module available 70% of the time.

Electrical Load (in kilowatts). This value represents the connected electrical load expressed in kilowatts. It was based on the electrical requirements of the equipment in the module plus the hotel load (i.e., the electrical load needed to support human occupancy). The hotel load includes lights, wall plugs, and where appropriate, air conditioning.

Estimate Basis: The resource use computer code contains estimates for the horsepower requirements of the equipment in the middle (or small) baseline facility. This was converted into watts and multiplied by the ratio of the module's throughput capacity to that of the baseline facility. A scaling factor was applied in instances where the throughput capacity of the module in question was outside the range of the baseline facilities.

The code also contains estimates of the hotel load in watts per square foot for each module. The hotel load was multiplied by the module's area and converted to kilowatts. Estimates of the hotel loads for the

processing, storage, and administrative modules were based on supporting technical documentation (INEL, 1996).

Fuel, Natural Gas or Liquid Propane Gas (in pounds). This value represents the fuel needed to heat the building for one year, assumed to be natural gas.

Estimate Basis: This estimate was based on supporting technical documentation (INEL, 1996). The calculation assumed that to heat the module for the entire winter, the furnace runs an equivalent of 2 months, 24 hours per day. It was further assumed that 3 British thermal units (BTUs) are needed to heat 1 cubic foot of volume for one hour. Multiplying the module volume by 3 BTUs/hour by 1440 hours yielded the total heat required. One cubic foot of natural gas equals 1,030 BTUs.

Fuel, Liquid (in gallons). This quantity represents the fuel required to operate specific pieces of process equipment for one year. Where required, it accounted for operating the equipment at full power as well as maintaining equipment in a hot standby condition. The fuel assumed for these calculations was standard diesel oil.

Estimate Basis: Some of the modules that process waste require fuel to operate. For those modules, the quantity of fuel required was calculated from the throughput capacity. Tables in the resource use computer program give the quantity needed for each 100 pounds of waste processed. The amount of fuel calculated from the throughput capacity per hour was then multiplied by the hours of operation per year.

In addition to the fuel needed to process waste, fuel is needed to keep the equipment in a hot standby condition. It was estimated that 75% of the amount needed for operation is required during the hours per year the plant is available. The plant was assumed to operate 4,032 hours per year, three shifts per day, 240 days per year, with the module available 70% of the time.

Water (in gallons). When required, water needed for operating process equipment was calculated specifically for the module in question. In addition, the quantities of water used and consumed by O&M employees were estimated. These were summed to derive the total water used per year.

Estimate Basis: Some of the modules that process waste utilize water. For those modules, the quantity of water required was calculated from the throughput capacity. Tables in the resource use computer program

give the quantity needed for each 100 pounds of waste processed. The amount of water calculated from the throughput capacity per hour was then multiplied by the hours of operation. The plant was assumed to operate 4,032 hours per year, three shifts per day, 240 days per year, with the module available 70% of the time.

Aqueous waste treatment was assumed to generate 86.7 pounds of water per hour for every 100 pounds of waste mass processed per hour. Incineration was assumed to use 109 pounds of water per hour, grouting 26.1 pounds of water per hour, and mercury recovery 10 pounds of water per hour.

Each FTE was assumed to use 20 gallons of water per day. The operating year for water use was taken as 252 days. The total water used was the sum of that used by the processing equipment and that used by the O&M personnel.

Total Disturbed Area (in acres). The disturbed area required for an individual module was assumed to encompass a space with sides 10 feet from the area needed for processing or other activities. The module was assumed to be rectangular with sides in a ratio of 4:1. The disturbed areas for each module were summed and the area of the parking lot added to yield the total disturbed area for the plant.

Plant Area (in acres). For each module, this value represents only the area needed for conducting the stated operation. The total facility area is a simple sum of the individual module areas that make up the facility.

Estimate Basis: Three different module sizes were used to baseline the cost rollup and resource use data for most modules. Only two sizes were used in a limited number of cases. The area required by any module can be obtained by calculating a regression curve relating the three baseline sizes to their throughput capacity. The area needed for any other module was then obtained from this curve, based on the throughput capacity of the module in question. A scaling factor was applied in instances where the throughput capacity of the module in question was outside the range of the baseline facilities.

Parking Area (in acres). Parking space was assigned to each FTE. Visitor parking was accounted for by assuming 15% of the FTEs will carpool. Unload/offload parking was assumed to be included within the plant area.

Estimate Basis: The number of FTEs was obtained from the cost rollup data by dividing the total number of O&M FTEs by the number of operating years. A total of 400 square feet was assigned to each FTE. This total included both parking area and maneuvering room.

Total Number of Worker Years (in FTEs). This value, in FTEs, was taken from the cost rollup data. An FTE represented one person working an 8-hour shift for 1 year composed of 252 days.

Hours per Week for Labor (in hours). A total of 40 hours was assumed.

Operating Labor (as a percentage of total skills). This value was taken as the total labor pool (i.e., the total number of O&M FTEs) less the number required for maintenance.

Estimate Basis: The average annual number of FTEs needed for both operations and maintenance was obtained from the cost rollup data. This number is equal to the total number of O&M FTEs divided by the number of operating years assumed for each module. The percentage of FTEs used for operating labor was obtained as follows: First, maintenance labor cost was calculated based on the equipment cost (see below). Next, the number of annual FTE maintenance employees was obtained by assuming each worker has an expense of $140,000 per year. The annual number of FTE operating personnel was obtained by subtracting the number needed for maintenance from the total average annual number of O&M FTEs. The ratio of annual operating FTEs to the total annual average O&M FTEs yielded a percentage.

Maintenance Labor (as a percentage of total skills). Annual maintenance labor was assumed to be equal to a percentage of the equipment cost plus a contingency factor. Equipment costs were obtained from the cost rollup data.

Estimate Basis: The annual number of maintenance FTEs was calculated as follows. First, the maintenance costs for labor were estimated by assuming that the labor costs are equal to 250% of the maintenance material costs for each module. The maintenance material costs were taken as a percentage of the equipment cost (between 3% and 7% depending on the module). By assuming each FTE cost was $140,000 per year, the total number of maintenance FTEs was calculated. The ratio of annual maintenance FTEs to the total annual average O&M FTEs yielded a percentage.

Maintenance ($\times$1,000). Annual maintenance costs were composed of two factors, material and labor. These values were estimated as a percentage of the cost of the equipment.

Estimate Basis: Maintenance cost was based on the equipment cost. It is assumed that 3% to 7% of the equipment cost was spent annually for maintenance materials, and the cost of maintenance labor is 2.5 times the material costs. To derive the total maintenance cost, a 25% contingency factor was added to this sum.

Operations ($\times$1,000). Operating costs constitute all costs needed except those required for maintenance.

Estimate Basis: The total annual cost of O&M was obtained from the cost rollup analysis. The annual cost was obtained by dividing the total cost by the number of operating years assumed for each module. The number of operating years was also obtained from the cost rollup data. The annual cost of operations was obtained by subtracting the maintenance costs (from above) from the annual O&M cost.

C.3.1.2 Resources Associated With Portable Modules

Small generator sites typically generate very small quantities of certain wastes. Where portable modules were used (TRUW and LLMW), resource consumption was identified for each portable module and its contribution was rolled up into the site resource totals.

C.3.1.3 Resource Data Estimate Methodologies for WM PEIS Alternatives

To analyze resources, the PEIS waste volume data were first divided into four waste types: LLW, LLMW, TRUW, and HW. These waste types were then subdivided into cases to analyze the alternatives. The cases were subdivided according to handling characteristics, sites, and construction or operations activities. Generic technology modules were identified and sized to meet the treatment, storage, and disposal requirements for each case. Resource data results were compiled for each alternative by summing the various resource data components for each module, then summing the module results for each site (DOE, 1996a).

For some alternatives, supplementary extrapolation methodologies were applied. The data for these alternatives were obtained from similar data computed as described in Sections 3.1.1–3.1.3, then scaled

based on either cost or waste processing rates. The supplemental resource methodologies used for LLW, LLMW, TRUW, and HW can be found in *Waste Management Environmental and Socioeconomic Impacts Methods and Results* (DOE, 1996a).

C.3.2 COST ESTIMATING

Costs were estimated using an approach that tied the cost of facilities and transportation to waste quantities. In addition, DOE used costs associated with existing technologies and historical industrial cost experience for estimating purposes.

C.3.2.1 Cost-Estimating Process Details

Each alternative includes a definition of the assumed technologies for the complete treatment process. For each site and each alternative, wastes were hypothetically routed through the waste management process, and the modules were individually sized to handled the processing requirements. Since many sites have existing treatment, storage, and disposal capabilities (INEL, 1994), the analyses accounts for existing facilities to minimize additional construction requirements. However, only O&M costs were estimated for existing facilities.

C.3.2.1.1 *Waste Management Facility Cost Information Reports*

The PEIS used a set of reports, collectively referred to as the "WMFCI reports," to develop cost and manpower estimates for the various alternatives and cases being considered. These reports were prepared for DOE by EG&G Idaho to provide a generic facility costing and resource use estimating methodology for programmatic analysis of treatment, storage, disposal, and inter-site transportation of radioactive and hazardous waste. The WMFCI reports consist of the following:

- Data extracts of the detailed facility equipment and construction estimates and other costing factors applied to base estimates for waste types
- Management analysis reports summarizing the findings of the data extract reports according to waste type

- Procedural reports that describe how to compute costs and manpower for the modules used for the treatment, storage, and disposal of waste types
- Data reports computed by PEIS alternative/case by waste type for cost and FTEs, and for resource consumption data supporting the environmental impacts analysis

The WMFCI reports provide a consistent and defensible basis for generating life-cycle cost information for treatment, storage, and disposal facilities using specific data for each major waste type. The WMFCI reports present cost and manpower information reports for LLMW, LLW, TRUW, and HW (INEL, 1995a-d). Within the waste-type categories listed above, cost information was developed for alpha-contaminated wastes (both LLW and LLMW) and remote-handled (RH) waste (LLW and TRUW). For some treatment processes, costs for portable systems were developed for non-alpha contaminated waste (LLW and LLMW); these were deemed more realistic and lower cost approach for treating extremely small waste loads. A separate report (INEL, 1995e) was developed to provide a cost computation methodology applicable to the shipment and routing information provided in Appendix E for the transportation of radioactive and hazardous wastes. A full listing of WMFCI reports is provided in the references cited section of this appendix.

The WMFCI reports were developed specifically for DOE-owned facilities. The cost-estimating used in the reports included provisions necessary to comply with all applicable regulatory requirements for a particular waste type and to meet the requirements of all applicable DOE orders. Indirect costs and overhead burden rates used in the WMFCI reports were based on those historically encountered at DOE's Idaho National Engineering Laboratory (INEL), which fall approximately in the middle of the range of cost factors found at several other DOE sites and which are, therefore, considered to be representative for complex-wide estimating purposes.

C.3.2.1.2 *Modular Estimating Approach*

To facilitate the development of comprehensive cost estimates covering cradle-to-grave management of wastes, the WMFCI reports categorized all necessary WM activities into a series of modules, each representing a discrete facility that carries out a single WM function. A unique set of cost information was developed for each WMFCI module (see Table C.3-1). Within a given module, a series of unit operations necessary to accomplish the specified function was defined in sufficient detail to enable development of the

Table C.3-1. Facility Cost Modules Included in WMFCI Reports[a]

Module	LLW	LLMW	TRUW	HW
Treatment Front-end Support	x	x	x	x
Small Generator Front-End/Back-End Support	x	x		
Waste Characterization			x	
Packaging	x	x	x	
Stored Waste Retrieval			x	
Receiving and Inspection	x	x	x	x
Open, Dump, and Sort	x	x	x	
Assay, Sort, and Package				x
Maintenance	x	x	x	
Incineration	x	x	x	x
Aqueous Waste Treatment		x	x	x
Neutralization	x		x	
Shredding/Compaction	x	x	x	
Supercompaction	x			
Metal Melting	x	x		
Wet-Air Oxidation		x		
Thermal Desorption		x		
Debris Washing		x		
Soil Washing		x		
Lead Recovery		x	x	
Mercury Separation		x	x	x
Organic Removal				x
Deactivation		x	x	x
Special Waste Processing	x	x	x	
Recycling				x
Organic Stabilization			x	
Grout Stabilization	x	x	x	x
Polymer Stabilization	x	x		
Vitrification	x	x	x	
Certification and Shipping	x	x	x	x
Storage Front-end and Back-end Support	x	x	x	
Storage Receiving and Shipping			x	
Storage	x	x	x	
Silo Storage	x		x	
Disposal Front-end Support	x	x		
Engineered Disposal	x	x		
Shallow Land Disposal	x	x		x
Silo Disposal	x	x		
Borehole Disposal	x	x		

[a] HLW facilities are covered in a separate report (ANL, 1996b) but included only storage facilities.

planning level cost information. For example, the incineration module included each of the following unit operations: feed preparation, incineration, secondary combustion, and off-gas treatment. The array of unit operations is sufficiently broad to accomplish the incineration tasks required by the identified waste inventories.

Once a particular WM alternative-based scenario was defined, a series of modules was selected that best represented all activities required to accomplish the necessary WM functions. Some scenarios may have required only 1 or 2 modules to fully define the WM functions, while others may have required 10 or more modules to capture all necessary functions. This modular approach to establishing the cost-estimating basis provided maximum flexibility; thus, the WMFCI was designed to be the full used to support a broad range of WM options.

Design of the WMFCI was based on standard, proven technologies and WM approaches. The modules represent a variety of treatment, storage, disposal, material handling, and support facilities, that were developed for all major DOE waste streams. The cost modules, are listed by waste type in tables found in (INEL, 1996).

Facility costs were established on the basis of the costs of DOE facilities (primarily at INEL) and commercial facilities. To the extent possible, equipment costs for each facility module were compared with data from anchor facilities to establish a cost confidence level with the boundaries established for programmatic life-cycle cost estimates. Both DOE and the commercial nuclear industry are now planning or operating similar facilities. These facilities were surveyed to obtain capacity and cost data and other information needed to support the cost methodology data. Before using these costs, the data were adjusted to account for capacity differences and escalation.

Additional assessment activities included a review of existing DOE facility capital and operating costs for comparison with the cost methodology data. Existing DOE facilities that have been evaluated include the Waste Experimental Reduction Facility (incineration, shredding, and compaction) at INEL; the Controlled Air Incinerator at Los Alamos National Laboratory; the Toxic Substances Control Act (TSCA) Incinerator at Oak Ridge Reservation; the Supercompactor and Repackaging Facility at Rocky Flats Environmental Technology Center; the Radioactive Waste Management Complex (LLW disposal) at INEL; and the Transportable Waste Water Treatment Unit from the Uranium Mill Tailings Remedial Action Project. Planned DOE facility costs at INEL were also evaluated for the Radioactive Waste Storage Facility, the

Waste Characterization Facility, the Idaho Waste Processing Facility, and the Mixed Low-Level Waste Treatment Facility.

Other facilities evaluated include the Illinois Compact Low-Level Engineered Disposal Facility and the Commonwealth of Massachusetts Low-Level Radioactive Waste Disposal Facility.

Cost estimates for facility components were adapted from commercial sources (INEL, 1995b-d, 1996). Commercial facilities evaluated include conceptual designs and cost estimates for air- and area-monitoring units from Eberline Corporation of Santa Fe, New Mexico; amalgam mixers from Miracle Paint Rejuvenator of St. Paul, Minnesota; blending equipment from Velmac Associates, Inc., of Novato, California; calciner/kiln units from ABB Raymond, Inc., of Lisle, Illinois; chemical oxidation units from Peroxidation System, Inc., of Tucson, Arizona; compactor units from Stock Equipment Company of Chagrin Falls, Ohio; concentrator units from LCI Corporation of Charlotte, North Carolina; drum capping and washing units from Stock Equipment Company of Chagrin Falls, Ohio; dry off-gas filters from Pall Advances Separation Systems of Cortland, New York; dry and wet off-gas treatment trains from NGK-Locke, Inc., and Callidus Technologies; drying equipment from Wyssmont Co., Inc., of Fort Lee, New Jersey; extruder equipment from Sterling Extruders, Davis-Standard Division of Edison, New Jersey; gross-organic removal units from McTighe Industries, Inc., of Mitchell, South Dakota; incineration packages from Joy Energy Systems of Charlotte, North Carolina, and ABB Raymond, Inc., of Lisle, Illinois; quencher and scrubber (wet scrubbing) units from Croll-Reynold Company of Westfield, New Jersey; melter units from Ajax Corporation and Retec Corporation; preparation and feed units from various vendor quotes; processing equipment from the U.S. Navy LLW processing facility of Lynchburg, Virginia; open, dump, and sort devices and robotic arms in consultation with personnel from DOE contractors involved with the Office of Technology Development, Robotic Technology Development Program; organic stripper units from APV Crepaco, Inc., of Tonawanda, New York; radiological and hazardous material measurement systems from conceptual designs and cost estimates provided by Lockheed-Martin; segmented gamma scanning (SGS) assay systems data from Atlan-Tech Corporation, Inc., of Roswell, Georgia; shredder units from Komor Industries, Inc., of Groveport, Ohio; feeder/shredder units from System Service Solutions of Wilsonville, Ohio; retort units from Denver Mineral Engineers, Inc., of Littleton, Colorado; size reduction and baler systems from Stock Equipment Company of Chagrin Falls, Ohio; selected solidification units from Stock Equipment Company; solidification module assemblies from Stock Equipment Company; stack monitoring units from Eberline Corporation of Santa Fe, New Mexico; suspended-solids filtration systems (Membralox) from U.S. Filter Corporation of Warrendale,

Pennsylvania; thin-film evaporator units from LCI Corporation of Charlotte, North Carolina; washing equipment from CF Systems (a subsidiary of Morrisen-Knudson); wet oxidation units from Zimpro of Rothchild, Wisconsin; and the commercial treatment and disposal processes for hazardous wastes from various vendors (INEL, 1995a-d).

C.3.2.1.3 *Cost-Estimating Basis*

A "bottom-up" estimating approach was used to develop the WMFCI unit costs. Initially, a capacity range for each facility cost module was established by studying the currently stored and future projections of DOE waste volumes. Process functional diagrams and facility layout drawings were developed at the individual unit operation level. After all unit operations required for a module were defined, major equipment lists, building configurations, and square footage requirements were established, and cost estimates for each facility were developed.

Data from the study defined baseline capacities for five facility sizes: portable, minimum-fixed, small, medium, and large. Using the five facility sizes, a generic design package for each cost module was developed and used as the basis for the Program Life Cycle Cost (PLCC) estimates. Each design package included a summary functional and operational requirements description, a process functional diagram with mass flow rates, a facility layout, manpower requirements for the processes, and cost and manpower (FTE) capacity-to-requirement curves. The design packages used as much available data from existing or planned DOE facilities as possible. This approach, referred to as "anchoring," provides the reference point used to estimate the various cost components. New designs were generated only if no existing data were available.

C.3.2.1.4 *Cost Components (Work Breakdown Structure)*

The costs for each WM facility included the following four components (each estimated separately): (1) pre-operational activities, including the costs of studies, demonstrations, generic designs, permitting, and startup; (2) facility construction, including definitive design, equipment and building, and construction labor costs; (3) O&M costs; and (4) decontamination and decommissioning (D&D) costs. Usages were determined separately for resources used during the construction period (which includes pre-operations and

construction) and resources used during the period of operations (which includes O&M and D&D). Life-cycle costs do not include speculative factors such as potential impacts on the long-term value of land.

Resource usage was estimated for all treatment, storage, and disposal facilities configured at each site for each waste type under each alternative. Building unit costs for various functions were developed by generating detailed material quantities, labor hours, and related costs for construction, using rates applicable to INEL. These building functional unit costs were multiplied by the functional floor space required within each module. The functional cost subtotals were summed to give a total building cost for each module.

Equipment costs were estimated either by soliciting budgetary costs from suppliers, by using existing data, or by making engineering judgments. Costs for the other three components of the estimate (operating budget-funded activities [pre-operation], O&M, D&D) were obtained from actual costs of existing facilities and from engineering estimates. These cost components do not include various site costs for the supporting infrastructure and basic site services known as "chargebacks." The allocation rules for chargebacks are site-specific and provide a similar site effect for all alternatives. They do not affect the relative cost ranking of the alternatives, and are not included in the PEIS.

To provide a comprehensive analysis of the WM facility requirements for support, the facilities required to manage the waste (for example, administration and maintenance) were also provided as separate facility cost modules. This approach facilitated analysis of scenarios that involve existing facilities where none, some, or all of the administrative functions may have already been in place.

C.3.2.1.5 *Cost Estimates Development*

To assist in application of the WMFCI, the baseline cost/capacity relationships defined for each cost module were translated into parametric cost relationships. These relationships were defined by linear and log-linear equations that uniquely define the costs over a broad range of capacity requirements. Each facility module had specific cost equations that defined the pre-operations costs, facility construction costs, O&M costs, and D&D costs. The cost relationships allowed the WMFCI to be consistently applied over a wide range of estimating scenarios.

Both DOE and the commercial nuclear industry have facilities similar to some of the cost modules examined by the WMFCI. Several facilities (for example, incinerators, metal-melters, supercompactors, spent nuclear fuel storage, and engineered disposal) were surveyed to obtain functional and operational requirements, capacity limitations, capital and operating costs, and other information needed to provide a basis for the WMFCI data.

To the extent possible, major equipment costs in each cost module were taken from similar facilities that had been constructed or that were in the advanced design stage. Before using costs from existing facilities, the data were adjusted to account for capacity differences and escalation. These cost validation steps established a cost confidence level for the PLCC estimates of plus or minus 30%.

Facility construction costs were based on the current cost-per-square-foot rates for five typical building functional envelopes defined by use—low hazard, moderate hazard, alpha-treatment, storage, and disposal functions—planned and under construction at INEL.

Indirect costs and overhead burden rates used in the cost-estimating methodology were based on those historically encountered at INEL. They fall approximately in the middle of the range of cost factors found at several other DOE sites and were therefore considered to be representative for complexwide estimating purposes.

C.3.2.2 WM PEIS Cost-Estimating Methodology

C.3.2.2.1 *Description of Alternatives*

Cost estimates for each PEIS alternative were developed at the module level for each site within the DOE complex. For a given WM alternative, every site with waste of that type played a role in management of that waste and consequently incurred some cost. The roles of the various sites could have ranged from simply packaging and shipping their own wastes to treating and disposing their own wastes and wastes from other sites. The contribution each site made toward the cradle-to-grave management of a given waste type was defined in each alternative through designation of treatment, storage, and disposal locations for each site's waste. The alternatives generally covered the range of possible configurations from a centralized waste

management strategy to a decentralized scenario. Other parameters that were also varied within the alternatives analyzed for a particular waste type included the level of treatment performed and the final waste form produced. Therefore, for each alternative, a unique set of responsibilities was defined for each site; this established the activities that had to be performed at each site and provided the basis upon which the cost estimates were developed.

C.3.2.2.2 *Waste Loads Development*

Once the WM activities to be performed at each site were defined for a particular alternative, the quantity of waste to be processed or handled through each module was calculated. This step was accomplished using a set of "raw" data that accounted for all waste stored and generated at each site. The waste information included quantities of waste currently in storage and projections for future waste generation. Each classification of waste (LLW, LLMW, TRUW, and HW) was broken down into "treatability groups." The treatability groups, based on the characteristics of the waste, helped to define which treatment processes were necessary to meet regulatory requirements for that waste type. (The generic configurations of processing modules necessary to treat, store, and dispose each waste treatability group were discussed earlier.) The raw data were transposed into the waste loads for each facility by applying the constraints and assumptions integral to the configuration designated for each alternative. Once a time factor was incorporated (for example, a 10-year operating period), the waste load for each module became a waste processing rate. The processing rates (throughput capacities) for each module was used to determine facility size and was the key factors used in developing the cost estimates.

C.3.2.2.3 *Existing Facilities Assessment*

A survey of existing and planned-or-approved WM facilities at each site, and their capacities, was performed to provide the baseline for cost-estimating purposes. Where existing capacities were identified, the total required operating capacity was reduced by that amount so that only the minimum necessary new facility construction was costed. Since existing facilities and their capacities were taken into account, the cost estimates developed for each alternative could be considered to be representative of actual future capital investments necessary to provide the additional capabilities required for the WM operations outlined in each alternative.

In some alternatives, where a homogeneous waste stream was currently being treated in a dedicated facility and actual operating costs were known, these actual costs were used in the PEIS cost estimates (rather than using bottom-up cost estimates for generic facilities designed to treat the same waste).

C.3.2.2.4 *Parameters and Assumptions*

The PEIS alternatives generally assumed that a 10-year implementation period was necessary to construct and start up the new WM facilities required for each alternative, and that a 10-year operating period would be used to work off the projected waste inventories. For new facilities, the costs of decontamination and demolition were included; for disposal facilities, the costs of custodial care after closure throughout a 300-year period of institutional control were included, but were not substantial.

Costs under the No Action Alternative for each waste type were estimated using a unique set of assumptions. The No Action Alernatives (with some exceptions for storage and disposal) used existing facilities for 20 years. This assumption was made to quantify the amount of useful facility life remaining in currently existing facilities. The assumption allows the current facilities to be considered for the complete 20-year period of analysis. Where projected waste loads exceeded existing treatment facility capacities, waste was assumed to be stored.

The HW alternatives were assumed to use commercial treatment contractors for 20 years; possible regional on-site treatment and disposal costs were also evaluated.

Costs associated with treating quantities totaling less than 0.1 pounds per hour or disposing quantities totaling less than 0.1 cubic feet per hour were considered to be insignificant and costs were not developed. These volume totals equate to treating a drum or less of waste per year and disposing 60 drums (one semi-trailer load) or less of LLW or LLMW per year. In such instances, bench-top-type treatment, or shipment to another facility, would be likely to occur.

The receiving and inspection module was used only for wastes received from another site for regionalized or centralized treatment. It was assumed that wastes generated on site would be characterized to the extent that inspection would not be required and that the waste could be transported directly to the treatment facility. Representative sampling of onsite waste characterization was assumed to be performed as necessary

through a variety of modules: certification and shipping (found at all sites), administration—with laboratory—(found at all treating, storing, and disposing sites), and waste characterization (found at all TRUW sites).

The "open, dump, and sort" module was used only for waste volumes currently in storage. It was assumed that these containerized wastes are heterogeneous and would need to be sorted before treatment. It was further assumed that wastes presently being generated or to be generated in the future would be segregated by treatment need and would not require sorting.

Except for TRUW, it was assumed that treated wastes would be accumulated in small batches (railcar or truckload quantities) and would be shipped directly for disposal, eliminating the need for storage. For TRUW, it was assumed that shipment could not be made directly to WIPP; therefore, costs were estimated for one year of storage before transportation to WIPP.

C.3.2.2.5 *Application of the Waste Management Facility Cost Information Methodology*

Curves for cost-versus-capacity and FTEs-versus-capacity were developed for each module through a bottom-up estimating method. These curves were developed over a finite range of capacities (referred to as the "standard capacity range") that, at the time the range was selected, would fit the anticipated cost-estimating needs. The standard capacity range selected was specific to each module. Cost versus capacity curves were developed for equipment (including installation), building requirements, operating labor, and operating materials. From these curves all other costs were determined through application of various cost factors. Combining all derived costs produced the life-cycle costs for each module. Costs for all modules were based on a 48-week year, three shifts per day, 5 days per week, and 70% availability, for a total operating period of 4,032 hours per year. The 4,032-hour year is a "rating" of achievable production capacity possible in a full 52-week workyear.

Curves for cost versus capacity were developed for numerous modules handling contact-handled (CH) LLMW, CH alpha-LLMW, RH LLMW, CH LLW, CH alpha-LLW, CH TRUW, RH TRUW, and HW. FTEs-versus-capacity curves were determined by applying a factor to the costs for an appropriate category.

With the release of updated waste data, the need for costs at capacities outside the standard capacity range of developed data became necessary. The following methodology was used to estimate the costs when the capacities fell outside the standard range for any particular module.

C.3.2.2.5.1 Costs Determination for Treatment Outside Standard Capacity Range

To estimate the costs for a treatment module at a throughput capacity falling below the standard range, the following extrapolation method was used. An "economy of scale" function was assumed to exist beyond the upper and lower bounds of the capacity-to-cost curve (developed as discussed above). The upper and lower bounds were the waste processing throughput capacities of the largest and smallest standard commercially available processing equipment for the particular module being adjusted. The basic formula is shown below:

$$[\text{Cost for higher/lower capacity}] = [\text{Cost for high/low bounding point}] \times [(\text{waste throughput capacity of higher/lower requirement})/(\text{waste throughput capacity of high/low bounding point})]^{0.7}$$

The ratio of required throughput capacity to the throughput capacity of the high or low bounding point of the capacity-to-cost curve was raised to the 0.7 power. The use of the 0.7 power scaling factor was based on estimating methods presented by Peters and Timmerhaus (1968) and Remer and Chai (1990). The resulting value was used to adjust the cost of the equipment, building requirements, operating labor, and operating materials. These adjusted costs were then used to estimate the costs associated for the lower-than-standard capacity (to eliminate unrealistically small modules). A module was never scaled down to below 10% of the smallest capacity in the standard range. Similar judgment would have been used when scaling to modules several times larger than the upper bounding capacity; however, waste loads never became that large, so this approach was not tested.

For the incinerator module and the small generator front-end support module, costs were developed for a module of "minimum" size designation. This represented the smallest module size that could be constructed with off-the-shelf equipment. A slightly different approach was used to estimate costs. For capacities falling between the minimum capacity and the lowest capacity in the standard capacity range, the costs were determined by the method described above. For capacities falling at or below the minimum, the "minimum module" capital cost was used and operating costs were scaled down from the minimum capacity using the

0.7 power factor method. To eliminate an unrealistically small module for very small capacity requirements, the number of shifts was limited to 0.1 shift per workday.

For seven other non-alpha modules (aqueous waste treatment, wet-air oxidation, thermal desorption, deactivation, lead recovery, mercury separation, and polymer stabilization), the minimum module was the same as the lowest capacity in the standard range. Costs for these seven modules were treated in a parallel manner as stated for incineration (above). For capacity below the range associated with these seven modules, capital costs from the minimum module were used and the operating costs were scaled down from the minimum capacity using the 0.7 power factor method.

To determine the costs of an AGDSP or an SLDSP at a capacity falling below the standard range (18 to 126 cubic feet per hour), the following extrapolation method was used. For disposal capacities within the standard capacity range (1.44 to 5.9 cubic feet per hour) for the SIDSP, costs for silo disposal were used. For disposal capacities falling between the standard ranges of the SIDSP and the AGDSP or SLDSP (5.9 to 18 cubic feet per hour), the ratio of the actual capacity to the lowest capacity of the AGDSP or SLDSP standard capacity range was raised to the 0.7 power. The resulting factor was used to adjust the cost of the equipment, building requirements, operating labor, and operating materials. These adjusted costs were then used to estimate the associated costs. For disposal capacities falling below the standard capacity range of the SIDSP, costs were determined by scaling down with a factor developed by taking the ratio of the actual capacity and the smallest capacity in the standard range for the SIDSP raised to the 0.7 power.

C.3.2.2.5.2 Portable Module Costs

Small generator sites typically generate very small quantities of certain wastes. To treat these small quantities, installation of permanent treatment facilities would not always be cost effective. To handle these small quantities, portable treatment modules were identified as an economical alternative. Portable modules were used for certification and shipping, decontamination, polymerization (which is capable of performing grout stabilization for very small volumes), thermal desorption, and wet oxidation (which could substitute for incineration for very small volumes).

Costs for portable treatment modules were developed based on processing 2.5 cubic meters of waste per treatment campaign. Waste to be processed was assumed to have an incoming density of 40 pounds per

cubic foot for all modules, except aqueous waste, which has a density of 62.4 pounds per cubic foot. Each treatment campaign was assumed to require 2 weeks, including setup, processing, and shutdown. Counting travel time and equipment maintenance time, the number of campaigns was limited to 12 per year. (If waste quantities were sufficiently high to exceed 12 campaigns per year, permanently installed modules were estimated.) The portable equipment was assumed to have a useful life of 5 years, or 60 campaigns. A host facility (warehouse, garage, or similar structure) with suitable utility support was assumed to be required.

Costs associated with portable modules were developed on a campaign basis. Each portable module has its unique campaign cost, computed to include all programmatic life-cycle cost components.

C.3.2.2.5.3 Supplemental Cost-Estimating Methods

For most WM alternatives, costs, manpower, and resource use data were computed using the above-described methodology. The computations were made by selecting the same data results from cases estimated using the WMFCI methods in LLW Cases 5, 7, 12, and 14 for cost/manpower and in Cases 1, 2, 4, 5, 7, 12, 14, and 14a for resource data; in HW Case 1 for cost/manpower and Cases 1 and 2 for resource data; in TRUW Cases 1, 10, and 11 for resource data; and in LLMW Cases 1, 7, 10, and 17 for resource data. For certain data points, exact matches did not exist; in such instances, data were scaled linearly, using waste processing throughput proportions, from the nearest data point computed using the WMFCI method. These computations are summarized in *Data Collection on Existing and Planned/ Approved Waste Management Facilities in Support of the EM PEIS* (INEL, 1994). Resource use data estimates were discussed in Section C.3.1.

Where modifications to the originally computed data were required because of changes in costing assumptions, a similar "exact selection, or scaling from closest data point" method was used. These computations have been summarized (INEL, 1996).

In the case of HLW, cost and manpower estimates for canister storage and transportation were abstracted from the many cost studies performed for vitrification of HLW at the West Valley Demonstration Project (WVDP), Savannah River Site (SRS), Hanford, and INEL. A summary of these findings is found at Section C.3.2.2.8.

C.3.2.2.6 *Transportation Cost Estimates*

Transportation costs were calculated for each alternative using mileage between sites (either by highway or rail) and mass quantities requiring shipment. Transportation costs were included for waste shipments between generator sites and treatment sites, between generator sites and disposal sites, and between treatment sites and disposal sites. Costs were compiled for each alternative for both truck and rail transportation. Transportation costs for most waste types were computed using linear regression formulas, where a fixed cost per trip (depending upon waste type) was multiplied by the number of shipments and added to a variable cost-per-loaded-mile multiplied by the total shipping mileage. The fixed and variable costs per waste type and the background of the transportation cost-estimate development are provided (INEL, 1995e). The cost-estimating process for the transportation of HLW is found at Section C.3.2.2.9.

C.3.2.2.7 *Quality Assurance*

The PEIS cost estimates were compiled for each alternative, and the detailed estimating backup information is documented in data packages retained in the PEIS engineering files. Each cost data package was thoroughly reviewed before publication of any cost results. The quality reviews verified that the estimating methodology was correctly and consistently applied, that the assumptions and alternative descriptions were followed, and that the results provided reasonable PLCC that can be used to compare the relative costs of the various alternatives.

C.3.2.2.8 *Cost-Estimating Procedures for High-Level Waste Canister Storage and Transportation*

The generic cost methodology used was modified to reflect the specific assumptions for HLW. These modifications are discussed below.

C.3.2.2.8.1 Methodology and Assumptions

The life-cycle costs for facilities used for treatment, storage, and disposal are incurred from the beginning of the period of analysis, lasting for 20 years. The decontamination and decommissioning costs for new treatment and storage facilities, and custodial costs of disposal facilities, are also included. The total life-cycle costs include all costs associated with waste handling following its generation, current storage and treatment, transportation, future disposal and monitoring. The WM PEIS does not provide cost analysis of the current storage of HLW, pretreatment and treatment of HLW (resulting in canisters of vitrified waste), or environmental impacts of HLW disposal. The WM PEIS does provide cost analysis of the storage of canisters and the transportation to storage sites and a candidate geologic repository. Because of the possibility of a prolonged delay of HLW disposal, two sets of timing assumptions for acceptance of HLW at the candidate repository were analyzed.

Projecting the cost of the HLW alternatives involved developing estimates of the individual cost components. The cost was divided into two components—capital investment and annual operating charges. The capital cost of a facility was assumed to include process equipment, construction materials (for example, steel and concrete), and labor, as well as indirect costs such as those for design, contingencies, and environmental compliance. The annual O&M costs were expenses estimated for O&M staff, fixed and variable supplies, annual operating fees, administration, and general expenses. These two cost components were estimated by reviewing and abstracting available data on the costs of storage and transportation of HLW (ANL, 1996b).

C.3.2.2.8.2 Canister Storage

Vitrified HLW from Hanford, SRS, WVDP and INEL would be placed in on-site storage facilities awaiting transport to the candidate geologic repository. The WM PEIS alternatives for HLW management include: (1) No Action—Continued storage (assumed for 30 years), (2) Decentralized—All sites provide storage for canisters until the candidate geologic repository begins accepting DOE HLW in 2015, with shipments beginning in 2016; (3) Regionalized 1—WVDP ships its canisters to SRS for storage until transportation to the candidate repository starting in 2016; (4) Regionalized 2—WVDP ships its canisters to Hanford for storage until transportation to the candidate repository begins in 2016; and (5) Centralized—WVDP, SRS, and INEL ship their canisters to Hanford for storage until transportation to the candidate repository begins

in 2016. For the alternatives, the assumption was made that the approval of the candidate repository will occur in a timely manner so that the amount of storage facilities to be constructed could be kept to the minimum required.

The second set of timing assumptions is configured identically to the No Action, Decentralized, Regionalized 1, Regionalized 2, and Centralized Alternatives, except that acceptance of DOE HLW at the candidate repository is deferred past 2015, requiring the construction of storage facilities at each site capable of holding the full amount of canisters to be stored at that site. These alternatives are costed assuming that the approval of the candidate repository is made in time to begin transportation in 2016 but after each site has completed construction of storage facilities for all canisters produced at that site. Further deferrals of the decision will increase the total cost of storage. Depending upon the alternative, the costs for storage operations will increase by an additional $8 million for every year past 2015 that acceptance of HLW canisters at the candidate geologic repository is delayed.

The storage technology selected for costing is the modular dry vault storage (MDVS) concept. It is assumed that the interim canister storage facility at Hanford and at SRS for the vitrified HLW would hold canisters in vertically sealed cavities within a concrete structure forming the storage vault. Each canister storage vault (CISV) will be an air-cooled dry storage vault for vitrified HLW. A thermosyphon ventilation system would be used to remove heat generated by the stored vitrified HLW. Activities at a given CISV include receipt and unloading of transportation cask containing canister(s) of vitrified waste, inspection of the canister, and storage of the waste until transfer to a permanent geologic repository. The CISV consists of rows of tubes or vaults laced below grade into which the canisters are lowered. Concrete plugs provide a cover for the tubes. The canisters are to be stored in sealed sleeves so that the cooling air would not directly come into contact with the potentially contaminated surfaces of the HLW canisters. Although the design for storage of canisters at INEL has not been decided, the PEIS assumed the storage technology to be the same as that for Hanford and SRS. Because the storage facility has been constructed at WVDP, these costs are not included in the PEIS analysis.

The rationale for costing the construction and operations of these facilities is provided (ANL, 1996b). The cost experience for monitored retrievable storage facilities was modified to the above concept. The below formula was developed to estimate capital costs:

$$[\text{Capital Cost (\$ million)}]_{MVDS} = 0.71\ [\text{Capacity (HLW Canister)}]^{0.53}$$

Annual O&M costs include the routine handling, storage, and retrieval, with the predominance of costs pertaining to the operation of facilities. The operating lifetime of the various storage facilities varies depending upon the transportation instruction for each Alternative. The correlation of the annual operating costs for the storage period as a function of capacity is:

$$[\text{Annual O\&M Cost (\$1,000/yr)}]_{\text{Storage}} = 38.6 + 0.27 \times [\text{Capacity (HLW canisters being stored)}]$$

Loading/unloading operations were evaluated in the reference; the following formula was developed:

$$[\text{Annual O\&M Cost (\$1,000/yr)}]_{\text{Loading}} = 770 \times [\text{Throughput (HLW Canisters shipped/yr)}]^{0.52}$$

With respect to the shipping rate to be assumed for the various alternatives, the loading rate into storage is taken to equal the maximum annual vitrification rate (190 canisters per year for SRS, 790 canisters per year for Hanford (No Action is 320 canisters per year), 300 canisters per year for WVDP, and 327 canisters per year for INEL). The total time for unloading the HLW canisters before shipment to the candidate repository is assumed to be performed at a rate of 800 canisters per year. The loading/unloading duration is dependent upon the shipping rate.

The quantities and timings shown in Chapter 9 were applied to the formulas C-1, C-2, and C-3, and totaled for each alternative under both sets of timing assumptions. The computation summaries are provided (INEL, 1996).

C.3.2.2.9 *Transportation of Vitrified HLW Canisters*

The rationale for costing transportation of HLW canisters between sites is provided in ANL (1996b). Based on numerous reports, there is general agreement that transportation costs for HLW would be similar in cost for spent nuclear fuel. The life-cycle cost for HLW transportation can, in general, be calculated by summing the following cost categories: shipping cost; security cost; cask, capital and decommissioning cost; cask maintenance cost; inspection cost; demurrage cost; handling cost (loading and unloading); and transportation support system costs.

The following assumptions were made for the HLW transportation cost analysis:

- The costs associated with the inspection cost category are included in the annual operating charges for the various HLW storage facilities.
- Demurrage (the charge for the detention of a freight car or truck by the shipper or receiver beyond the time allowed for loading, unloading, or shipping) is assumed to be negligible in comparison with other cost components.
- The handling cost for loading and unloading at the HLW storage facility has already been considered in the storage cost; the handling cost at the candidate repository is assumed to be out-of-scope for this PEIS.
- Transportation support system cost include the costs to maintain the railcars and trailers which are assumed to be negligible (average annual O&M cost for a truck trailer is approximately $14,000; for a rail car, $5,000).

Table C.3-2 presents the formulas used to compute truck and rail transportation costs.

C.4 Phase III: Environmental Impacts Evaluation

This section describes the scientific approach and analytical methods used to evaluate the impacts of the WM alternatives on air quality, water resources, ecological resources, the local and National economies and social environments, environmental justice issues, land use, infrastructure, and cultural resources.

The general impacts methods were applied as appropriate to analyze the effects of management alternatives for each of the five waste types. Construction and operation of treatment, storage, and disposal facilities and intersite transportation of wastes were the principal activities analyzed for impacts, as applicable (Table C.4-1) under each of the waste-type alternatives.

The engineering analysis Phase II output data served as the input data for the environmental impacts assessments. These engineering outputs included estimates of the costs, labor, and resources required to build and operate the WM facilities and estimated facility discharges of pollutants to air and water.

Air quality impacts were analyzed by comparing estimated pollutant increases to applicable standards for the Air Quality Control Region (AQCR) at each site. The analysis addressed criteria pollutants, airborne

Table C.3-2. Assumed Relationship for the Four Transportation Cost Components

Cost Variable	Relationship Assumed in This Study	
	Rail-Based	**Truck-Based**
SPEED (mph)	DIS/(0.04204 × DIS + 4)[a]	35 (i.e., a constant value)[b]
Annual Cask Requirement, ACR	$\sum$ {[(2 × DIS)/SPEED$_{rail}$]/24 + 2 × (5 days)}[c]	$\sum$ {[(2 × DIS/SPEED$_{truck}$]/24 + 2 × (3 days)}[c]
Shipping Cost, less than 1,000 miles (1985 dollars)	$\sum$ ([2.32 + 0.0067 × DIS] × 2,000) + ([2.15 + 0.0063 × DIS] × 1,800) × [No. of Canisters]/5[c,d]	$\sum$ ([1.493 + 0.0033 × DIS] × 500) + ([0.428 + 0.0034 × DIS] × 475) × [No. of Canisters][c]
Shipping Cost, greater than 1,000 miles (1985 dollars)	$\sum$ ([5.07 + 0.004 × DIS] × 2,000) + ([4.72 + 0.0037 × DIS] × 1,800) x [No. of Canisters]/5[c,d]	$\sum$ ([-0.16 + 0.0049 × DIS] × 500) + ([-0.19 + 0.004 × DIS] × 475) × [No. of Canisters][c]
Security Cost (1985 dollars)	$\sum$ {291.65 × [DIS$^{-0.5987}$] × DIS} × [No. Of Canisters]/5	$\sum$ {7.93 × [DIS$^{-0.1855}$] × DIS} × [No. of Canisters]
Cask Capital Cost (1985 dollars)[e]	$\sum$ (ACR/300) × [No. of Canisters] × (2.5 × 10^5)	$\sum$ (ACR/300) × [No. of Canisters] × (1.5 × 10^5)
Cask Maintenance Cost (1985 dollars)[f]	$\sum$ (ACR/300) × [No. of Canisters] × (2.5 × 10^4)	$\sum$ (ACR/300) × [No. of Canisters] × (1.5 × 10^4)

[a] DIS = distance traveled (one-way miles); is a function of WM PEIS alternative.
[b] Conservative value, based on DOE (1986); a value of 40 mph is cited in DOE (1991).
[c] The summations are to be performed over all shipping routes.
[d] Assumes five HLW canisters per rail shipping cask, one HLW canister per truck shipping cask (DOE, 1986).
[e] Assumes a capital cost of $2.5 million for rail cask, $1.5 million for truck cask (both in 1985 dollars) (DOE, 1986).
[f] Assumes an annual maintenance cost of $125,000 for rail cask, $75,000 for truck cask (both in 1985 dollars) (DOE, 1986).

radionuclides, and other hazardous and toxic air pollutants from construction and operation of WM facilities at each DOE site. Criteria pollutant increases from mobile (transportation) and stationary sources were evaluated, as applicable.

Water resources impacts were analyzed by evaluating the effects on natural water sources of the use or discharge of large volumes of water during construction or operation of WM facilities at each site. Water quality impacts were evaluated for hypothetical releases of waste, that could leach into groundwater the releases were assumed to come from deteriorating packages or containers in disposal facilities.

Table C.4-1. WM Actions Analyzed for Environmental Impacts

WM Action	Waste Type				
	LLMW	LLW	TRUW	HLW	HW
Treatment Facility Construction and Operation	✓	✓	✓		✓
Storage Facility Construction and Operation	✓[a]		✓	✓	
Disposal Facility Construction and Operation/(& Postclosure Effects)	✓	✓			
Transportation of Wastes Between Sites	✓	✓	✓	✓	✓
Waste Transport to Repository or Commercial Treatment/Disposal			✓	✓	✓

[a] For No Action Alternative only.

Ecological impacts were evaluated in terms of the potential for loss of habitat from site clearing for WM facility construction, indirect facility construction and operation effects on sensitive habitats, exposure of terrestrial species to airborne contaminants released from treatment facilities, and a scenario-based assessment of the consequences of releases of wastes to aquatic habitats in transportation accidents.

Economic impacts were analyzed by estimating employment and income increases in the regional economies supporting the DOE sites that might be caused by the infusion of funds to build and operate WM facilities. Impacts on the National economy were also assessed using the sum of all expenditures at all sites and for waste transportation under each waste-type alternative.

Population impacts were evaluated in terms of changes caused by the in-migration of workers in response to increased labor requirements for construction and operation of facilities.

An analysis of environmental justice considerations—disproportionate effects on minorities or low-income populations—discusses and displays the minority and poverty status of the populations at each WM site to highlight sites where those populations might be disproportionately affected by WM activities.

Land use impacts were evaluated by estimating the likelihood that building WM facilities at the sites under a WM alternative would require a commitment of land that might substantively alter the use of land at the site or that might require DOE to acquire additional land to implement the alternative. Conflicts with site development plans and current adjacent land uses were also considered.

Infrastructure impacts were evaluated by estimating the effects of building and operating WM facilities on site water supply, waste water treatment facilities, electrical power supply, and transportation infrastructure. Community infrastructure impacts were evaluated in terms of the estimated level of increased demand on community infrastructure caused by the influx of new labor and their families to support the WM projects.

The potential for cultural resources effects was considered comparatively in terms of the extent of construction site disturbance at each site under each alternative as an indicator of the requirement for cultural resources surveys that would be conducted at the site or project level. Impacts on cultural resources were not evaluated directly because the WM facility locations on each site are not yet proposed.

Environmental impacts considered in the PEIS, but not evaluated in detail, included effects on geology and soils, the noise environment, and visual resources. Those impacts are discussed in Chapter 5 of the PEIS.

All chemical and radiological discharges and direct radiation effects were estimated using computer models that simulate the fate and transport of contaminants in the environment. The computer models are described in the sections on air quality, water resources, and ecological resources. The models are further described in the facility risk appendixes (Appendices D and F) and the transportation risk appendix (Appendix E).

C.4.1 Human Health Impacts

C.4.1.1 Human Health Risk Assessment for Waste Treatment, Storage, and Disposal

Human health risk assessments were conducted for the construction and operation of treatment and storage facilities, for hypothetical individuals exposed downgradient of disposal facilities, for transportation of wastes, for accidents involving facilities at the sites, and for transportation accidents. Details of the human health risk assessment that estimated risks at the facilities resulting from routine construction and operation activities and from facility accidents are given in Appendix D. Details of the routine transportation and transportation accident risk assessments are given in Appendix E. Further details of the facility accident risks are given in Appendix F.

C.4.1.2 Population Risk Vulnerability Evaluation for LLMW and LLW Disposal

The objective of the population risk vulnerability analysis was to develop a basis for comparison of LLMW and LLW disposal alternatives using measures that characterize their relative potential to cause risks to offsite populations from groundwater contamination.

C.4.1.2.1 *Introduction*

Although maximally exposed individual (MEI) and population (or collective) risk estimations are both routinely used to characterize the potential health consequences of Federal agency actions, certain considerations led DOE to conclude that an alternative to collective risk estimation was needed for comparison of LLMW or LLW disposal alternatives in the WM PEIS.

First, other DOE efforts to address disposal risk do not generally estimate population risk. DOE has been addressing the issue of protecting the public from the effects of exposures to radioactive and mixed waste constituents released from disposal facilities. Ongoing Department efforts include performance assessments conducted for LLW disposal facilities in compliance with the requirements of DOE Order 5820.2A (DOE, 1988) and performance evaluations conducted for candidate LLMW disposal sites by the FFCAct Disposal Workgroup. Although these efforts currently address risks to single individuals at specified compliance points, they do not attempt to predict collective risks to current or future populations. A brief description of these efforts is provided in Section C.4.1.2.5.

Second, DOE determined that estimation of offsite population risk from exposure to disposal facility contaminants in the WM PEIS would require too many speculative assumptions and would not provide a credible basis for comparison of LLMW or LLW disposal alternatives. The concentrations of contaminants in the groundwater and the number of people potentially exposed will be determined in large part by the locations of the disposal units and the receptor wells. Estimation of the number of adverse health effects in current offsite populations would require information about the exact locations of the disposal facilities on the sites. Since the WM PEIS does not attempt to make such siting decisions, offsite population doses (e.g., person-rem) and risks (e.g., number of latent cancer fatalities) from disposal were not estimated. Analysis of future offsite population risks requires similar siting information and involves additional

uncertainty with respect to the sizes of future populations. Therefore, the WM PEIS could not credibly estimate adverse health impacts from disposal for future offsite populations.

Therefore, an alternative analysis methodology was needed for the WM PEIS to characterize the LLMW and LLW disposal alternatives that would utilize relevant information about the sites but that would not require quantitative estimates of collective dose and risk. This section describes the statistical methodology and data used to characterize the population risk vulnerability of the proposed disposal sites and to compare the population risk vulnerability of the disposal alternatives. The results of the analysis are presented in Chapters 6 and 7 of WM PEIS Volume I.

C.4.1.2.2 *Analytical Methods*

The two-part methodology consisted of (1) a factor analysis to identify the principal axes of variability of the site environmental data and relate those factors to population risk vulnerability and (2) a cluster analysis to identify distinct groups of sites on those principal axes.

C.4.1.2.2.1 Factor Analysis

Factor analysis is a statistical technique that can be used to identify a relatively small number of factors to represent relationships among a set of many interrelated variables (Norusis/SPSS Inc., 1993). The factors are derived to explain the observed correlations among the interrelated variables. The more highly correlated the original set of observations (cases) on the variables, the fewer factors are required to describe the relationships—that is, the more of the total variability in the data set can be represented by the first few derived factors. If the variables are completely uncorrelated, factor analysis will not provide a more compact explanatory solution than the original variables. A good factor solution is also interpretable. The factors can be interpreted as revealing underlying attributes of the variable set that can be readily described in broad terms.

Norusis/SPSS Inc. (1993) describe a four-step procedure for factor analysis:

1. Correlation matrix computation and factor model assessment
2. Factor extraction

3. Factor rotation
4. Factor score computation

In step 1, the interrelatedness of the variables is determined by examination of the simple Pearson correlation coefficients and some simple statistical tests of the correlation matrix to determine if a factor analysis is an appropriate technique to apply to the data set. In step 2, factors are extracted, usually initially by using principal components extraction, in which linear combinations of the variables are derived. These principal component vectors account in sequence for decreasing portions of the data variability and are independent of one another (orthogonal). The principal components may then be interpreted by the analyst as identifying a general underlying measure of the variables. In step 3, the initial factor solution is rotated to produce factors that are easier to interpret. In step 4, the factor scores for each case are computed by multiplying the original variable set by the principal components or rotated factors. These factor scores can be plotted to show how the different cases relate to each other in factor-space.

C.4.1.2.2.2 Cluster Analysis

Cluster analysis is a statistical technique used to identify relatively homogeneous subgroups or clusters from data on members of a larger population. Members of these subgroups can then be considered to share common characteristics and to be relatively distinct from other subgroups in terms of the important measured variables used to determine the clusters (Norusis/SPSS, Inc., 1993). Cluster analysis establishes groupings based on distance/nearness calculations for a set of specified variables. In the most commonly applied calculation method, clusters are derived by using squared Euclidean distances.

C.4.1.2.3 *Analysis Methods Applied to Population Risk Vulnerability of WM Disposal Sites*

C.4.1.2.3.1 Selection and Transformation of Explanatory Variables

The variables selected for use in the factor and cluster analyses of the 16 candidate disposal sites were six site characteristics that were considered likely to cause or be associated with future levels of offsite population risk from radioactive or mixed waste disposal: annual rainfall, annual groundwater recharge,

aquifer depth, travel time of water (from the time it infiltrates the ground surface to the time it reaches the aquifer and appears in a downgradient well), current human populations within 50 miles of the site, and site acreage (Table C.4–2). The first three variables, which characterize the surface and groundwater hydrology of the sites, are measures known to determine the speed, duration, and extent of dispersal of contaminants from disposal facilities and the level of resulting downgradient contaminant concentrations in groundwater. The estimates of travel time are based on the physical properties of the soils, the aquifer depth, and the groundwater velocity at each site. Current census population levels are considered the most appropriate measure of the potential size of the population at risk in the near term, at least on a relative basis from site to site. Site acreage provides an indirect measure of two associated characteristics — the size of the potential populations at risk and the likelihood that contaminants in downgradient groundwater would appear in a publicly accessible wellwater source. Site size is related to population size because the larger sites exclude population growth on extensive areas. Site size is related to groundwater contamination and exposure because of the relationship between the proximity of offsite population centers to locations on the sites where disposal facilities would be constructed. Data on annual rainfall, aquifer depth, current human populations within 50 miles of the site, and site acreage were taken from ORNL (1995c). Estimates of time of travel were made using environmental setting data on unsaturated and saturated soil zones for the 16 disposal sites provided in ORNL (1995c). Data on annual groundwater recharge was taken from SNL (1996). These site characteristics are generally strongly correlated with each other — for example, the smaller sites tend to be situated in regions of denser population with higher rainfall. Therefore, it was expected that the six variable measures could be represented by a limited number of principal factors that are composite measures of the important variations in the site characteristics.

Examination of the variable distributions (see, for example, Figures C.4–1 and C.4–2) showed that many were not normally distributed, so log transformations were performed to create a more linearized data set (Table C.4–3). These transformations ensure a more appropriate application of the statistical general linear model and, among other benefits, help minimize the tendency for larger measures to be unduly weighted in the factor solutions.

Table C.4–2. Environmental and Population Data Used to Group Disposal Sites in Terms of Population Risk Vulnerability

Site	Population Within 50 mi	Acreage	Annual Rainfall (cm)	Aquifer Depth (ft)	Annual Aquifer Recharge (ft/yr)	Time of Travel of Water to Downgradient Well (years)
ANL-E	7,939,785	1,025	80	90	0.33	246
BNL	5,738,554	5,263	107	200	0.50	59
FEMP	2,764,589	1,050	104	59	0.50	18
Hanford	377,645	370,656	16	236	0.16	191
INEL	153,061	572,160	23	600	0.23	298
LLNL	6,324,234	6,900	36	98	0.08	70
LANL	159,152	28,000	47	749	0.05	411
NTS	14,266	864,000	19	787	<0.001	1,352
ORR	895,379	34,560	139	26	0.60	11
PGDP	500,502	3,425	120	49	0.43	17
Pantex	265,185	16,000	51	320	0.02	175
PORTS	639,062	4,032	101	24	0.39	24
RFETS	2,171,877	6,550	38	18	0.16	25
SNL	610,714	2,791	20	94	0.06	132
SRS	620,618	192,700	122	110	1.30	23
WVDP	1,698,391	220	104	10	0.23	226

Notes: ANL-E = Argonne National Laboratory-East; BNL = Brookhaven National Laboratory; FEMP = Fernald Environmental Management Project; Hanford = Hanford Site; INEL = Idaho National Engineering Laboratory; LLNL = Lawrence Livermore National Laboratory; LANL = Los Alamos National Laboratory; NTS = Nevada Test Site; ORR = Oak Ridge Reservation; PGDP = Paducah Gaseous Diffusion Plant; Pantex = Pantex Plant; PORTS = Portsmouth Gaseous Diffusion Plant; RFETS = Rocky Flats Environmental Technology Site; SNL = Sandia National Laboratories; SRS = Savannah River Site; and WVDP = West Valley Demonstration Project.

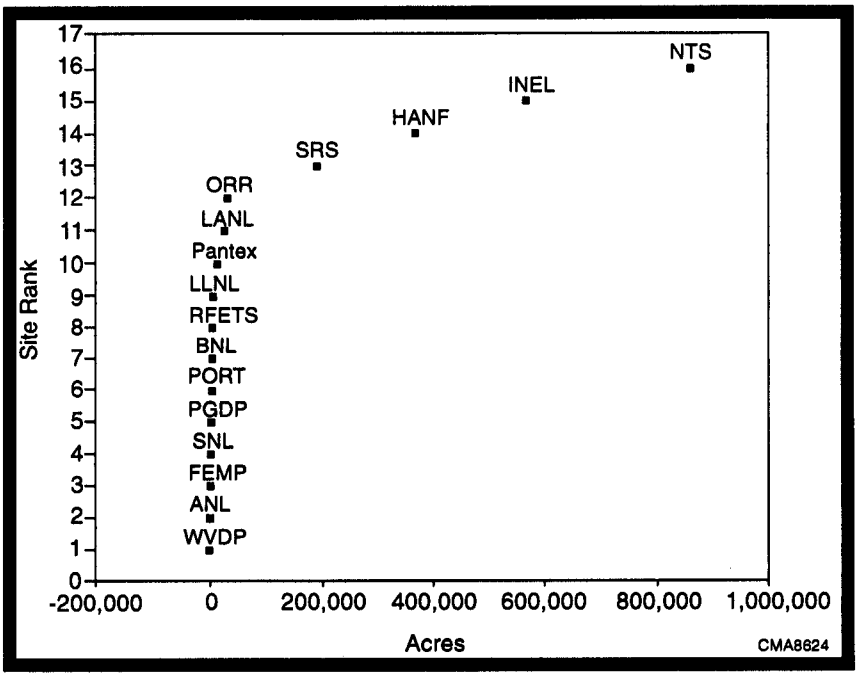

Figure C.4–1. Sites Plotted According to Increasing Acreage, Showing Nonlinearity in Data.

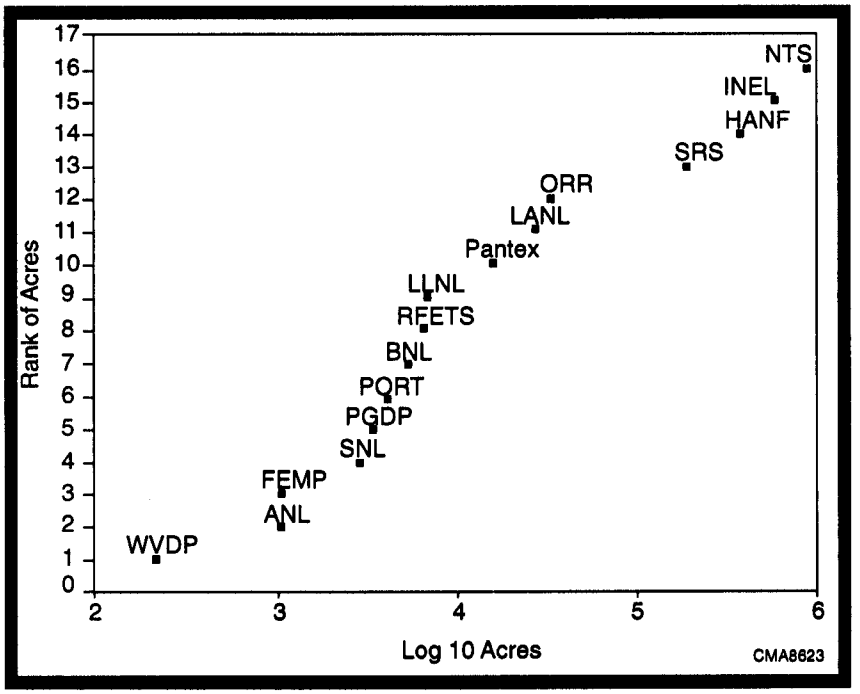

Figure C.4–2. Sites Plotted According to Increasing Site Acreage, Showing Applicability of Loglinear Transformation.

Table C.4–3. Transformed Environmental and Population Data Used to Categorize Disposal Sites in Terms of Population Risk Vulnerability

Site	log10 (Population in 50 mi)	log10 (Acreage)	log10 (Annual Rainfall [cm])	log10 (Aquifer Depth)	log10 (Recharge [m/yr])	log10 (Distance to Water)
ANL-E	6.90	3.01	1.90	1.95	-0.48	2.39
BNL	6.76	3.72	2.03	2.30	-0.30	1.77
FEMP	6.44	3.02	2.02	1.77	-0.30	1.25
Hanford	5.58	5.57	1.20	2.37	-0.80	2.28
INEL	5.18	5.76	1.36	2.78	-0.63	2.47
LLNL	6.80	3.84	1.56	1.99	-1.10	1.85
LANL	5.20	4.45	1.67	2.87	-1.30	2.68
NTS	4.15	5.94	1.28	2.90	-3.00	3.13
ORR	5.95	4.54	2.14	1.41	-0.22	1.03
PGDP	5.70	3.53	2.08	1.69	-0.37	1.22
Pantex	5.42	4.20	1.71	2.65	-1.69	2.24
PORTS	5.81	3.61	2.00	1.38	-0.41	1.37
RFETS	6.34	3.82	1.58	1.26	-0.80	1.40
SNL	5.79	3.45	1.30	1.97	-1.22	2.12
SRS	5.79	5.28	2.09	2.04	0.11	1.36
WVDP	6.23	2.34	2.02	1.00	-0.64	2.35

Notes: ANL-E = Argonne National Laboratory-East; BNL = Brookhaven National Laboratory; FEMP = Fernald Environmental Management Project; Hanford = Hanford Site; INEL = Idaho National Engineering Laboratory; LLNL = Lawrence Livermore National Laboratory; LANL = Los Alamos National Laboratory; NTS = Nevada Test Site; ORR = Oak Ridge Reservation; PGDP = Paducah Gaseous Diffusion Plant; Pantex = Pantex Plant; PORTS = Portsmouth Gaseous Diffusion Plant: RFETS = Rocky Flats Environmental Technology Site; SNL = Sandia National Laboratories; SRS = Savannah River Site; and WVDP = West Valley Demonstration Project.

C.4.1.2.3.2 Factor Analysis of Environmental Variables

C.4.1.2.3.2.1 Correlation Matrix Computation and Appropriateness of the Factor Model

Simple correlations among the transformed environmental variables were computed (Table C.4–4). Measures of the appropriateness of the factor model were computed, including Bartlett's test of sphericity, the Kaiser-Meyer-Olkin (K-M-O) overall measure of sampling adequacy, and individual measures of sampling adequacy. Bartlett's test gave a value of 50.61 with a significance of 0.00001, indicating that it is highly unlikely that the variables are uncorrelated. The K-M-O value of 0.64851 indicates that correlations between pairs of variables can be adequately explained by the other variables. The substantial degree of correlation shown between variables and the results of the appropriateness tests indicated that factor analysis would be a fruitful technique for investigation of the data.

Table C.4–4. Correlation Matrix of Transformed Environmental Variables

	Site Acreage	Aquifer Depth	Population in 50 mi	Annual Rainfall	Groundwater Discharge	Time of Travel
Site acreage	1.00000					
Aquifer depth	.67119	1.00000				
Population in 50 mi	-.70651	-.57654	1.00000			
Annual rainfall	-.52114	-.54939	.47536	1.00000		
Groundwater recharge	-.35054	-.55470	.64883	.66101	1.00000	
Time of travel	.32030	.66135	-50204	-.65108	-.73246	1.00000

C.4.1.2.3.2.2 Factor Extraction

The first principal component derived in the analysis (Table C.4–5) accounts for approximately 64% of the variability (information content) in the site characteristics data. It is a vector that substantially measures all six variables—the absolute values of the loadings (vector elements that, by vector multiplication, transform the original data set into the components) exceed 0.5 for all variables. It can be interpreted as accounting for the fact that the smaller sites are generally the sites with higher populations and wetter hydrologic conditions. These conditions include higher rainfall, a generally shallow water table, and a relatively short groundwater time of travel. The second principal component accounts for an additional 15% of the data variability but is not as readily interpretable. (The sites are plotted according to their scores on the first two principal components in Figure C.4–3.) Therefore, factor rotation was performed to derive factors that could be more satisfactorily interpreted.

C.4.1.2.3.2.3 Factor Rotation

The factor rotation technique selected for the analysis, oblique rotation, produces more easily interpretable factors in this instance, although the factors are not independent. The first two oblique factors (Table C.4–5)

Table C.4–5. First Two Principal Components of Site Environmental Variables and Rotated Factors Derived From Oblique Rotation of the Principal Components

	Principal Components		Rotated Factors	
Site Environmental Variables	**First PC**	**Second PC**	**First RF**	**Second RF**
Acreage	-.73202	.63199	.20112	1.07112
Aquifer depth	-.83433	.15024	-.37317	-.57330
Population within 50 mi	.80974	-.30622	.19267	-.73860
Rainfall	.80146	.21037	.73326	-.14784
Groundwater recharge	.82579	.37202	.91960	.02403
Time to travel to downgradient well	-.80913	-.44507	-.98616	-.11504

can be interpreted as (1) a site hydrology factor that is positively loaded on rainfall and groundwater recharge and negatively loaded on time of travel of water to a downgradient well, and (2) a general site characteristics factor that might be described as the "small, shallow water table, high population" factor. The factors have a correlation of -.58603; sites that have higher scores on oblique factor 1 tend to have lower scores on oblique factor 2.

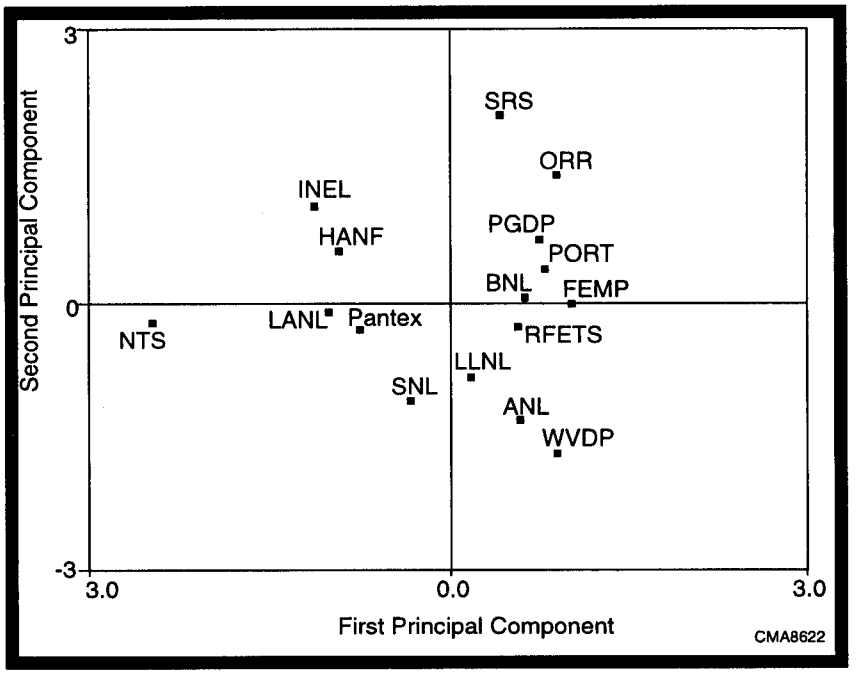

Figure C.4–3. Sites Plotted According to Their Scores on the First Two Principal Components of the Environmental Data.

C.4.1.2.3.2.4 Oblique Factor Scores

Sites are plotted according to their scores on the first two oblique factors in Figure C.4–4. To provide a more understandable presentation of the rotated factors, the site scores on the second oblique factor were reversed (multiplied by negative 1) before being plotted in the oblique factor diagram. Sites to the right in the diagram have higher scores on the first factor, indicating that they have groundwater hydrologic conditions that would tend to move contaminants more quickly downgradient from disposal units and possibly to drinking water wells that might be used by the public. Sites to the left in the diagram are those where site characteristics would tend to limit migration of contaminants and increase the time over which any movement might result in wellwater contamination. In terms of scores on the second factor, sites plotted in the upper portion of the diagram are those that are smaller in size with higher surrounding populations. Those plotted lower are the larger sites with lower surrounding populations. Land uses on and near the sites, the site size itself, and the size of the surrounding populations are more likely to change substantially during the time contaminants may be leaching from disposal units than are the physical characteristics of the site. Therefore, DOE considers the first factor scores more important than the second factor scores in characterizing the sites' relative potentials for offsite population risk.

C.4.1.2.3.3 Derivation of Population Risk Vulnerability Groups

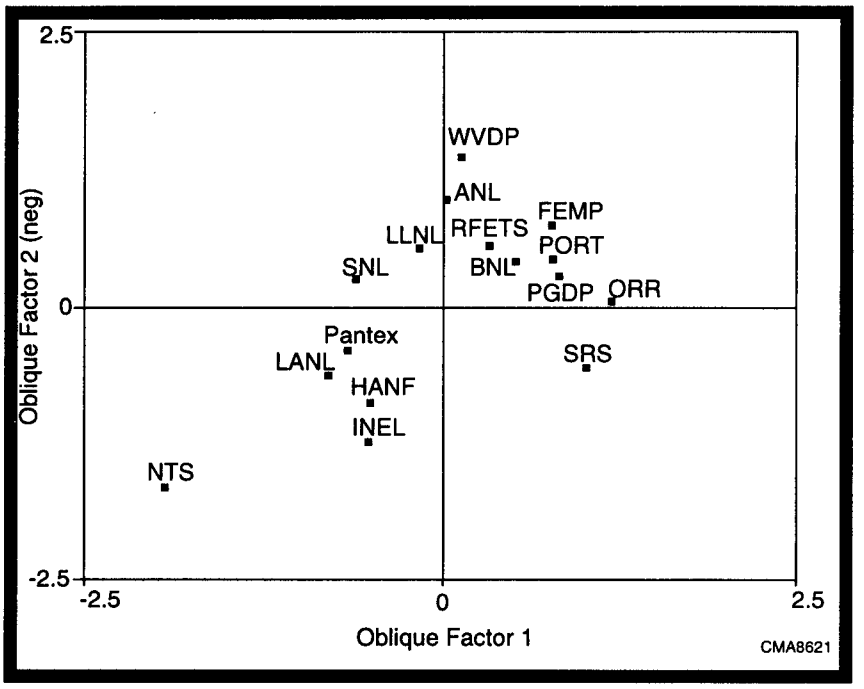

Figure C.4–4. Sites Plotted According to Their Scores on the First Two Oblique Factors of the Environmental Data.

The factor analysis provides a general indication of the relative population risk vulnerability of the 16 proposed disposal sites. The factor scores of the 16 sites show relationships among the sites in hydrologic and population characteristics that would be reasonable to conclude would be directly related to the levels of population dose and risk. DOE further identified distinct groups of sites representing similar levels of potential for population risk from waste disposal. The sites were grouped using a cluster analysis of the same six site characteristics.

In the cluster analysis, DOE used the site environmental data on the six variables to calculate measures of overall difference among the 16 sites. These difference measures were used to extract clusters of sites by combining sites with generally similar characteristics. The difference measures are greater between clusters than they are for sites within a cluster. By labeling the factor plots with the cluster membership of each site, distinct risk vulnerability groupings were identified. A dendrogram (Figure C.4–5) illustrates the combining of the sites into a decreasing number of clusters on the basis of the squared-Euclidean distance method applied to the standardized variables until all 16 sites are combined. A set of five clusters was derived for the population risk vulnerability analysis. Reading of the dendrogram from left to right as sites are successively linked, the last five clusters derived were used in the population risk vulnerability analysis. Two of the five clusters combine ANL, BNL, LLNL, RFETS, and SNL in Cluster 1 and combine FEMP, ORR, PGDP, PORTS, and SRS in Cluster 2. Hanford, INEL, LANL, and Pantex are linked as Cluster 3. NTS and WVDP are distinct enough to remain as separate Clusters 4 and 5. Sites are arrayed by cluster number in Figure C.4–6.

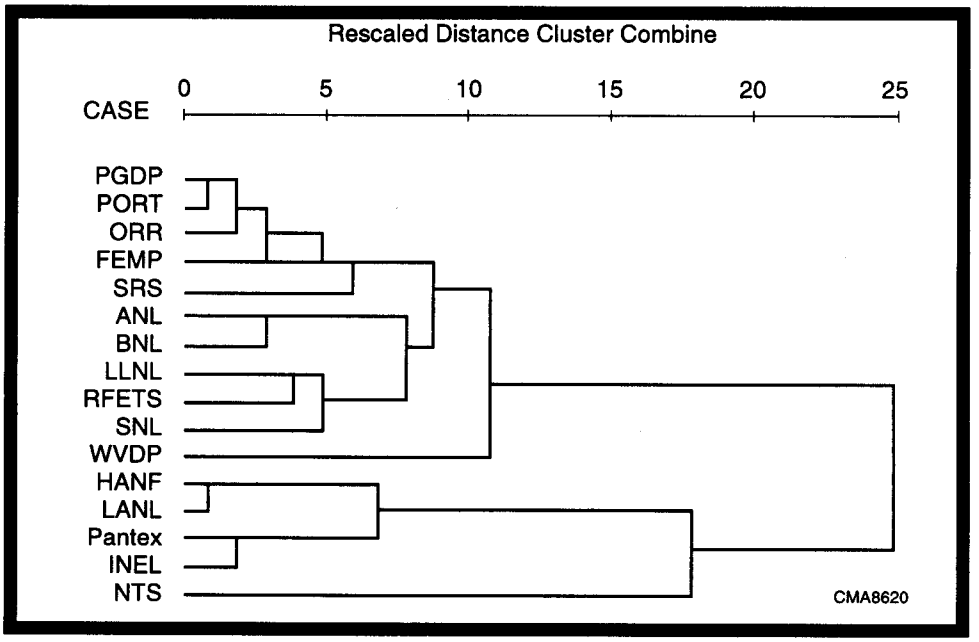

Figure C.4–5. Dendrogram Illustrating Derivation of Site Clusters From Environmental Data.

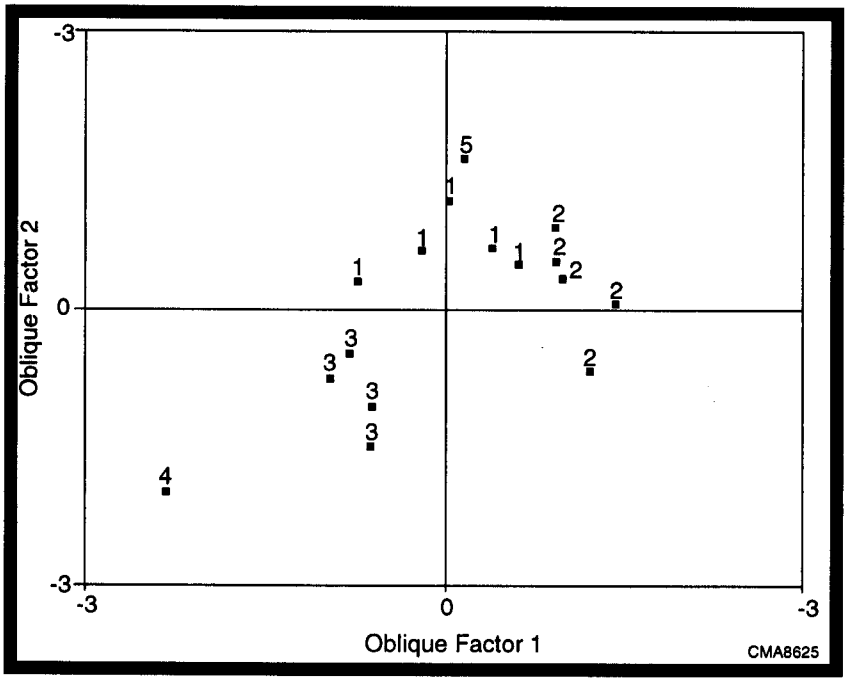

Figure C.4–6. Sites Arrayed by Cluster Number According to Their Scores on the First Two Oblique Factors of the Environmental Data.

The cluster analysis was used to identify three general site groups according to their expected relative population risk vulnerability. The single-site clusters (4 and 5) were combined with their nearest neighbor clusters. The resulting groups were renumbered to indicate higher (3), intermediate (2), and lower (1) relative population risk vulnerability. The groups are listed with the basis of their relative population risk vulnerability ratings in Table C.4–6.

C.4.1.2.4 *Comparison of LLMW and LLW Alternatives by Population Risk Vulnerability*

LLMW and LLW disposal alternatives were arrayed in terms of greater or lesser potential for population risk based on the population risk vulnerability designation of the sites proposed for disposal under each alternative and the waste volume, curie load, and number of disposal units required at those sites. LLMW

Table C.4–6. Interpretation of Site Clusters in Terms of Relative Potential for Offsite Population Risk From Disposal

Population Risk Vulnerability Group Number	Relative Offsite Population Risk Level	Original Cluster Number	Sites in Cluster	Scores on Oblique Factors	
				Hydrology	Site Size/Population
3	Higher	2	FEMP, ORR, PGDP, PORTS, SRS	High	Intermediate
2	Intermediate	5	WVDP	Intermediate	Highest
		1	ANL, BNL, LLNL, RFETS, SNL	Low to Intermediate	Intermediate to High
1	Lower	3	HANF, INEL, LANL, Pantex	Low	Low to Intermediate
		4	NTS	Lowest	Lowest

Notes: ANL = Argonne National Laboratory; BNL = Brookhaven National Laboratory; FEMP = Fernald Environmental Management Project; Hanford = Hanford Site; INEL = Idaho National Engineering Laboratory; LLNL = Lawrence Livermore National Laboratory; LANL = Los Alamos National Laboratory; NTS = Nevada Test Site; ORR = Oak Ridge Reservation; PGDP = Paducah Gaseous Diffusion Plant; Pantex = Pantex Plant; PORTS = Portsmouth Gaseous Diffusion Plant; RFETS = Rocky Flats Environmental Technology Site; SNL = Sandia National Laboratories; SRS = Savannah River Site; and WVDP = West Valley Demonstration Project.

and LLW alternatives were then summarized in terms of the total waste volume, curie load, and number of disposal units required at all sites within each population risk group. Those alternatives with greater volume, curie load, and number of disposal units at group 3 sites could generally be considered to represent a relatively greater risk to populations than alternatives that concentrate disposed wastes at group 1 and 2 sites. From a population risk perspective, alternatives that concentrate disposed wastes at group 1 sites would represent the lowest risk.

C.4.1.2.5 *Disposal Analyses Conducted for DOE*

As a basis for analysis of radiological waste disposal, DOE issued Order 5820.2A (DOE, 1988), which requires DOE to dispose of all LLW and LLMW in a manner that ensures protection of the health and safety of the public.

DOE Order 5820.2A (DOE, 1988) contains policies, guidelines, and minimum requirements established by DOE for managing its radioactive waste, mixed waste, and contaminated facilities. Chapter III of this order is applicable to the management of LLW. The specific performance objectives set forth in this order state that DOE LLW that has been disposed of after issuance of the order shall be managed in a way that achieves the following goals:

- Protect public health and safety in accordance with standards in applicable environmental health orders and other DOE Orders.
- Ensure that external exposure to the waste and concentrations of radioactive material that might be released into surface water, groundwater, soil, plants, and animals results in an effective dose equivalent (EDE) that does not exceed 25 mrem/yr to any member of the public. The EDE is the sum of the products of the dose equivalent received by specific tissues of the body and tissue-specific weighting factors. The sum is a risk equivalent value and can be used to estimate health effects to the exposed individual. The EDE includes the CEDE (committed effective dose equivalent) from internal deposition of radionuclides and the EDE from penetrating radiation from sources external to the body. Reasonable efforts should be made to maintain radioactive releases in effluents to the environment as low as is reasonably achievable (ALARA).
- Ensure that the CEDE received by individuals who inadvertently intrude into the facility after the loss of institutional control (100 years) will not exceed 100 mrem/yr for continuous, chronic exposure or 500 mrem for a single acute exposure.

- Protect groundwater resources consistent with federal, state, and local requirements.

As indicated above, DOE Order 5820.2A provides general guidelines on how to safely dispose of LLW; however, the order does not specify (1) a time period over which they are to be applied; (2) a point of compliance; (3) which federal, state, and local requirements would be used to demonstrate that groundwater resources were adequately protected; or (4) the time and the number of people required for calculating a population dose.

C.4.1.2.5.1 Comprehensive Performance Assessments

A number of approaches have been used to demonstrate compliance with DOE Order 5820.2A. Some of these approaches have been documented in performance assessments (PAs) (systematic analyses of the potential risks posed by waste management systems to the public and environment, with a comparison of these risks to established performance objectives) of LLW management complexes (Martin Marietta, 1994; Maheras et al., 1994; Magnuson et al., 1993).

In general, the PAs derive radiological performance objectives from a combination of DOE Orders (including Order 5820.2A) and other guidance, as well as EPA regulations.

In demonstrating compliance with a combination of DOE Orders and other guidance, as well as EPA regulations, the PAs used three time periods of interest: the operational period (period of time that the facility is in operation), the institutional control period (period of time after closure in which institutional control is maintained for the facility, usually 100 years after the end of operations), and the postinstitutional control period (extending from the end of institutional control to 10,000 years in the future). If the maximum impact occurred after 10,000 years, analyses were also performed and evaluated at the time of maximum risk. EDE calculations for these times were performed at two distances: a point on the site boundary in the direction of groundwater flow downstream of the source (operational and institutional control periods), and a point 100 m downstream of the source (postinstitutional control).

Compliance with protecting the quality of groundwater is demonstrated in the PAs by showing that predicted contaminant concentrations are within guidelines specified by the EPA in the Safe Drinking Water

Act (40 CFR 141; EPA, 1991a). This compliance is usually demonstrated by showing that contaminant concentrations are below specified maximum concentration limits (MCLs) or proposed MCLs.

In addition to demonstrating compliance by showing that contaminant concentrations are below their associated MCLs, EPA's 40 CFR 141 requires that the EDE for a drinking water system (well that has at least 15 connections and serves 25 people) be below 4 mrem/yr. During operations, this well is assumed to be located at the site boundary, directly downgradient of the contaminated source. For the postinstitutional control period (10,000 years), the well is assumed to be located 100 m downgradient of the source. In either case, compliance is demonstrated by calculating the appropriate EDE, even if there is no drinking water system in place at the site.

C.4.1.2.5.2 Disposal Workgroup Performance Evaluations

Because mixed waste has a hazardous chemical component, it must be treated in compliance with land disposal restrictions (LDRs) of the Resource Conservation and Recovery Act. Because of a lack of sufficient capacity and available technologies to treat this type of waste, the Federal Facilities Compliance Act (FFCAct) of 1992 requires the Secretary of Energy to develop and submit site treatment plans (STPs) for the development of treatment capacity and technologies for treating mixed waste for each facility at which the DOE stores or generates these wastes.

Although the FFCAct does not specifically require addressing mixed waste disposal, the DOE and the States realized that the method of treatment for a specific waste is an integral component of any considerations for its ultimate disposal (Waters et al., 1996). In June 1993, DOE established the Disposal Workgroup (DWG) to work with the States to define and develop a process for evaluating LLMW disposal options. In particular, the DWG sponsored performance evaluations (PEs) at each of 15 sites (Lawrence Livermore National Laboratory, Rocky Flats Environmental Technology Site, Idaho National Engineering Laboratory, Argonne National Laboratory, Paducah Gaseous Diffusion Plant, Nevada Test Site, Los Alamos National Laboratory, Sandia National Laboratories-New Mexico, West Valley Demonstration Project, Fernald Environmental Management Project, Portsmouth Gaseous Diffusion Plant, Savannah River Site, Oak Ridge Reservation, Pantex Plant, and the Hanford Site) to quantify and compare the limitations of these sites for the disposal of LLMW (Waters et al., 1996).

For purposes of analysis and comparison, the PE teams used three primary performance measures consistent with DOE Order 5820.2A and EPA's 40 CFR 141. These performance measures are:

- 4-mrem/yr EDE from the drinking water pathway for releases to groundwater
- 10 mrem/yr for atmospheric releases
- 100 mrem/yr from all exposure pathways for chronic, long-term exposure to inadvertent intruders

For consistency, all of the calculations were performed at a performance boundary that was 100 m from the edge of the disposal facility, and all performance measures were applied for 10,000 years after disposal. This approach for demonstrating compliance is very similar to the methodology used for the comprehensive PAs. As with the PAs, the PEs do not attempt to calculate population dose.

C.4.1.2.5.3 Composite Analysis of Interacting Source Terms

In April 1996, DOE issued guidance (DOE, 1996b) on how to perform a "composite analysis" that is required by DOE pursuant to the Recommendations 94-2 from the Defense Nuclear Facilities Safety Board (DNFSB, 1994) and by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This analysis relates to LLW disposal facilities. The composite analysis is intended to supplement PAs required by DOE Order 5820.2A or risk assessments required by CERCLA.

The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from the active or planned LLW disposal facility and other sources of radioactive material in the ground that may interact with the LLW disposal facility. The projected total dose to a hypothetical future member of the public (receptor) from these sources will be compared with the DOE primary dose limit of 100 mrem/yr plus ALARA (as low as reasonably achievable) as set forth in DOE Order 5400.5 and proposed rule 10 CFR 834.

Under either of two conditions, an options analysis to identify alternatives for reducing future doses to tolerable limits is required. These conditions are (1) the calculated dose to the receptor exceeds the 100-mrem primary annual dose limit; or (2) the calculated dose exceeds a significant fraction of the dose limit, which is taken as 30 mrem/yr. The time of assessment is taken as 1,000 years.

The options analysis involves an ALARA process to assess cost-beneficial ways of reducing dose. The guidance discusses ways of applying an ALARA process and when an expensive, quantitative ALARA process is justified. The criterion is whether the cost of the ALARA review of alternatives is a small fraction (20%) of the monetary valuation of a possible dose reduction.

In using this criterion, the guidance suggests that the estimate of collective dose be conservative but reasonably realistic. It describes a reasonable screening process as considering the average dose from the groundwater pathway at the point of assessment to a number of individuals who might be considered to be at that point, such as the number of persons using water from a public drinking water supply system at the point of assessment. The guidance discusses that the point or points of assessment need not be in the immediate vicinity of the waste. A point of assessment should be a location where the public could be expected to have access based on future land-use plans (or conservative assumptions) and that is downgradient from the facilities that would release radioactivity to the ground.

The guidance provides that only options that could significantly reduce the dose should be considered in detail in the options analysis. Control or mitigation alternatives that might be considered include refining the analysis to reduce conservatism, improving the design of the LLW disposal facility, limiting the receipt of waste to be disposed of in the LLW disposal facility, requiring waste form performance for the waste to be disposed of at the LLW disposal facility, remediating the other sources of existing contamination, and optimizing the long-term land-use boundary. In an extreme case, termination of disposal in the LLW disposal facility may be considered. The options analysis should identify the preferred action and justify the choice based on the cost benefit analysis conducted, the level of uncertainty inherent in the composite analysis, and other relevant factors. When the 100-mrem annual dose limit is exceeded, the No Action Alternative is not acceptable.

To summarize, collective dose to a population from disposal plays a conditional role in a composite analysis. If the estimated dose to a hypothetical future member of the public does not exceed 30 mrem/yr, computation of a collective dose is not recommended. If the 30-mrem/yr value is exceeded, then the collective dose should be estimated.

C.4.2 AIR QUALITY IMPACTS

Air quality impacts were determined for pollutant-emitting activities associated with managing each of the five waste types: LLMW, LLW, TRUW, HLW, and HW. Air quality impacts were assessed for the construction of new treatment, storage, and disposal facilities; for the O&M of the facilities; and for shipment of wastes between sites. Air quality impacts were analyzed only for those pollutants for which emissions estimates were provided. The following sections describe in detail the methods used to estimate the air quality impacts for each WM alternative.

C.4.2.1 Air Quality Impacts Analysis Methods

Air quality impact assessments predict the consequences in terms of deterioration in air quality at off-site locations resulting from the release of contaminants from various categories of pollutant sources. This PEIS evaluated the potential for any of the alternative WM actions to lead to deterioration of local or regional air quality at any of the sites. The analysis also evaluated the potential for the actions across sites, in combination with pollutants emitted in the waste transportation corridors, to lead to deterioration of National air quality.

C.4.2.1.1 *Air Pollutants Considered*

The air quality impacts analysis estimated the air emissions for WM facility construction and O&M activities. O&M activities include waste treatment, storage, disposal, and transportation of waste. Estimates were made for each action for four classes of air pollutants: (1) the criteria air pollutants regulated under the National and State Ambient Air Quality Standards (NAAQS and AAQS), (2) radionuclides and other Hazardous Air Pollutants (HAPs) regulated under the National Emissions Standards for Hazardous Air Pollutants (NESHAP),

Major Types of Air Pollutants

***Criteria Air Pollutants**: Carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than 10 microns in diameter (PM_{10})*

***Hazardous Air Pollutants:** 189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

***Toxic Air Pollutants**: Other toxic compounds regulated by EPA and state or local governments*

***Ozone Depleting Substances**: Certain man-made halocarbons (including CFCs, halons, carbon tetrachloride, and 1,1,1-trichloroethane) whose manufacture and use is regulated by EPA under the Clean Air Act.*

and (3) other types of toxic air pollutants (TAPs), which are regulated by some states, and (4) ozone depleting substances (ODS), such as chlorofluorocarbons (CFCs) and halons. The analysis evaluated air quality impacts qualitatively from stationary sources and transportation sources for the first three classes of pollutants. ODS impacts are discussed qualitatively, but their emissions were not quantified.

Criteria pollutants consist of the six substances regulated by EPA (40 CFR 50) for which NAAQS have been established under the Clean Air Act (CAA): carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter < 10 microns (PM_{10}). They are regulated both in terms of annual production in tons per year and in terms of ambient concentrations emanating from point and mobile sources. In addition to national criteria pollutants, certain states have adopted state-regulated criteria pollutants. The state-adopted criteria pollutants are listed in the *Technical Report on Affected Environment*, Volumes I and II, for each of the DOE sites (DOE, 1995b). Unlike the other five criteria pollutants, ozone is not a direct emission but is formed in the atmosphere through a complex reaction of ozone precursor pollutants, sunlight, and temperature.

Ozone precursor pollutants include nitrogen oxides (NO_x) and nonmethane hydrocarbons. The analysis of ozone impacts was done by evaluating NO_x and volatile organic compounds (VOCs) emissions as criteria pollutants.

Hazardous air pollutants include 189 substances listed in Section 112 of the CAA of 1990 (42 USC 7401 *et seq.*), as amended through May 1992, whose emissions standards are regulated by the NESHAP in 40 CFR 61. In particular, HAPs include cancer-causing agents such as arsenic, benzene, carbon tetrachloride, and formaldehyde, as well as materials with noncancer health hazards, such as fluoride, ammonia, and hydrochloric and sulfuric acids. EPA regulates radionuclides as a total annual dose limit (10 mrem/yr) from the air pathway under the NESHAP (40 CFR 61). *Radionuclides* are also regulated by the DOE (DOE, 1990; 1993b) as a total annual dose limit (100 mrem/yr).

Toxic air pollutants include cancer causing agents and compounds with noncancer health hazards. These substances are regulated by the EPA, and on a state or local basis, through allowable ambient standards or guidelines.

Ozone depleting substances are certain man-made halocarbons, including CFCs, halons, carbon tetrachloride, and 1,1,1-trichloroethane, that react in the upper atmosphere to deplete the stratospheric

ozone layer. These compounds are regulated through the CAA and by the Montreal Protocol on Substances that Deplete the Ozone Layer.

Subsequent to December 6, 1995, HW and LLMW facilities are subject to the requirements of RCRA regulation 40 CFR Part 264, subpart AA, regarding air emission standards from process vents, and subpart BB, regarding air emission standards for process leaks. Compliance with the requirements of 40 CFR Part 264, subpart CC, regarding air emissions of volatile organic compounds from tanks, surface impoundments, and containers, was deferred until June 6, 1996 (60 FR 56952).

C.4.2.1.2 *Air Quality Impacts Analysis Procedures*

The air quality impacts analysis varied according to the pollutant classes and emissions sources expected to be important in each WM activity. Different analytical assumptions and techniques were used to best estimate the amounts of pollutants that could be emitted by each source. A summary of the air quality impacts that were evaluated in the PEIS is shown in Table C.4–7.

C.4.2.1.2.1 Analytical Approach for Different Pollutant Classes

For the air quality impacts analysis, stationary-source and area-source emissions were modeled and simple vehicular emissions factors were used to estimate mobile-source emissions for worker vehicle trips and waste transportation activities under each alternative.

C.4.2.1.2.1.1 Comparisons With Emission-Based and Concentration-Based Standards

The analysis of criteria pollutants varied according to the attainment status of a site's Air Quality Control Region (AQCR) for each pollutant. Annual emissions of the criteria pollutants from sites located in attainment areas were estimated for comparison with the allowable increment levels established in the Prevention of Significant Deterioration (PSD) regulations (40 CFR 52.21). The PSD allowable increments,

Table C.4-7. Impacts Evaluated for Air Quality

Impacts Assessed	Relevant Waste Types	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Presentation of Results
Criteria Air Pollutant Emissions	All five waste types	Construction	Use of construction equipment and worker vehicles	Percent of tons/year standard	Tabular or text discussion
		Operations	Operation of incinerators, fuel use by all other WM facilities, worker vehicles, and waste shipment vehicles, where applicable	Percent of tons/year or concentration standard	Tabular or text discussion
Radionuclide Emissions	LLMW, LLW and TRUW[a,c]	Operations[b]	Operation of WM treatment, storage and disposal facilities, where applicable	Percent of dose standard	Tabular or text discussion
Hazardous and Toxic Air Pollutant Emissions	LLMW, TRUW and HW[c]	Operations[b]	Operation of WM treatment, storage and disposal facilities, where applicable	Percent of concentration standard	Tabular or text discussion

[a] Emissions of radionuclides from HW are assumed to be negligible.
[b] Emissions assumed to be negligible during construction.
[c] Emissions of radionuclides and other hazardous and toxic air pollutants from storage of vitrified HLW are assumed to be negligible due to the physical form of the waste. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals, such that releases to the atmosphere are negligible.

in tons per year, regulate stationary-source emissions and do not include mobile-source emissions such as those from automobiles. Criteria pollutant emissions from sites located in nonattainment areas were estimated for comparison with the General Conformity Rule (GCR) guidelines *de minimis* levels, in tons per year (40 CFR 93). The GCR guidelines regulate both stationary-source and mobile-source emissions.

Ambient concentrations of the criteria pollutants were estimated for comparison with the NAAQS and State AAQS. Concentrations of the HAPs (including radionuclides) and TAPs were estimated to compare with the EPA or State ambient allowable limits (AALs).

C.4.2.1.2.1.2 Stationary-Source Estimates From Human Health Risk Modeling

In the analysis of air quality impacts from stationary-source emissions, it was assumed that ambient concentrations of criteria, hazardous, and radioactive pollutants would increase according to estimated emissions from treatment, storage, and disposal facilities and that the most conservative estimates of those increases would be the estimates of concentrations that the maximally exposed individual (MEI) would be subject to in the human health risk assessment done for this PEIS (ORNL, 1995a). Therefore, the air quality impacts analysis of stationary-source emissions used data on emissions, airborne transport and fate, and MEI doses assembled for the human health risk assessment to evaluate air quality effects. This is a conservative approach that will result in overestimating air quality impacts because the MEI doses from the health risk assessment include ingestion of farm products in addition to direct inhalation. The air quality impacts analysis used modeled estimates of local stationary-source ambient concentrations for hazardous and toxic air pollutants by waste type. Radionuclide data were taken directly from the offsite MEI doses estimated in the human health risk assessment.

C.4.2.1.2.1.3 Transportation Source Assumptions

In the air quality analysis, it was assumed that transportation sources (mobile-sources) may be an important source of criteria pollutant emissions in addition to those emanating from the facilities. Transportation sources were not expected to contribute significantly to hazardous (including radioactive) and toxic airborne contaminants in routine operations. Therefore, for criteria pollutants only, the analysis estimated local transportation-source annual tonnage of criteria pollutants, intersite transportation annual tonnage of criteria pollutants, and a national annual tonnage of criteria pollutants from all activities proposed under each alternative.

C.4.2.1.2.2 Emissions Estimation Techniques

Details of the estimation methods for construction-phase and operations-phase air emissions are presented in this section.

C.4.2.1.2.2.1 Construction-Phase Air Emissions Estimates

Emissions due to construction activities were calculated using estimates the amount of fuel used by construction equipment, and by construction workers traveling to and from the work site.

Construction Equipment Fuel Use. Fuel use in gallons of liquid fuel for the construction of WM facilities (as described in Section C.3) were used to calculate annual emissions for the WM alternatives, in tons per year, for the criteria pollutants CO, NO_2, SO_2, PM_{10}, and ozone (as NO_x and VOCs).

The fuel use values were divided by the WM alternative construction period (in years) to obtain an annual fuel usage in gallons. For the assessment of air emissions it was assumed that diesel fuel was used to operate construction equipment at the site. Emission rate factors, in pounds per gallon of fuel consumed, were obtained from *Compilation of Air Pollutant Emission Factors, Volume II, Mobile Sources*, also known as AP-42 (EPA, 1985a). The gallons of fuel used were multiplied by the pounds of pollutant per gallon consumed to obtain the annual emissions in pounds per year. This amount was divided by 2,000 pounds per ton to obtain the annual tons emitted for each of the criteria pollutants.

Worker Vehicle Fuel Use. The total number of FTEs for the construction period (as described in Section C.3) was divided by the construction period in years to obtain the total number of annual workers for each site and alternative combination. In order to provide an upper bound on air quality impacts, it was assumed that each construction worker travels to and from the construction site in a single vehicle, and that no employees carpool.

Vehicle emissions rates for the worker vehicle trips were obtained by running the EPA-approved vehicle emissions models Mobile5a (EPA, 1994a) and PART5 (EPA, 1994b). Emissions from the Mobile5a model were calculated in grams of pollutant emitted per vehicle mile traveled (VMT) for the pollutants CO, NO_2, and VOC. The PART5 model calculated PM_{10} emissions from vehicle exhaust in grams of pollutant emitted per VMT. For local impacts, it was assumed that the worker vehicles traveled 20 miles to and from work or 40 miles round trip each day. The total number of worker trips per day was multiplied by 40 miles per day and then by 240 working days per year to obtain the VMT per year. The annual VMT was then multiplied by the Mobile5a and PART5 emission rate factors in grams of pollutant per VMT to obtain the total number of grams emitted per year for the criteria pollutants CO, NO_2, VOC, and PM_{10}. The annual

emissions in grams were then multiplied by 0.0022 pounds per gram and divided by 2,000 pounds per ton to obtain the annual emissions for worker vehicles in tons per year.

C.4.2.1.2.2.2 Operations-Phase Air Emissions Estimates

The impacts to air quality from the operation and maintenance of WM treatment, storage, and disposal facilities were determined by calculating the emissions from facility fuel use, incineration of waste, transportation of waste, and worker vehicle trips to and from the sites.

Waste Management Fuel Use. Facility fuel use values during the operation period of WM facilities were supplied in pounds of natural gas and gallons of liquid fuel. These fuel use values were used to calculate annual emissions for the WM Alternative, in tons per year, for the six criteria pollutants at each site under each alternative.

The fuel use values were divided by the WM alternative period (in years) to obtain an annual usage for both natural gas, in pounds, and liquid fuel, in gallons. It was assumed that both classes of fuel were burned in an industrial boiler to produce heat and steam for the WM facilities. Emission characteristics for the burning of No. 4 fuel oil, with an assumed sulfur content of 1%, were used to represent the liquid fuel.

Emission rate factors in pounds per million cubic feet for natural gas and pounds per 1,000 gallons of liquid fuel for No. 4 fuel oil were obtained from the *Compilation of Air Pollutant Emission Factors, Volume I Stationary Sources* (AP-42) (EPA, 1985b). The estimates of natural gas use, in pounds, were divided by a natural gas density of 0.0448 pounds per cubic foot to obtain a total number of cubic feet. The total number of cubic feet was then divided by 1 million to obtain the number of million cubic feet used. The number of million cubic feet used was multiplied by the pollutant emission factor, in pounds per million cubic feet, to obtain the amount of pollutant emitted in pounds per year. The total annual pounds emitted was divided by 2,000 pounds per ton to obtain the annual tons emitted for each of the six criteria pollutants.

Direct Emissions From Incinerators: Criteria Pollutants. Criteria pollutant emissions from incineration of waste were calculated for annual emissions, in tons per year, and in parts per million or micrograms per cubic meter. The annual emissions were calculated using waste volumes for treatment and pollutant emission rate data. The emission rate data were supplied for each of the six criteria pollutants in grams of

pollutant emitted per kilogram of waste incinerated. The kilograms of waste incinerated per year were multiplied by the grams of pollutant per kilogram of waste treated to obtain the total amount of pollutants emitted in grams per year. The total grams emitted per year were multiplied by 0.0022 pounds per gram and then divided by 2,000 pounds per ton to obtain the total amount of pollutant emissions in tons per year.

Ambient concentrations of the criteria pollutant emissions were calculated by obtaining the annual emissions in grams per year, as described above, and dividing by the period of incineration operation, in seconds per year, to obtain a pollutant emission rate in grams per second. The annual emission rate in grams per second was multiplied by the highest off-site receptor concentration obtained from dispersion modeling. The dispersion model used was the EPA-approved Industrial Source Complex Long-Term Dispersion Model, Revision 2 (EPA, 1987). The model was run using an emission rate of one gram per second to produce annual receptor concentration values in micrograms per cubic meter per one gram per second ($\mu g/m^3/g/s$). To obtain a new concentration value for a different emission rate, the normalized concentration was multiplied by the new emission rate; the new concentration value was in micrograms per cubic meter ($\mu g/m^3$). The new annual concentration was divided by averaging period persistence factors, obtained from the EPA document *Air/Superfund National Technical Guidance Study Series, Screening Procedures for Estimating the Air Impacts of Incineration at Superfund Sites* (EPA, 1992a), to produce short-term concentrations for different averaging periods. These concentration values were compared to the NAAQS or State AAQS pollutant specific averaging periods as appropriate.

Direct Emissions From Incinerators: Hazardous and Toxic Air Pollutants. Annual exposure concentrations of HAPs and TAPs, in $\mu g/m^3$, to the off-site MEI were obtained from the human health risk assessment (Appendix D). For comparison of the HAPs and TAPs concentrations to State or EPA AALs, the concentrations were multiplied by the appropriate AAL averaging period persistence factor. The HAPs concentrations were divided by the AALs to obtain the percentage of the HAPs to the AALs.

The following four AAL guidelines were used; State, EPA Region III, EPA Region IX, and EPA long-term action level. The order in which the different guidelines were applied was as follows: the state guideline was applied in all cases where the state had established guidelines; for those states with no adopted guidelines and located in either EPA Region III or IX, the EPA Region guidelines were applied; for those states with no guidelines which were not located in either EPA Region III or IX, the EPA long-term action levels were applied.

Worker Vehicle Fuel Use. The total number of FTE employees for the waste treatment period was divided by the treatment period in years to obtain the total annual number of workers for each site and WM alternative. It was assumed (with the exception of Hanford) that each worker travels to and from the site in a single vehicle each day. For Hanford, the worker trips were adjusted to account for the percentage of employees who participate in ride-sharing programs. A worker trip reduction value of approximately 19% was obtained from the *FY 1993 Annual Report on In-house Energy Management* (Kaiser Engineers Hanford and Westinghouse Hanford Company, 1994), and applied to all Hanford worker trip numbers.

Vehicle emissions rates for the worker vehicle trips were obtained by running the EPA-approved vehicle emissions models Mobile5a and PART5. Emissions from the Mobile5a model are calculated in grams of pollutant exhaust per VMT for the pollutants CO, NO_2, and VOC. The PART5 model calculated PM_{10} emissions from vehicle exhaust in grams of pollutant emitted per VMT.

For local impacts, it was assumed that the worker vehicle traveled 20 miles to and from work, or a round trip distance of 40 miles per day. The total number of worker trips per day was multiplied by 40 miles per day and then by 240 working days per year to obtain the total VMT per year. The annual VMT was multiplied by the Mobile5a and PART5 emission factors in grams of pollutant per VMT to obtain the total number of grams emitted per year for the criteria pollutants CO, NO_2, VOC, and PM_{10}. The annual emissions in grams were multiplied by 0.0022 pounds per gram and then divided by 2,000 pounds per ton to obtain the annual emissions for worker vehicle trips in tons per year.

Indirect Emissions From Waste Shipments. Air emissions from shipment of waste from site to site (intersite), and to commercial waste handlers for HW, were calculated for local and national impacts. Local impacts were calculated for the site region of influence (ROI) (defined as a 50-mile radius), while intersite impacts were calculated based on the mileage traveled between sites, excluding the emissions calculated locally in the 50-mile radius. The intersite shipment emissions represent the contributions to regional or national levels of the criteria air pollutants, which are not accounted for in the site analysis.

The total number of waste shipments entering and leaving each WM site for the treatment period was obtained from ANL-E. The number of shipments per treatment period was then divided by the length of the treatment period in years to obtain the total number of shipments to and from the site on an annual basis.

Vehicle emissions rates for the truck shipments were obtained by running the EPA approved vehicle emissions models Mobile5a and PART5 as described above.

For local impacts the shipment miles were calculated using a travel distance of 50 miles to and from the site, or a round trip of 100 miles. The annual shipment numbers were multiplied by 100 miles to obtain the total annual VMT. The annual VMT was then multiplied by the Mobile5a and PART5 emission rate factors, in grams of pollutant per VMT, to obtain the total annual number of grams emitted for the criteria pollutants CO, NO_2, VOC, and PM_{10}. The annual emissions in grams were then multiplied by 0.0022 pounds per gram and then divided by 2,000 pounds per ton to obtain the annual emissions for shipment by truck in tons per year.

Radiation Dose Estimates. Total radiation dose values, in rem, were obtained from the human health risk assessment for the MEI at an offsite location. The total dose values in rem were multiplied by 1,000 to obtain the dose in millirem (mrem). The dose was then divided by the period of operation (10 or 20 years) and compared to the NESHAP dose standard of 10 mrem per year.

C.4.2.1.3 *Air Quality Impacts Evaluation*

In general, air quality impacts were evaluated by comparing estimated emissions and concentrations to 10% and 100% of Federal or State standards.

C.4.2.1.3.1 Impacts Evaluation for Criteria Pollutants

Criteria pollutant effects were assessed based on the air quality *attainment status* of each site's AQCR, for each of the six criteria pollutants. In general, the site's applicable AQCR is in attainment for a particular criteria pollutant if monitored ambient levels are below the NAAQS for that pollutant. The site's applicable AQCR is a nonattainment area for a particular criteria pollutant if ambient levels equal or exceed the NAAQS for that pollutant. The attainment status of the DOE sites for the NAAQS criteria pollutants are listed in Table C.4–8. Table C.4–9 explains the nonattainment status designations.

Table C.4-8. Criteria Pollutant Attainment Status at the 17 Major Sites

Site	State	NAAQS Attainment Status					
		CO	NO_2	O_3	Pb	PM_{10}	SO_2
ANL-E	IL	A	A	S-17	A	MOD	A
BNL	NY	A	A	S-17	A	A	A
FEMP	OH	A	A	MOD	A	A	A
Hanford	WA	A	A	A	A	A	A
INEL	ID	A	A	A	A	A	A
LANL	NM	A	A	A	A	A	A
LLNL	CA	A	A	A	A	A	A
NTS	NV	MOD-2	A	A	A	MOD	A
ORR	TN	A	A	A	A	A	A
PGDP	KY	A	A	MAR	A	A	A
PORTS	OH	A	A	A	A	A	A
Pantex	TX	A	A	A	A	A	A
RFETS	CO	MOD-2	A	TRANS	A	MOD	A
SNL/NM	NM	MOD-1	A	A	A	A	A
SRS	SC	A	A	A	A	A	A
WIPP	NM	A	A	A	A	A	A
WVDP	NY	A	A	A	A	A	A

Notes: CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; PM_{10} = particulate matter < 10 micrometers; SO_2 = sulfur dioxide; A = attainment; nonattainment codes: S-17 = severe-17; MOD-2 = moderate-2; MOD-1 = moderate-1; MOD = moderate; MAR = marginal; TRANS = transitional.

Source: 40 CFR 81, Subpart C: Section 107 *Attainment Status Designations* (1992), except LLNL, which is based on 1995 data.

C.4.2.1.3.1.1 Impacts for Installations in Attainment Regions

Any predicted increases to ambient concentration levels in areas designated as attainment by the EPA were compared to the NAAQS. If the estimated ambient concentrations exceeded the NAAQS then that WM alternative and the affected area were noted in the PEIS.

The annual criteria emissions, in tons per year, were compared to the allowable increase levels specified in 40 CFR 52.21, Regulations for the PSD of Ambient Air Quality. PSD regulations are applicable in those

Table C.4–9. Nonattainment Status Definitions[a]

Criteria Pollutant	Nonattainment Designation	NAAQS Exceedance Range
Carbon monoxide (CO)	Moderate-1	9.1 to 12.7 ppm
	Moderate-2	12.8 to 16.4 ppm
Ozone (O_3)	Marginal	0.121 to 0.138 ppm
	Moderate	0.138 to 0.160 ppm
	Severe-17	0.190 to 0.280 ppm
Particulate matter (PM_{10})	Moderate	Greater than NAAQS

[a] Only the nonattainment status designations used in Table C.4–8 are shown.

areas which are listed as in attainment of the NAAQS for each of the criteria pollutants. These allowable increases are referred to in the PSD regulations as PSD increments and PSD significant emission levels (SELs). If the estimated annual emissions exceeded the allowable PSD SELs increments, then that WM alternative and the affected area were noted in the PEIS. The air analysis only compared annual emissions to PSD SELs to determine whether a site could exceed the SELs and an action at a particular site could trigger a PSD review. The analysis should not be interpreted as being a refined PSD analysis. A refined PSD analysis would need to be performed prior to installation of any action at a potential PSD site. PSD increases account for all stationary-source emissions that can be reasonably attributed to the action but do not account for emissions from mobile sources. PSD increases for attainment areas are listed in Table C.4–10.

C.4.2.1.3.1.2 Impacts for Installations in Nonattainment Regions

New stationary sources or major modifications of existing sources located in *nonattainment* areas for criteria pollutants must conform to New Source Performance Standards for new, or modified, existing pollutant sources. In addition, Federal actions which are located in nonattainment areas are required to follow the GCR guidelines (40 CFR 93) in determining the conformity of the action to Section 176(c) of the CAA and to approved State or Federal implementation plans. The GCR establishes specified *de minimis* levels for criteria pollutant emissions, in tons per year, based on the AQCR's nonattainment designation. Actions producing emissions which are below the *de minimis* levels are considered to conform, while those equal to or above the limits are required to perform a conformity determination as outlined in the GCR. The GCR

Table C.4–10. PSD Increments for Criteria Pollutant Emissions in Attainment Areas

Pollutant	Tons/Year
Carbon monoxide (CO)	100
Nitrogen dioxide (NO_2)	40
Ozone (as VOC)	40
Lead (Pb)	0.6
Particulate matter	25
Particulate (PM_{10})	15
Sulfur dioxide (SO_2)	40

Source: 40 CFR 52.21.

accounts for all stationary-sources and mobile sources of emissions that can be reasonably attributed to the action. GCR limits for criteria pollutants in nonattainment areas are listed in Table C.4–11.

C.4.2.1.3.2 Impacts Evaluation for Hazardous (Including Radionuclides) and Toxic Air Pollutants

The determination of applicable emissions limits and allowable ambient concentrations for pollutants other than the six criteria pollutants, was performed on a site-by-site basis. This approach was necessary because site-specific information on existing levels of noncriteria contaminants was not readily available from the site or regulatory agencies. Information on ambient concentrations of such substances from DOE site monitoring and environmental impact statements was used when available and applicable. In addition, the applicable regulations and standards vary considerably from state to state. Detailed procedures were defined on a site-by-site basis and described in the pertinent site air quality analyses section in the PEIS waste-type chapters.

Table C.4-11. General Conformity Rule de minimis Levels for Nonattainment Areas

Pollutant and Nonattainment Designation	*de minimis* Level (tons/year)
Ozone (Volatile Organic Compounds or Nitrogen Oxides):	
- Serious Nonattainment Areas	50
- Severe Nonattainment Areas	25
- Extreme	10
- Other ozone Nonattainment Areas (outside an ozone transport region)	100
- Marginal and moderate Nonattainment Areas (inside an ozone transport region)	
VOC	50
NO_x	100
Carbon Monoxide (CO):	
- All Nonattainment Areas	100
Sulfur Dioxide (SO_2) or Nitrogen Dioxide (NO_2):	
- All Nonattainment Areas	100
Particulate Matter < 10 microns (PM_{10}):	
- Moderate Nonattainment Areas	100
- Serious Nonattainment Areas	70
Lead (Pb):	
- All Nonattainment Areas	25

Source: 40 CFR 51.

C.4.2.1.3.3 Impacts Evaluation for Ozone Precursor Emissions

Ozone pollution is generally caused by reactions between VOC and NO_x, in the presence of sunlight, and generally reaches its maximum many miles downwind of the sources of these substances. The impacts of the WM alternatives on ambient ozone levels were assessed by comparing changes in emissions of VOC and NO_x with the total rate of emissions of these substances from the DOE site, the county, or the AQCR in which the emissions occur. It was assumed that changes in ozone precursor emissions would result in corresponding changes in downwind ozone levels.

C.4.2.1.3.4 Ozone Depleting Substances

The stratospheric ozone layer protects the earth from the penetration of harmful ultraviolet radiation. On the basis of substantial scientific evidence, a national and international consensus currently exists that certain man-made halocarbons (including CFCs, halons, carbon tetrachloride, and methyl chloroform), react in the upper atmosphere to deplete the stratospheric ozone layer.

In response to this awareness, the United States and 22 other countries in 1987 signed the Montreal Protocol on Substances that Deplete the Ozone Layer. The Montreal Protocol, as originally drafted, called for a freeze on the production of CFCs at 1986 levels and for CFCs to be reduced by 50% by 1998.

The CAA, as amended, includes requirements for controlling ozone depleting substances that are generally consistent with, but in some cases, more stringent than those contained in the Montreal Protocol. Title VI of the CAA, and the implementing regulations (40 CFR 82), call for a phaseout of CFCs by January 1, 2000. In addition to the phaseout of ODS, Title VI includes a variety of other provisions intended to reduce emissions of ODS and promote the recycling of these substances. In addition, DOE facilities are required to adhere to Executive Order 12843 of April 23, 1993: *Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances*. This Executive Order stipulates that all Federal Agencies must implement cost-effective programs to minimize the procurement of materials and substances that contribute to the depletion of stratospheric ozone; and give preference to the procurement of alternative chemicals, products, and manufacturing processes that reduce overall risks to human health and the environment by reducing the depletion of ozone in the upper atmosphere.

Impacts to the stratospheric ozone layer due to emissions from WM activities were estimated. The analysis was performed at the alternative level since emissions of ozone depleting substances is a global rather than a site issue. The analysis was performed for waste types where treatment of waste containing hazardous constituents occurs (i.e., LLMW, TRUW and HW). The compounds analyzed include the ozone depleting substances identified by EPA in 40 CFR 82. Emissions of ozone depleting substances from incineration were tallied from information supplied by the health risk assessment. The total emissions from each alternative were found to be exceedingly small for all waste types, and in fact were <0.1 pound per year for all LLMW alternatives (DOE, 1996a). These minor emissions would not be expected to have any measurable affect on upper atmosphere ozone levels. Emissions of ozone depleting substances from other

treatment, storage and disposal operations were assumed to be small due to the nature of these activities, and the mandated phase-out of the use of ozone depleting substances.

C.4.3 WATER RESOURCES IMPACTS ANALYSIS METHODS

This section describes the methods used to estimate the impacts of proposed WM alternatives on surface water and groundwater resources. Section C.4.3.1 provides an introduction, C.4.3.2 briefly describes the regulations that limit impacts to water resources, C.4.3.3 lists the assumptions used in the impacts analyses, C.4.3.4 describes impacts that were considered but not evaluated in detail, and C.4.3.5 describes the methods used to assess the impacts on water resources that were evaluated in detail.

C.4.3.1 Introduction

The alternatives analyzed in this PEIS can affect the quantity or the quality of surface water and groundwater. Water availability elements that may be affected include surface water flow, floodplains, groundwater flow, and aquifer water levels. Surface water and groundwater rights, allocations and usage may also be affected. Water quality elements that may be affected include areas of surface water and groundwater that are already contaminated, and receiving water bodies such as streams, lakes, rivers, and groundwater aquifers. The ROI for water resources is the area encompassed by onsite and offsite surface water and groundwater bodies and their watersheds, which may be affected by site activities.

Water availability is affected when water withdrawal or discharge causes an appreciable change in surface water flow or groundwater levels. Water quality is affected when discharges cause an appreciable increase in the concentration of sediments or contaminants in the receiving water body. In addition, water quality may be affected when activities cause the movement of existing contamination. For example, activities that change the water table gradient could accelerate offsite movement of a plume of groundwater contamination.

Construction, operation, and transportation activities can adversely affect water resources, both during normal operations and when an accident occurs. Waste management activities may adversely affect surface and groundwaters, as a result of increased water use, increased stormwater runoff, increased wastewater discharges, and releases to groundwater from disposal facilities. Transportation of wastes may affect water

resources from the deposition of exhausts emitted from the vehicles and from accidental spills into water bodies.

C.4.3.2 Regulatory Considerations

The Clean Water Act (33 USC 1251 *et seq.*), as amended, requires a permit for all discharges to surface waters (including stormwater discharges) under the National Pollutant Discharge Elimination System (NPDES) program. NPDES permits set discharge limits for contaminants and require periodic monitoring to ensure compliance. In addition, Section 404 of the Clean Water Act regulates the discharge of fill material into navigable waters of the United States.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 USC 9601 *et seq.*), as amended, requires the cleanup of contaminated areas and specifies cleanup levels by application of Applicable or Relevant and Appropriate Requirements (ARARs).

The Safe Drinking Water Act (42 USC 300 *et seq.*) regulates drinking water quality. The maximum contaminant levels established in the implementing regulations (40 CFR 141), although not directly applicable to groundwater quality, are commonly used as ARARs to determine appropriate levels for groundwater cleanup. Since the drinking water standards adequately protect human heath, concentrations of contaminants in groundwater at or below these levels present a low risk. In addition, DOE derived concentration guides for drinking water (DOE, 1990) are sometimes cited as "to be considered" requirements under CERCLA.

Executive Order 11988 (Floodplain Management) and 10 CFR 1022 (Compliance with Floodplain/Wetland Environmental Review Requirements) require that proposed projects be reviewed to determine their impact on floodplain and wetland areas. Federal agencies are required to avoid, when possible, occupying and modifying floodplains. Floodplain and wetland assessments are required for actions that occur within the 100-year floodplain, and for "critical actions" that occur within 500-year floodplains.

Monitoring of effluents and nearby water bodies for adverse effects from WM facilities is required by a number of statutes and their related regulations. Under the Clean Water Act, the NPDES requires that discharges to waters of the United States be monitored and that levels of contaminants in the effluent remain

below permitted levels. The Clean Water Act, as amended, also requires stormwater discharges to be monitored. The regulations implementing the RCRA (42 USC 6901 *et seq.*) have extensive requirements for groundwater monitoring at hazardous waste treatment, storage, and disposal facilities. Levels of contaminants in the groundwater must remain below levels described in the regulations. The regulations of the Toxic Substances Control Act (15 USC 2601 *et seq.*) require similar monitoring at treatment, storage, and disposal facilities for asbestos and polychlorinated biphenyls (PCBs). DOE orders (e.g., 5820.2A [DOE, 1988]), require surface water and groundwater monitoring at radioactive waste treatment, storage, and disposal facilities. In addition, EPA regulations (40 CFR 191) require monitoring of treatment, storage, and disposal facilities at DOE sites that dispose of HLW and TRUW.

Monitoring generally involves periodic measurement of characteristics of the effluent or receiving water body including measurement of radionuclide and chemical concentrations, temperature, pH, and flow. Groundwater monitoring usually involves the analysis of samples collected from wells drilled for this purpose. Surface water monitoring generally involves sampling from stations located downstream from the effluent discharge point. These monitoring stations are located such that they are likely to intercept any releases from a WM facility.

Monitoring provides the opportunity to detect excessive discharges from a WM facility before significant harm is done to human health or the environment. Once the cause of the excessive discharge is located, corrective actions are implemented to contain and then eliminate the source of the problem. DOE will comply with all applicable monitoring requirements.

C.4.3.3 Assumptions

Assumptions for the water resources impacts analysis included the following:

- Current conditions of water resources adequately represent future baseline conditions.
- Water for WM activities would be supplied by current water sources. If water is currently supplied by wells in aquifer X, water for the proposed alternatives would be supplied by wells in aquifer X. If water is currently supplied by a municipal system, then water for the proposed alternatives would be supplied by that system. If water is currently supplied by river Y, water for new facilities would be supplied by river Y.

- Because municipal water is used as the current source, onsite surface water and groundwater resources would not be affected by water withdrawals at Rocky Flats Environmental Technology Site (RFETS), Sandia National Laboratories-New Mexico (SNL/NM), and Waste Isolation Pilot Plant (WIPP). Because groundwater is used as the current source, impacts to surface water resources are likely to be small as a result of groundwater withdrawals at Argonne National Laboratory-East (ANL-E), Brookhaven National Laboratory (BNL), Fernald Environmental Management Project (FEMP), INEL, Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL) Site-300, Nevada Test Site (NTS), Pantex Plant, Portsmouth Gaseous Diffusion Plant (PORTS), and SRS. Because surface water is the current source, impacts to groundwater resources are likely to be small as a result of surface water withdrawals at Hanford, Oak Ridge Reservation (ORR), Paducah Gaseous Diffusion Plant (PGDP), and WVDP.
- Although some sites under consideration receive water from more than one source, they are assumed to obtain their water as follows: (1) Hanford Site from surface water; and (2) LLNL Site-300 and SRS from groundwater. Since only a small portion of the Hanford Site is supplied by groundwater, it was assumed that all water would be supplied by surface water. At LLNL Site-300, water is supplied by an offsite municipal source and onsite groundwater, but to be conservative, it was assumed that groundwater supplied all the water to the site. At SRS, surface water is generally used only for cooling water. Therefore, it was assumed that groundwater would be used to supply WM facilities.
- During normal operations, no untreated sanitary or process wastewater would be discharged to surface or groundwaters at any site. Wastewater would be recycled to the extent possible and then discharged to existing process or sanitary treatment plants, as appropriate. After treatment, wastewater would be discharged from these plants in compliance with all NPDES and industrial wastewater discharge permits.
- Sanitary wastewater treatment capability was not included among the new WM facilities to be constructed. Therefore, it was assumed that sanitary wastes would be discharged to existing plants. New capability to treat process wastewater was included for WM facilities to be constructed.
- The manner of disposing wastewater would not change. If wastewater is currently discharged to a municipal sewer system, than future wastewater would be discharged to that system. If wastewater is currently discharged to a treatment plant, effluent would continue to be discharged to the treatment plant.
- Since the locations for the WM have not been selected, it was not possible to determine which particular onsite water course(s) would be affected. For this impacts assessment, the major offsite water body was assumed to be the receiving water body.

- Onsite surface water resources would not be affected by effluent discharges at SNL/NM, because wastewaters are discharged to municipal wastewater treatment systems. Surface water resources would not be affected by effluent discharges at Hanford, INEL, LANL, LLNL Site-300, NTS, Pantex, or WIPP, because generally, wastewaters are discharged to dry stream beds or man-made ponds, and not to natural-flowing surface water bodies.
- For municipal water supply systems, withdrawals up to the capacity of the site distribution system are acceptable. It was assumed that, if water is available from the utility, the necessary steps have been taken to ensure that operations meet Federal, State, and local environmental regulations. These steps may include withdrawal permits, water rights agreements, and environmental impact reports. This same assumption applies to municipal wastewater treatment.
- During normal operation of waste storage facilities, no water (including precipitation, surface water, or groundwater) would be allowed to come into contact with the waste. Therefore, surface and groundwater quality would not be affected because runoff would not be contaminated. During normal operation of waste treatment facilities, no releases directly to groundwater would occur. Therefore, groundwater quality is not likely to be affected.
- Seepage of contaminated groundwater from disposal facilities could contaminate surface water. This contamination would be diluted by surface water flows such that the concentration in the surface water would be less than the concentration in the groundwater.
- As described in Appendix E, for waste transported in U.S. Nuclear Regulatory Commission (NRC) Type B certified containers, the probability of container leakage during an accident would be very low. Therefore, transportation accidents involving Type B containers were assumed not to affect surface or groundwater resources.

C.4.3.4 Impacts Considered but Not Evaluated in Detail

This section describes potential impacts to water resources that were not evaluated in detail in the PEIS. These impacts were not evaluated in detail because they (1) could be evaluated generically rather than for each alternative; (2) are believed to be minor; or (3) require site-specific analyses that are not possible at this time.

C.4.3.4.1 *Impacts to Floodplains*

If possible, new WM facilities would be located outside the 100-year floodplain, and if the facilities are considered "critical actions," would be located outside the 500-year floodplain. As a minimum, facilities managing LLMW or HW would be required to meet additional design criteria and/or siting requirements to obtain an RCRA permit. Even if the WM facilities are located outside floodplains, access roadways and utility corridors may encroach on floodplains. The impacts of these activities cannot be estimated at this time since the specific locations of the WM facilities have not been selected. Compliance with floodplain and wetland review requirements, including Executive Order 11988 (Floodplain Management) and 10 CFR 1022 (Compliance with Floodplain/Wetland Environmental Review Requirements), would be examined in detail when specific locations are proposed during sitewide or project-specific NEPA reviews.

C.4.3.4.2 *Impacts From Runoff and Sedimentation*

During the construction period, surface water resources could be affected by runoff and sedimentation from site clearing. During operations, water resources could be affected by increased runoff from buildings, parking lots, and cleared areas. Generally, the impacts would be proportional to the amount of land disturbed during construction or occupied during operations. In all cases, the effects would be minimized by implementing the best management practices for stormwater runoff and erosion control. These practices include the use of silt fences, runon and runoff diversion ditches, and stormwater retention and sedimentation ponds. In addition, stormwater discharges would be regulated by the new NPDES stormwater discharge permits. Therefore, impacts from these activities are not expected to be major, and should not influence the choice of alternatives. If necessary, these impacts would be evaluated in sitewide or project-specific NEPA documents.

During WM operations, stormwater runoff may be contaminated with small quantities of materials deposited from air-borne emissions. Some of the potentially contaminated stormwater runoff would be contained within onsite stormwater collection ponds. The stormwater runoff would evaporate or infiltrate into the ground, although the ponds may discharge to surface water bodies during high flow conditions. The volume of stormwater in the ponds would be expected to change somewhat between the alternatives, depending on the size of the areas drained, but the quality of the water would be expected to be similar. Stormwater runoff would be routinely monitored and any discharges would be in compliance with site-specific permit

limits. The impacts of runoff were not evaluated in quantitative fashion but were assumed to be low due to regulations and practices for erosion control and stormwater management. Impacts from stormwater runoff are highly site-specific and would be considered in NEPA documents tiered to the WM PEIS.

Stormwater runoff that is not contained within the stormwater management system may contaminate surface waters. This runoff may contain small amounts of contamination from airborne emissions. Controls would be implemented at each site to minimize the potential for contaminated stormwater runoff. Impacts from contaminated stormwater runoff are expected to be minor, but are highly site-specific and would depend on the design of the stormwater management system, meteorologic conditions, topography, soil, and the affected surface water body at the site. These impacts should not influence the choice of alternatives, but would be considered in sitewide or project-specific NEPA documents if necessary.

C.4.3.4.3 *Impacts From Sanitary Wastewater Discharges*

The majority of any new aqueous waste would be sanitary waste generated by the employees needed for the alternative. Sanitary wastes by definition are nonhazardous and would be discharged to existing sanitary wastewater treatment facilities. After treatment, sanitary wastewaters would be recycled, or discharged from these plants in compliance with site-specific NPDES, or industrial wastewater discharge permit limits. Limits on the amount of contaminants in the effluent are set by the regulators after consideration of potential adverse ecological and human health effects in the receiving water body. The impacts on existing sanitary wastewater treatment facilities are discussed in the infrastructure sections of each waste-type chapter.

Although the volume of sanitary wastewater may vary between alternatives, it would remain similar in quality. Therefore, current conditions would not change appreciably unless the discharge volume was a large percentage of the flow in the receiving water body. The impacts of combined sanitary and process wastewater discharges on surface water availability were evaluated for all waste types in the site tables, and show only minor (less than 1%) changes in flow. Since the quality of effluent discharges from sanitary wastewater treatment facilities would not change, and the flow would not be a significant fraction of the average flow in the major receiving water body, current monitoring captures the majority of the water quality effects of sanitary wastewater treatment plant discharges for the alternatives. Therefore, impacts from these activities are not expected to be major, and should not influence the choice of alternatives. If necessary, these impacts would be considered in sitewide or project-specific NEPA documents.

C.4.3.4.4 *Impacts From Process Wastewater Discharges*

Process wastewater is wastewater potentially contaminated by hazardous or radioactive constituents during treatment, storage, or disposal activities. In the WM PEIS, it was assumed that easy-to-treat and hard-to-ship wastes, such as aqueous wastes and slurries (process wastewater), would be treated at the generating site and would not be shipped off site for treatment. After treatment, wastewaters would be recycled or discharged in compliance with site-specific DOE, NPDES, or industrial wastewater discharge limits. Because process wastewater treatment would continue at the sites where it presently occurs and because the volumes of process wastewater treated at each site would vary only slightly between alternatives, the effects of process wastewater treatment on surface water and groundwater quality are largely accounted for in the affected environment section. Therefore, the impacts from these activities should be similar for all alternatives and should not influence the choice of alternatives. If necessary, these impacts would be evaluated in sitewide or project-level NEPA documents.

C.4.3.4.5 *Impacts to Small Onsite Streams*

Wastewater released by WM facilities may enter small onsite water courses before entering the major surface water body near the site. Additional effluents in these small streams, may cause eroding of parts of the stream channel and sedimentation in other parts of the channel. Water quality may also be affected because the facility effluents may form a large fraction of the natural streamflow. Before NPDES permits are renewed or issued by the EPA or state agencies, water quality in the receiving water body would be considered in setting effluent limits for the facilities. Impacts on small onsite water bodies would be considered in detail in sitewide or project-specific NEPA documents.

C.4.3.4.6 *Impacts of Water Withdrawals on the Movement of Groundwater Contamination*

Withdrawals of groundwater for use by WM facilities could cause the movement of existing areas of groundwater contamination. This could occur where water levels are lowered by water withdrawals. Impacts of this sort are unlikely because existing wells would be used to the extent possible, and new wells would be located to minimize their impact on the movement of existing contaminant plumes. Impacts on

existing areas of contamination would be considered in detail in sitewide or project-specific NEPA documents.

C.4.3.4.7 *Impacts From Waste Disposal on Surface Water Quality*

Seepage of contaminated groundwater from disposal facilities could contaminate surface water. This would be expected to occur at sites with shallow groundwater, and surface water bodies that are fed by groundwater discharge (springs). Some sites (INEL, NTS, and Pantex) are located above deep groundwater such that surface water would not be expected to become contaminated. Other sites (LANL, LLNL, SNL/NM, and WIPP) have a low potential for surface water contamination due to the intermittent nature of most of the sites streams. Where contaminated groundwater discharges to the surface, dilution in "clean" surface waters would cause concentrations of contaminants in surface water to be lower than concentrations in groundwater. Therefore the groundwater pathway was assumed to be the major pathway for movement of contaminants beyond the disposal facility boundary, and was the pathway that was examined in detail.

C.4.3.4.8 *Impacts From Transportation*

Routine transportation would involve the intersite movement of waste by truck or rail, and the travel of workers to and from work. Waste materials would not be released during routine transportation of wastes. Therefore, impacts from transportation would be limited to the deposition and runoff of vehicle emissions to surface waters and the infiltration of materials deposited on the surface into groundwaters. As described in Section C.4.2 on air quality, vehicle emissions at any one place from transportation would be small. Therefore, the impacts of routine transportation on surface and ground waters would be minimal.

C.4.3.4.9 *Impacts From Transportation Accidents*

Because the waste would be shipped in sealed NRC or DOT approved containers, impacts to water resources would be unlikely unless a ruptured container fell directly into a surface water body. In the unlikely event that waste was released from a shipping container, cleanup response to the accident would be swift, and the release would be contained and cleaned up as quickly as possible. The spill response and

cleanup, and any subsequent remediation, would be conducted in accordance with the CERCLA as amended, the National Oil and Hazardous Substances Pollution Contingency Plan, and DOE emergency response requirements. Since a swift cleanup would occur, long-term impacts to water quality are unlikely. Potential short-term impacts on water quality and on aquatic resources are addressed in Sections 7.7.5 and 8.7.5 of Volume I.

C.4.3.4.10 *Vulnerability of Sites to Surface Water Impacts*

The primary water-related impacts of WM activities are likely to be through groundwater. Nevertheless, there may be sites at which WM activities could cause surface water impacts. This section provides a qualitative assessment of the vulnerability of sites to surface water impacts. The approach used here is to identify some of the key factors that could contribute to surface water impacts and identify those sites at which surface water may be an important pathway for movement of contaminants offsite. It is important to recognize that these sites are not pristine areas, but are already the source of some pollutants that potentially affect the surrounding surface water bodies.

Table C.4–12 provides information on:

- Average annual precipitation, which gives an indication of the likelihood for pollutants to be transported offsite through stormwater runoff
- The major surface water bodies near each site, their distance from the site, and their average flow rate, which indicates the relative importance of the surface water body and the likely impact on it of contaminants from the WM activities
- The presence of groundwater discharge to surface water bodies near the site, which indicates a mechanism other than direct discharge by which WM activities could impact surface water quality
- The presence of nearby surface water supply intakes downstream from the site, which indicates the potential exposure of human populations

Several of the sites are in arid to semiarid climates with limited rainfall and have no discharges to major surface water bodies (i.e., INEL, NTS, Pantex, and WIPP). Site wastewater discharges and stormwater runoff are unlikely to reach major surface water bodies, and little or no groundwater discharges into streambeds. These characteristics make it unlikely that WM activities would produce major surface water impacts near these sites.

Table C.4–12. Key Factors Contributing to Surface Water Impacts

Site	Average Annual Precipitation (cm)[a]	Major Surface Water Bodies			Presence of Groundwater Discharge to Surface Water Onsite or near Site Boundary[b]	Presence of Nearby Drinking Water Supply Intakes Downstream from Site[b]
		Major Surface Water Bodies Within 10 Miles of Sites[b]	Distance to Major Surface Water Bodies[b]	Average Flow Rate of Major Surface Water Bodies Near Sites (gpd)[b]		
ANL-E	80	Des Plaines River	<1 mile	582 million	Yes	No
BNL	107	Peconic River	Onsite	1 million	Yes	No
FEMP	104	Great Miami River	<1 mile	1.823 billion	Yes	No
Hanford	16	Columbia River	Onsite	77.560 billion	Yes	Yes
INEL	23	None[c]	NA	NA	No	No
LANL	47	Rio Grande	At site boundary	1.727 billion	Yes	No
LLNL-Livermore	36	None[c]	NA	NA	No	No
LLNL-Site 300	36	None[c]	NA	NA	Yes	No
NTS	19	None[c]	NA	NA	No	No
ORR	139	Clinch River	At site boundary	3.003 billion	Yes	Yes
PGDP	120	Ohio River	<2 miles	174.521 billion	Yes	No
Pantex	51	Onsite playa basins that do not connect with offsite surface water bodies	NA	NA	No	No
PORTS	101	Scioto River	<1 mile	3.036 billion	Yes	No
RFETS	38	Walnut Creek	Onsite	142 million	Yes	Yes; but all onsite discharges are diverted around water supply
SNL-NM	20	Rio Grande	6 miles from edge of Kirtland AFB	651 million	Yes	No
SRS	122	Savannah River	At site boundary	6.463 billion	Yes	No
WIPP	31	None[c]	NA	NA	No	No
WVDP	104	Buttermilk Creek	Onsite	41 million	Yes	No

Note: NA = not applicable.
[a] Data from DOE (1996a).
[b] Data from DOE (1995b).
[c] Stream channels are dry for most of the year.

At three other sites with arid to semiarid climates (LANL, LLNL, and SNL-NM), discharges off site occur uncommonly and are made up largely of stormwater runoff or snowmelt. At these sites, groundwater can seep into the beds of the intermittent streams at times during the year. These characteristics also make it unlikely that WM activities would cause major surface water impacts near these sites.

At RFETS, annual average precipitation is also low, although groundwater discharges into the nearby creeks. Parts of the site originally drained via small creeks to two reservoirs that are used for drinking water supplies by the towns of Broomfield and Westminster. Since 1989, all discharges from the RFETS are contained in onsite manmade ponds and diverted to the Broomfield Diversion Ditch, which bypasses the reservoirs and discharges to Walnut Creek downstream from the reservoirs. Although past activities at RFETS have impacted surface water resources, it is unlikely that major impacts to surface waters would occur from the incremental addition of WM activities.

ANL-E, FEMP, Hanford, ORR, PGDP, PORTS, and SRS are near major water bodies that have large to very large average flows. Groundwater at these sites recharges into the nearby streams and rivers. These characteristics indicate that although some impacts to surface water are likely to occur near these sites, it is unlikely that major surface water impacts would occur.

BNL and WVDP are near water bodies with small to medium average flows. During wet periods groundwater discharges to onsite streams. While these sites are more vulnerable to surface water contamination than are the sites discussed in the previous paragraphs, in the near term surface water impacts from the incremental addition of WM activities are not expected to be major. As described in the Draft WVDP closure EIS, significant impacts to surface water could occur in the future if erosion breaches the waste disposal facilities.

Most of the sites do not have downstream water supply intakes nearby, although there are nearby water supply intakes downstream from Hanford, ORR, and RFETS. At RFETS site discharges are routed around the water supply reservoirs and at Hanford and ORR the large surface water bodies provide a great deal of dilution of any contaminants released from the sites; therefore, major impacts to downstream drinking water supplies from WM activities at these sites are unlikely.

Impacts on surface water resources and drinking water supplies would be considered in sitewide or project-specific NEPA documentation, after the locations of WM facilities on the sites are selected.

C.4.3.5 Impact Assessment Methods for Water Resources

The environmental impacts on surface water and groundwater availability and groundwater quality were assessed by determining the potential change from baseline conditions caused by implementing the Alternatives. A summary of the water resources impacts that were evaluated in detail in the PEIS is shown in Table C.4–13.

First, current conditions at the sites were summarized from data in the *Technical Report on Affected Environment* (DOE, 1995b). Table C.4–14 shows the affected environment information used for each site, which includes the following types of information:

- Source(s) of water for the site
- Current rate of municipal water use (gallons per day)
- Current rate of surface water use (gallons per day)
- Current rate of groundwater use (gallons per day)
- Location of wastewater discharge(s)
- Average streamflow for the major water body (gallons per day)
- The presence of Sole-Source Aquifers in the ROI as defined by the EPA
- The presence of Federally designated Wild and Scenic Rivers in the ROI

Then the applicable facility design data for the sites affected by the proposed alternatives were assembled from the data tables in this appendix, including:

- Water used during construction (total gallons)
- Water used during operations (gallons per year)

Water used during construction was converted to daily usage by dividing by the total number of days of the construction period, assuming 250 work days per year and a 2-year construction period. Water used during operations was converted to daily usage, assuming 250 work days per year. Figures for the number of work days per year for construction and operation and for the duration of the construction period were supplied in the EG&G reports (e.g., EG&G and MK, 1994).

Table C.4-13. Impacts Evaluated in Detail for Water Resources

Impacts Assessed	Relevant Waste Types	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Presentation of Results
Water Availability	All five waste types	Construction	Estimated for water used: - by personnel - for concrete - for dust suppression	Percent increase in current water use	Tabular and text discussion
				Percent decrease in stream flow	Text discussion
	All five waste types	Operations	Estimated for water used: - by personnel - by treatment and disposal processes	Percent increase in current water use	Tabular and text discussion
				Percent decrease in stream flow	Text discussion
			Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion
Groundwater Quality	LLMW and LLW	Post-Closure	Disposal of waste	Percent of drinking water quality standard	Tabular and text discussion

The following calculations were performed for each alternative by combining the baseline environmental data with the facility design data:

- Percentage of current site water usage for increment added during construction
- Percentage of average streamflow for water usage increment added during construction
- Percentage of current site water usage for increment added during operations
- Percentage of average streamflow for water usage increment added during operations
- Percentage of average streamflow for effluent discharge increment added during operations, assuming that all water used is ultimately discharged as effluent from a wastewater treatment facility

These calculations formed the basis for assessing the impacts of the proposed alternatives on water availability.

Table C.4–14. Affected Environment Data for Water Resources[a]

Site	Source of Water Supply for Site	Current Use (gpd)			Waste-Water Discharge Location	Average Flow in Major Stream (gpd)
		Municipal Water	Surface Water	Groundwater		
ANL-E	Chicago Sanitary & Ship Canal and Niagara Aquifer	NA	350,000	626,000	County of DuPage Municipal Sewer System, Sawmill Creek	582,000,000
BNL	Upper Glacial Aquifer & Magothy Aquifer[b]	NA	NA	4,500,000	Onsite Streams & Peconic River	1,000,000
FEMP	Miami Valley Aquifer[b]	NA	NA	400,000	Onsite Streams & Great Miami River	1,823,000,000
Hanford	Columbia River, Deep Wells and City of Richland Municipal System	d	9,567,000	184,000	Onsite Drain Fields, Evaporation Ponds & Columbia River	77,560,000,000
INEL	Snake River Plain Aquifer[b]	NA	NA	5,700,000	Onsite Evaporation Ponds	NA
LANL	Main Aquifer	NA	NA	4,100,000	Onsite Canyons	1,727,000,000
LLNL Site-300	Deep Groundwater & Hetch Hetchy Aqueduct	e	NA	87,000	Onsite Ponds and Leach Fields	NA
LLNL-L	Hetch Hetchy Aqueduct and Alameda County	717,000	NA	NA	City of Livermore Municipal Sewer System	NA
NTS	Groundwater	NA	NA	1,367,000	Onsite Evaporation Ponds	NA
ORR	Clinch River	NA	18,300,000	NA	Onsite Streams & Clinch River	3,003,000,000
PGDP	Ohio River	NA	15,000,000	NA	Onsite Streams & Ohio River	174,521,000,000
Pantex	Ogallala Aquifer	NA	NA	548,000	Onsite Playas	NA
PORTS	Alluvial Aquifer & Scioto River	NA	0	14,000,000	Onsite Streams & Scioto River	3,036,000,000
RFETS	Denver Water Board	272,000	NA	NA	Onsite Streams & Walnut Creek	142,000,000
SNL/NM	City of Albuquerque & Kirtland Air Force Base	1,000,000	NA	NA	City of Albuquerque WWTP	651,000,000
SRS	Groundwater & Savannah River	NA	112,000,000	1,600,000	Onsite Streams & Savannah River	6,463,000,000
WIPP	City of Carlsbad Municipal System	14,400	NA	NA	Onsite Evaporation Ponds	NA
WVDP[c]	Two Onsite Surface Water Reservoirs	NA	70,000	NA	Onsite Streams & Buttermilk Creek	41,000,000

Notes: WWTP = waste water treatment plant. NA = not applicable. INEL includes INEL, ANL-W, and NRF. LLNL-L includes LLNL-L and SNL/CA. SNL/NM includes SNL/NM and ITRI.

[a] Data from the *Technical Report on Affected Environment for DOE Sites Considered in the Waste Management Programmatic Environmental Impact Statement* (DOE, 1995b). No Sites have Federally designated Wild and Scenic Rivers in the ROI, although the Hanford Reach of the Columbia River was recommended for inclusion (DOI, 1994).

[b] Sole-source aquifer.

[c] Site is upstream from a sole-source aquifer.

[d] Water use rate not available. Municipal water used to supply administrative areas (700, 1100, and 3000 Areas) near the City of Richland only.

[e] New system that has a capacity of 500,000 gallons/day.

Percentages less than or equal to 1% were considered to be negligible and were not discussed further. The 1% threshold is based on the assumption that a change in current conditions of this magnitude is not likely to produce a significant impact. Thus the 1% level was used as a screening level below which impacts were assumed to be minor.

Percentages greater than 1% were examined on a case-by-case basis because impacts would depend on the characteristics of the affected site. At one site a change in groundwater usage of 10% may be problematic, while at another site a change of this magnitude may not be a problem. When necessary, water usage was compared to the capacity of the water supply distribution system, regional water use, or water rights agreements to determine if these values would be exceeded. The effects of projected demands for proposed facilities on existing water supply or wastewater treatment infrastructures are evaluated in the section on infrastructure impacts.

The impacts of waste disposal on groundwater quality were estimated by using the information for the groundwater pathway generated during the health effects modeling. The movement of contaminants was modeled for each site using the Multimedia Environmental Pollutant Assessment System (MEPAS) code, modified to better account for radioactive decay and ingrowth of daughter radionuclides. The model estimated concentrations for radionuclides and hazardous constituents at a hypothetical well located 300 meters from the center of the disposal facility for 70-year increments between the end of institutional control and 10,000 years. Impacts from leakage during operations and institutional control are unlikely since leachate and groundwater monitoring are likely to detect the leak before significant degradation of groundwater quality could occur. Disposal of 36 radionuclides was evaluated for LLMW and LLW; disposal of 15 hazardous constituents was evaluated for LLMW. The maximum concentrations above 0.001 pCi/L for radionuclides and 0.000001 mg/L for hazardous constituents were then tabulated and compared to groundwater quality comparison criteria. The year of the maximum concentration was also included in the tabulation. Values above 25% of the comparison criteria were noted, and the potential impacts of these concentrations were discussed in the PEIS. Appendix D provides more detail on the health effects methodology used to model the groundwater pathway. This appendix states that the uncertainty in the health risk results for the groundwater pathway is approximately one or two orders of magnitude.

As shown in Table C.4-15, water quality comparison criteria used in the PEIS include maximum contaminant levels of the EPA National Primary Drinking Water Regulations (40 CFR 141) and standards for drinking water from DOE Order 5400.5 (DOE, 1990). Drinking water standards promulgated under the SDWA are applicable to treated drinking water at the tap and therefore do not directly apply to

Table C.4-15. Water Quality Comparison Criteria

Constituent	EPA Drinking Water Regulations			DOE Derived Concentration Guides for Drinking Water[d]	EPA Quality Criteria for Fresh Water[e]	
	MCL[a]	SMCL[b]	Proposed MCL[c]		Acute	Chronic
1,2-Dichloroethane	0.005				118	20
Actinium-227			1.27	0.4		
Americium-241			6.34	1.2		
Americium-242m			1.27	1.2		
Americium-243			6.37	1.2		
Arsenic	0.05				0.36	0.19
Barium	1					
Benzene	0.005				5.3	
Cadmium	0.005				0.0039	0.0011
Carbon Tetrachloride	0.005				35.2	
Carbon-14			3,200	2,800		
Cesium-135			794	800		
Cesium-137			119	120		
Chromium +VI	0.1				0.016	0.011
Curium-242			133	40		
Curium-244			9.84	2.4		
Curium-245			6.23	1.2		
Cyanide	0.2				0.022	0.0052
Iodine-129			21	20		
Lead	0.015[f]				0.082	0.0032
Mercury	0.002				0.0024	0.000012
Methylene Chloride	0.005					
Neptunium-237			7.06	1.2		
Nickel-59			27,000	28,000		
Nickel-63			9,910	12,000		
Palladium-107			36,600	40,000		
Plutonium-238			7.02	1.6		
Plutonium-239			62.1	1.2		
Plutonium-240			62.2	1.2		
Plutonium-241			62.6	80		
Potassium-40				280		
Protactinium-231			10.2	0.4		
Radium-226	3[f]		20	4		
Samarium-151			14,100	16,000		
Selenium	0.05				0.26	0.035
Selenium-79				800		
Silver		0.1			0.0041	0.00012
Strontium-90	8		42	40		
Technetium-99			3,790	4,000		
Thorium-229			49.3	1.6		
Thorium-230			79.2	12		
Thorium-232			88	2		

Table C.4-15. Water Quality Comparison Criteria—Continued

Constituent	EPA Drinking Water Regulations			DOE Derived Concentration Guides for Drinking Water[d]	EPA Quality Criteria for Fresh Water[e]	
	MCL[a]	SMCL[b]	Proposed MCL[c]		Acute	Chronic
Tin-126 (mg/L)			293	320		
Uranium-233 (pCi/L)			13.8	20		
Uranium-234 (pCi/L)			13.9	20		
Uranium-235 (pCi/L)			14.5	24		
Uranium-236 (pCi/L)			14.7	20		
Uranium-238 (pCi/L)			14.6	24		
Zirconium-93 (mg/L)			5,090	3,600		

Note: Blank cells indicate that no official standard or criterion exists for this constituent. MCL = maximum contaminant level. SMCL = secondary maximum contaminant level. Comparison criteria for 1,2,2-trichloro-1,1-trifluoroethane and acetone were not found.
[a] Source: 40 CFR 141, *National Primary Drinking Water Regulations*, and EPA (1991a).
[b] Source: 40 CFR 143, *National Secondary Drinking Water Regulations*. SMCLs based on taste and odor effects.
[c] Source: EPA (1991a). Concentration based on 4 mrem/year dose. Alpha emitters based on lifetime incidence risk of 1×10^{-4}.
[d] Source: DOE Order 5400.5 (DOE, 1990). Concentration based on 4 mrem/year effective dose equivalent.
[e] Source: EPA (1986).
[f] Action level.

groundwater quality. Since there are no Federal standards for groundwater quality protection, predicted concentrations of contaminants in the groundwater are compared with drinking water standards to indicate the level at which adverse impacts to water quality may occur. These criteria are commonly used as Applicable or Relevant and Appropriate Requirements (ARARs) to determine appropriate levels for groundwater cleanup under RCRA and CERCLA cleanup actions. Since drinking water standards adequately protect human health, groundwater contamination at or below these levels is considered to result in low risk to human health. EPA National Secondary Drinking Water Regulation secondary maximum contaminant levels (40 CFR 143) were used as comparison criteria where maximum contaminant levels did not exist, although they focus on qualities of taste and odor rather than protection of health.

The EPA proposed maximum contaminant levels for radionuclides in drinking water (EPA, 1991a) were not used because they are proposed regulations that are not yet in effect. Note that most of the EPA proposed drinking water standards for radionuclides are similar to the DOE derived concentration guides that were used. EPA quality criteria for fresh water (EPA, 1986) were not used since these apply primarily to surface water quality.

Federal water quality standards were used to provide a consistent means of comparison among sites. Using State water quality standards could bias the analysis toward sites with less stringent environmental laws.

This would be unfortunate since impacts occur in relation to the amount of contamination present. Impacts do not necessarily parallel regulation of the contamination.

It is important to note that DOE Order 5820.2A (DOE, 1988) for radioactive waste management, RCRA for hazardous waste, the Toxic Substances Control Act for waste containing PCBs, and DOE's Performance Assessment process would not allow a disposal facility to be constructed that would cause significant contamination of groundwater outside the facility boundary. If significant groundwater contamination was predicted by the Performance Assessment process, changes in the waste acceptance criteria would be made to limit disposal of the waste causing the problem. The wastes would require additional treatment prior to disposal, would be disposed at another DOE site where the wastes meet the waste acceptance criteria, or would be stored until a method was found to treat or dispose of the waste. In no case would DOE knowingly dispose of waste in violation of legal requirements.

Indirect impacts to water resources were deferred to site-specific or project-level NEPA documents. These include the effects of increased offsite water use caused by in-migrating employees and their families.

C.4.4 Ecological Impacts Analysis Methods

Effects on ecological resources of waste treatment, storage, or disposal activities proposed at the 17 major DOE sites and the impacts of waste transportation were evaluated for each waste type under each alternative for:

- Routine activities of constructing and operating WM facilities
- Accidental releases of transported wastes

Table C.4–16 lists the ecological impact type, the particular resources affected, the general method used, the waste types to which each method was applied, and the type of presentation format for each ecological impact evaluated.

C.4.4.1 Routine WM Activity Impacts

The ecological impacts of routine WM activities were assessed in terms of potential disturbance or loss of nonsensitive terrestrial habitat resulting from site clearing for construction of WM facilities, the potential

Table C.4-16. Ecological Resources Impacts Analyzed for the WM Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Impact Analysis Method	Applicable Waste Types	Presentation of Results
Habitat Effects—Routine WM Activities				
Nonsensitive Habitat Loss	Terrestrial plants and animals	Comparison of habitat loss at WM construction sites to general habitat range	All five types	Text discussion
Potential for Sensitive Habitat Effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats by comparing construction acreage to available acreage of nonsensitive habitats	All five types	Text discussion
Contaminant Exposures—Routine WM Activities				
Terrestrial Species Exposures	Terrestrial animal species	Comparison of estimated radiation dose of representative species with toxicity standard	LLMW, LLW, TRUW	Text discussion
Habitat Effects or Contaminant Exposures—Routine WM Activities				
Sensitive Species Concerns	Federally and State-listed endangered and threatened species	Numbers of Federally and State-listed species displayed by site/alternative	All five types	Tabular listing
Contaminant Exposures—Accidents				
Effects of Transportation Accidents	Aquatic Species in Streams crossing transportation corridors	Results of scenario-based modeling analysis of accidental spill effects on fish in various size streams	LLMW, LLW, TRUW	Text discussion

for site clearing and WM facility operations to affect nearby sensitive habitats, and the potential for airborne contaminant releases from waste treatment facilities to be toxic to terrestrial wildlife.

C.4.4.1.1 *Direct Nonsensitive Habitat Impacts*

During the construction phase, ecological resources will be affected through disturbance or loss of habitat resulting from site clearing. Terrestrial resources will be directly affected by land clearing through changes in vegetative cover, which will adversely affect the habitat of terrestrial animals.

These changes may be important for individual animals of certain species with limited home ranges, such as small mammals and songbirds. Likely impacts include increased direct mortality and susceptibility to predation. Individual animals with larger home ranges, such as game animals and raptors, may not be adversely affected by the decreases in vegetative cover resulting from site construction. In general, it is not expected that any nonsensitive species populations will be affected by the limited amounts of nonsensitive habitats lost or disturbed in the WM program. The discussion of the potential for these effects in the waste-type chapters draws a comparison between the limited amounts of acreage likely to be disturbed in managing the waste type at individual sites and the extent of the nonsensitive habitats available regionally.

C.4.4.1.2 *Indirect Sensitive Habitat Impacts*

Many of the DOE sites contain sensitive habitats. The degree to which those habitats would be unaffected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby WM facility construction or operations activities at any site would depend on DOE's ability to avoid locating the facilities near the sensitive habitats. A measure of this ability is the percentage of available land that facility construction under any WM alternative would require at a site. Available acreage was estimated from site development plans either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. Potential for impacts was assessed by estimating the percentage of available land by site and alternative and listing those that equal or exceed 1% in the waste-type chapters. Further evaluation of those sites where the percentage equals or exceeds 1% is presented in the waste-type chapters in terms of the expectation that DOE will be able to avoid impacts to sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff and sedimentation loadings to surface waters from disturbed terrestrial areas. However, the use of various mitigation techniques should minimize potential facility construction impacts to aquatic ecological resources. Direct discharges of contaminants to surface waters from the routine operation of facilities are expected to be limited by engineering control practices. Therefore, impacts to aquatic organisms are expected to be minimal.

Habitat Effects Data Sources. Estimates of the acreage cleared to build WM facilities were compiled from the engineering analysis outputs described in Section C.3 of this appendix. For each waste type and WM

alternative, the total disturbed area was estimated by summing the plant area required for all WM facility modules (plus 25-foot buffer zones) and the parking area. Plant area was estimated as a function of waste throughput requirements, whereas, parking area was estimated on the approximate number of full-time plant employees. Available acreage was estimated using site development plans and site environmental reports.

Habitat Effects Data Evaluation. For nonsensitive habitat impacts, the construction acreage requirements at each site under each alternative are compared qualitatively with the general extent of these habitats in the affected regions.

For sensitive habitat impact evaluation, sites where the proposed construction activities would disturb more than 1% of the available WM area are noted in the waste-type chapters and additional discussion is included about whether these greater percentages would indicate that indirect effects to sensitive habitats are likely. Additional investigations of the type that would be conducted as part of the site-specific or project-level NEPA evaluations tiered to the PEIS, would be needed to confirm or refute any presumed significant habitat impacts.

C.4.4.1.3 *Potential Toxicity to Terrestrial Wildlife*

The impacts of airborne releases of radionuclides and hazardous chemicals to terrestrial animals living near waste treatment facilities were estimated using atmospheric emission/deposition modeling. This modeling, which used the same atmospheric emissions estimates as used in the human health risk assessment, provided estimates of doses of radiological and nonradiological contaminants deposited onto near-field and far-field surface soils. The model also estimated uptake from the soils and transfer in a terrestrial food chain leading to exposure of a small mammal used as a model terrestrial receptor.

The white-footed mouse (*Peromyscus leucopus*) was used in this analysis to be representative of most small mammals because it is sensitive to contaminant exposure, it has a varied diet (for example, it eats both plants and insects), and it is a common prey species for a number of predators. In addition, field mice are ubiquitously distributed. These animals have a limited home range relative to estimated contaminant distributions. Therefore, mice live within potentially contaminated areas and can be expected to consume all of their diet from these areas.

C.4.4.1.3.1 Data Sources

Contaminant toxicity evaluations were conducted using the same estimates of waste treatment facility airborne emissions as were used in the human health risk analyses. These annual emission rate estimates, provided by ANL, were assumed to be constant over a 10-year operating period. Contaminants that accounted for up to 80% of total emissions were included in the assessment; trace emissions were not assessed.

Emission estimates were used as inputs to atmospheric dispersion/deposition models, which provided estimates of contaminant concentrations deposited to surface soils. Surface soil contaminants were then modeled for distribution in terrestrial food chains using a number of transfer factors.

Estimates of maximum near-field and far-field contaminant concentrations were developed in order to conservatively assess exposure. The pathways used to estimate internal and external exposure include direct exposure to external radiation, incidental soil ingestion, and uptake of contaminants from soils into terrestrial food chains. Exposure from the inhalation and water ingestion pathways was assumed to be minimal due to dilution.

Surface soil concentration estimates were developed for each contaminant by applying the maximum near-field and far-field deposition rates to the contaminant emission rates. Except for tritium, contaminants were conservatively assumed to accumulate in the soil over the 10-year operation period. Radioactive decay was accounted for in the analysis. Contaminants were assumed to be evenly distributed in the top six inches of soil.

Terrestrial food chain contaminant concentration estimates were made by applying transfer factors to soil concentrations to develop concentration estimates in plant tissues. Since reliable transfer factors were not available for estimating concentrations in insect tissue from plant tissue concentrations, complete (100%) plant to invertebrate transfer was conservatively assumed to estimate invertebrate tissue concentrations (ORNL, 1995b).

Tritium exposure was assessed separately. Tritiated water is the principal form of tritium in the environment. Therefore, tritium can be expected to be incorporated into a great variety of compounds but cannot be assumed to accumulate in soils. For tritium, a simplifying assumption was made that tritium

deposition is continuous and uniform over time and that tritium in the receptor mouse has attained a steady state equilibrium with environmental tritium (IAEA, 1992). Transfer factors for tritium were conservatively assumed to be 100% (ORNL, 1995b).

C.4.4.1.3.2 Data Evaluation

The potential toxicity of the radiological contaminants was assessed by comparing the estimated total internal and external doses to a benchmark value of 100 mrad/day, established by the International Atomic Energy Agency (IAEA, 1992). No-observable-adverse-effect levels (NOAELs) were used as benchmarks for the nonradiological (i.e., hazardous chemical) contaminants. The radionuclides selected for each analysis comprised 80% of the total volume of all radionuclides expected to be emitted at a given site. The radionuclides were used in calculating hazard indexes (HIs) for each selected site/alternative combination as composite ratios between the estimated species exposures to each of the contaminants and known, contaminant-specific toxic levels. The resulting ratio, the HI, was used to identify WM alternatives that may be of concern for potential ecotoxicity. An HI greater than one would indicate a potential for the combined exposures to adversely affect the health of terrestrial species. Hazardous and toxic chemicals were evaluated using a separate HI in the same way.

C.4.4.1.4 *Potential Impacts to Sensitive Species*

Location-specific analyses would be required to address impacts to sensitive habitats and sensitive species, including species listed by the U.S. Fish and Wildlife Service as endangered or threatened. Those analyses would be part of the impacts analyses in NEPA documents tiered to this PEIS. For comparison of WM program effects on sensitive species, the waste-type chapters list the numbers of Federal and State-listed endangered and threatened species at each site under each alternative where a major action is proposed. Reference is made to the PEIS Chapter 4, Affected Environment, which lists the sensitive species at the 17 major sites.

C.4.4.2 Impacts of Accidental Releases

The ecological impacts of waste transportation accidents were evaluated as consequence assessments of spills into aquatic environments. These assessments estimated the potential ecological impacts of transportation accidents involving varying size releases of radionuclides under certain spill scenarios. However, they do not include estimates of the probability of these events occurring.

Because hazardous constituents would vary so widely in volume and type in any particular mixed or hazardous waste shipment, no attempt was made to quantify the consequences of hazardous constituents in transportation accidents. Where applicable, the PEIS acknowledges that the consequences of those spills may be as severe or more severe than the consequences of spills of radioactive wastes.

Accidental spills in nonsensitive terrestrial environments were not quantified but are expected to have more limited consequences than those estimated for the aquatic scenarios because the extent of the affected area would be more limited to the immediate locality of the spill and cleanup would likely be more effective because of the stable nature of the affected substrate. Airborne contaminants released downwind through such accidents could affect terrestrial species through all routes of exposure. The effects of such releases on nearby exposed humans were evaluated and are presented in the PEIS waste-type chapters and the human health risk appendix (Appendix D). Terrestrial species would be at similar levels of risk for any acute effects.

Facility accidents would also likely affect terrestrial and aquatic environments on and near the affected site. Such accidents were evaluated for effects on human health. Ecological impacts are likely to be as severe as those shown in the human health effects analysis, however, no separate quantitative analysis of ecological impacts was done.

The transportation accident scenario used involves a rail shipment spill of waste directly into surface waters of different size classes. Assessments were performed for stream size classes ranging from a small second order stream (for example, flow rate of a few meters per second) to a tenth order major continental river (for example, the Mississippi River). Stream order is a method of numbering steams as part of a drainage basin network. The smallest tributary is called first order, the stream receiving the tributary is called second order, and so on. There are about 350,000 second-order streams in the United States and only one tenth-order stream, the Mississippi River.

The environmental fate of the spilled waste was evaluated under two assumptions. In one case, it was assumed that all spilled material remained suspended or dissolved in the water column and was transported downstream. Aquatic organisms present at any given location were assumed to be exposed for a maximum of four days to the maximum concentration of waste material. Contaminant concentrations would be reduced by longitudinal dispersion as the contaminants move downstream. Biota in the water column would receive an external exposure to suspended or dissolved radioisotopes.

In the other case, it was assumed that all of the released material was immediately deposited on the stream sediment at the release site. Aquatic organisms present at the release site were assumed to be exposed over their entire lifetime. Benthic (that is, bottom dwelling) biota would receive an external exposure from radiological waste deposited in sediment. If the deposited materials were allowed to remain in the sediment for a sufficient length of time, many isotopes would become incorporated into aquatic food chains. Food chain exposure would produce internal exposures for benthic organisms and for fish or other organisms that feed on them.

C.4.4.2.1 *Data Sources*

Estimates of the potential impacts of transportation accidents to aquatic organisms were conducted by Oak Ridge National Laboratory (ORNL, 1995b). ORNL used the waste load source term data provided by ANL as inputs to aquatic environmental fate models to estimate maximum credible radiological releases for transportation accidents involving HLW, LLW, and CH and RH TRUW. For each waste type, ANL provided information on the radionuclides and total activity present in a shipment and on the total release in a maximum severity accident. ANL concluded that for HLW and TRUW only a small portion of the total shipment inventory would be released because the only credible accidental release mechanisms for these waste types involve small cracks and seal failures in shipping containers. The entire contents of the LLW shipment were assumed to be released during a maximum severity accident; however, only a small fraction of the release was assumed to be soluble. The analysis of LLMW was based on the LLW results. Effects for HW and the chemical component of LLMW were not quantified as noted above (ANL, 1996a).

The source terms used in the assessment were obtained by screening the source terms from all sites for all alternatives for these waste types to identify the waste shipments that would result in the highest releases.

The environmental fate of the spilled contaminants was estimated using a two-dimensional aquatic chemical fate model (EPA, 1985c). It was assumed that all of the spilled material remained in the water column for transport downstream or to sediment (ORNL, 1995b).

C.4.4.2.2 *Data Evaluation*

For aquatic biota, adverse short-term effects (that is, acute toxicity) are assumed to occur if the estimated doses exceeded the maximum safe dose of one rad per day (rad/day) recommended by the National Council on Radiation Protection and Measurements (NCRP, 1991). The results of the water column assessment include estimates of (1) the length (meters) of the stream (for each size class) affected before longitudinal dispersion reduces the exposure below the NCRP threshold; and (2) the time (hours) required for this dispersion to occur.

The results of the sediment assessment include estimates of the amount (kilogram) of clean sediment needed to dilute the spilled material to a sediment activity level corresponding to a one rad/day lifetime dose to a large fish residing at the bottom of the stream and feeding on benthic biota. This value also should be a reasonable estimate of the amount of sediment that would have to be removed during a remedial action taken following the spill.

C.4.5 Economic Impacts Analysis Methods

The economic impact analysis methods were used to estimate the economic impacts of the WM alternatives on the regional and National economies. The impacts assessment addressed potential changes in regional employment, personal income, and industry output due to WM expenditures at the 17 major sites (Table C.4–17). The assessment also addressed changes in National employment, personal income, and industry output due to the sum of spending on WM facility activities at all applicable sites and on waste transportation between sites under each waste type alternative. This section describes the analysis procedures, assumptions, data, evaluation techniques, and the presentation of the results from the economic impacts analysis.

Table C.4-17. Economic Impacts Analyzed for the WM Alternatives

Economic Impact Analyzed	Affected Aspect of Economy	Impact Analysis Method	Presentation of Results
Effect on regional employment	Level of regional employment at the major sites	Proposed site expenditures multiplied by regional employment multiplier at each major site	Tabular or text-only depending on range of results
Effect on regional incomes	Level of regional personal income at the major sites	Proposed site expenditures multiplied by regional income multiplier at each major site	Tabular or text-only depending on range of results
Effect on regional industry output	Value of regional industrial production	Proposed site expenditures multiplied by regional income multiplier at each major site	Presented in Environmental Impacts Technical Report only
National economic effects	National employment, personal income, and industry output	Proposed site expenditures at all involved sites plus intersite transportation costs multiplied by national employment, income, and industry output multipliers	Text discussion

C.4.5.1 Focus of the Economic Impact Assessment

The economic impact analyses of the WM alternatives used a methodology that is standard for industrial construction projects, although the WM program presents several unique economic considerations because the WM facilities are designed to treat, store, and/or dispose of radioactive and hazardous waste. Because processing of these wastes requires substantial provisions to decrease the probability of harm to human health and the environment, special costs apply that include the costs of environmental documentation, for example, under Resource Conservation and Recovery Act (42 USC 6901 *et seq.*) and NEPA (42 USC 4321 *et seq.*), for monitoring, and for shielding.

The specific project expenditure categories include design and planning, testing, construction, cold start, O&M, D&D, and transportation. These expenditures and their respective time periods are not uniform across waste types. For example, there is no D&D phase for high-level waste. In the case of the alternatives for hazardous waste, there are expenditures proposed for commercial treatment, storage, and disposal facilities that factor into the National economy. Expenditures were aggregated into three major phases: construction, operations, and transportation. The construction phase encompasses all activities from the design phase through the cold start. The operations phase encompasses the O&M period as well as D&D. The transportation phase generally coincided with the O&M portion of the operations phase. The analysis

focused on the economic consequences of spending money on waste management activities within these major project phases. The full economic consequences of waste management activities were assumed to continue for an additional five years beyond the end of each phase (Cuthbertson and Nitzsche, 1994).

DOE recognizes the potential for economic effect on the ROI resulting from negative perceptions associated with its waste management program; for example, real estate property values in the vicinity of a radioactive waste disposal facility may decline, or the ability of the region to attract a diversified business base may be affected. However, although these potential impacts are recognized, they are not amenable to analysis at the programmatic level and in the absence of a specific location for the facility proposed. The nature and extent of such impacts is therefore not included in this PEIS.

C.4.5.2 Quantitative Effects

The principal variables selected to characterize the regional and National economics and provide the baseline conditions for the 17 major sites—employment, per capita income, and population—are presented in Chapter 4. Per capita income was multiplied by population to calculate total personal income. Data for these variables are provided for 1990 in 1990 dollars.

The economic analysis employed three standard measures of change—employment, personal income, and industry output—as indicators of the potential impact of the WM alternatives. Changes in these indicators form the basis for the comparison of alternatives. Results of the analysis are presented both as absolute numbers and as changes over the 1990 baseline for the ROI as a whole. Since the absolute numbers are used, alternatives can be compared with each other in terms of absolute overall effect, independent of other, external changes in the prevailing conditions of the region of influence.

By comparing values for these indicators with the No Action and Decentralized Alternatives at a given site, the effect, in terms of a net change (either decrease or increase), can be determined for each of the other alternatives (see site tables, volume II). In addition to providing data on potential increases in these variables, the analysis also provides a basis for assessing the potential for losses in employment due to the shifting of work away from the site. This is available in the existing analysis as a comparison of the effects presented for the Decentralized or No Action Alternatives with the remaining alternatives.

The economic impact analysis estimated changes in employment, personal income, and industry output that would result from the direct infusion of project dollars into the regional and national economies and subsequent multiple cycles of spending. The following definitions of these variables apply to both the affected environment and impact chapters of the PEIS.

C.4.5.2.1 *Employment*

One of the variables that the economic impacts generated by the model described below is "job-years." The variable "job-years" is equivalent to person-years, or full-time equivalents. One job-year is equal to 2,080 hours of employment in a twelve month period. Employment is the count of full- and part-time jobs. Job-years is converted to jobs or employment by dividing the number of job-years by the number of years over which the initial expenditures take place, plus the additional time it takes for the successive rounds of expenditure to occur (i.e., five years for each phase).

Employment impacts are presented according to place of work. Employment by place of work shows how many people work in a given region irrespective of where they live. The workforce of a regional economy is considered to be the number of people that work in a given region (as opposed to the number of people that live and work in the region). The economic impact analysis is geared to determine what the change in direct, indirect, and induced employment would be given a change in expenditures in the region. The research question is one of how many jobs will be generated in total, not how many jobs will be generated for the people that live in a given county.

The employment by place of residence shows how many people in a given region (a county or aggregation of counties) have jobs, irrespective of which region their jobs are in. The affected environment chapter in the PEIS (Chapter 4) provides employment by place of residence for the 17 major DOE sites. The ratio of the site workforce to employment by place of residence is an indicator of regional economic dependence on DOE sites. If there were a change in the number of jobs at a site, the change in the unemployment rate would be reported by where people live, not work.

While the data will indicate the direction of change, information on the magnitude of the changes will be more vague. It will be difficult to gauge the change in the unemployment rates due to a change in waste management spending, for example, but estimates of the magnitude of change in employment can be given. The percentage of earnings to labor from each of the "division level" Standard Industrial Classification

(SIC) codes gives a useful snapshot of the character of the economy, but it will not be possible to determine how the composition of labor earnings will change given the implementation of one of the alternatives at a site. This is because the programmatic level of analysis must focus on a level of detail that enables a comparison of alternatives across sites and waste types. Analyzing changes in the composition of earnings obscures the importance of variables that facilitate a meaningful comparison of alternatives.

Baseline employment (by place of work) and baseline personal income for every ROI has been extracted from the U.S. Bureau of Economic Analysis' Regional Economic Information System (DOC, 1992a) and is presented in Tables C.4–18 and C.4–19.

C.4.5.2.2 *Personal Income*

Total personal income is defined as pre-tax disposable income to the household sector. It is useful as a measure of the purchasing power available to consumers. The impacts analysis uses a measure of income that subtracts taxes out of the first cycle of spending. While the two measures are not identically defined, the numbers are similar enough that they can be combined.

C.4.5.2.3 *Industry Output*

Output is defined as gross industry receipts (DOC, 1992b), i.e., the number of units of goods and services that are sold times the price per unit. Output is useful in illustrating the magnitude of economic activity in a given region or in the national economy. Output, however, has two important limitations:

- Output includes the revenues for each cycle of expenditure. Therefore, the value of a given good or service may be accumulated several times as an intermediate good before it is ultimately sold as a final good to the consumer.
- Baseline measures of output are not available at the regional level. The model used to determine impacts provides a change in output given a change in initial expenditures, but data are not available to compute a percent change in the baseline output.

Table C.4-18. Baseline Employment Data

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
Ames	Boone (IA)	10,266	11,351	11,684	11,006	11,205	9.1%
	Hamilton (IA)	8,237	8,969	9,427	9,418	10,210	24.0%
	Hardin (IA)	10,110	10,809	11,822	11,290	11,323	12.0%
	Jasper (IA)	15,997	16,390	16,889	16,770	17,823	11.4%
	Marshall (IA)	20,632	22,377	23,519	21,779	23,065	11.8%
	Polk (IA)	157,758	179,201	206,377	216,637	255,686	62.1%
	Story (IA)	28,296	33,610	40,419	42,245	46,365	63.9%
		251,296	282,707	320,137	329,145	375,677	49.5%
ANL-E	Cook (IL)	2,780,014	2,742,358	2,873,797	2,885,969	3,080,458	10.8%
	Du Page (IL)	154,520	215,484	282,623	382,481	510,994	230.7%
	Kane (IL)	108,159	117,301	131,252	141,234	171,116	58.2%
	Will (IL)	87,178	90,369	100,401	104,134	121,273	39.1%
		3,129,871	3,165,512	3,388,073	3,513,818	3,883,841	24.1%
BCL	Delaware (OH)	15,851	17,914	21,449	23,432	27,026	70.5%
	Fairfield (OH)	27,211	30,877	36,655	35,308	38,948	43.1%
	Franklin (OH)	399,431	447,635	512,397	576,164	680,737	70.4%
	Licking (OH)	41,660	43,642	50,269	52,119	56,828	36.4%
	Madison (OH)	9,124	9,763	10,205	10,262	13,287	45.6%
	Pickaway (OH)	14,546	16,037	17,188	16,031	17,800	22.4%
	Union (OH)	10,672	11,289	12,486	15,042	22,671	112.4%
		518,495	577,157	660,649	728,358	857,297	65.3%
Bettis	Allegheny (PA)	730,822	731,255	765,235	742,910	802,173	9.8%
	Armstrong (PA)	22,139	24,075	24,607	23,111	24,280	9.7%
	Beaver (PA)	81,428	87,386	86,106	64,258	62,093	-23.7%
	Butler (PA)	46,384	49,600	56,201	56,647	67,382	45.3%
	Washington (PA)	71,399	77,275	79,039	73,958	80,823	13.2%
	Westmoreland (PA)	123,374	131,997	147,434	141.501	151,582	22.9%
		1,075,546	1,101,588	1,158,622	1,102,385	1,188,333	10.5%
BNL	Nassau (NY)	556,601	581,113	648,039	749,839	771,414	38.6%
	Suffolk (NY)	317,836	378,992	470,017	586,728	647,626	103.8%
		874,437	960,105	1,118,056	1,336,567	1,419,040	62.3%
Charleston	Berkeley (SC)	12,091	15,250	23,617	27,331	33,869	180.1%
	Charleston (SC)	130,125	147,319	167,296	196,497	226,839	74.3%
	Colleton (SC)	10,507	10,942	11,591	12,568	13,805	31.4%
	Dorchester (SC)	8,701	11,782	15,983	21,662	25,392	191.8%
		161,424	185,293	218,487	258,058	299,905	85.8%
Colonie	Albany (NY)	179,332	183,478	203,657	225,005	256,215	42.9%
	Columbia (NY)	17,950	19,455	20,598	22,942	25,561	42.4%
	Greene (NY)	11,675	13,144	14,306	15,456	17,034	45.9%
	Rensselaer (NY)	44,314	44,726	46,767	52,406	61,152	38.0%
	Saratoga (NY)	30,254	35,894	44,418	54,378	68,058	125.0%
	Schenectady (NY)	71,461	75,442	75,567	75,564	79,628	11.4%
	Schoharie (NY)	7,799	8,514	8,656	9,267	10,655	36.6%
		362,785	380,653	413,969	455,018	518,303	42.9%
ETEC	Kern (CA)	136,096	166,838	198,411	231,191	259,475	90.7%
	Los Angeles (CA)	3,326,115	3,551,891	4,272,799	4,661,161	5,199,569	56.3%
	San Luis Obispo (CA)	37,913	48,874	65,028	83,929	103,621	173.3%
	Santa Barbara (CA)	113,665	134,333	163,668	193,381	213,960	88.2%
	Ventura (CA)	131,954	166,800	216,109	259,345	320,927	143.2%
		3,745,743	4,068,736	4,916,015	5,429,007	6,097,552	62.8%
Fermi	Cook (IL)	2,780,014	2,742,358	2,873,797	2,885,969	3,080,458	10.8%
	De Kalb (IL)	31,128	31,702	34,187	35,438	38,832	24.7%
	Du Page (IL)	154,520	215,484	282,623	382,481	510,994	230.7%
	Kane (IL)	108,159	117,301	131,252	141,234	171,116	58.2%
	Kendall (IL)	13,871	16,224	17,041	13,700	10,763	-22.4%
	McHenry (IL)	41,314	46,505	55,262	65,007	81,866	98.2%
	Will (IL)	87,178	90,369	100,401	104,134	121,273	39.1%
		3,216,184	3,259,943	3,494,563	3,627,963	4,015,302	24.8%
FEMP	Butler (OH)	82,804	87,339	99,638	103,659	115,182	39.1%
	Hamilton (OH)	488,962	490,210	540,620	562,639	630,991	29.0%
	Warren (OH)	17,209	21,622	27,641	31,891	44,723	159.9%
	Dearborn (IN)	10,779	11,322	12,629	12,114	13,480	25.1%
		599,754	610,493	680,528	710,303	804,376	34.1%

Table C.4-18. Baseline Employment Data—Continued

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
GA	Imperial (CA)	33,842	41,879	45,988	40,725	52,289	54.5%
	Orange (CA)	531,119	711,851	1,038,731	1,271,121	1,552,291	192.3%
	Riverside (CA)	166,660	192,861	256,835	317,421	436,293	161.8%
	San Diego (CA)	633,738	733,668	963,302	1,154,677	1,396,552	120.4%
		1,365,359	1,680,259	2,304,856	2,783,944	3,437,425	151.8%
GE	Alpine (CA)	200	248	520	707	802	301.0%
	Amador (CA)	4,720	5,839	7,656	9,173	11,974	153.7%
	Calaveras (CA)	4,618	4,743	7,524	8,880	10,610	129.8%
	San Joaquin (CA)	123,076	139,076	162,927	181,349	211,109	71.5%
	Stanislaus (CA)	81,872	98,597	121,735	132,122	166,656	103.6%
	Tuolumne (CA)	7,473	9,570	13,817	16,582	20,641	176.2%
		221,959	258,073	314,179	348,813	421,792	90.0%
GJPO	Delta (CO)	5,515	6,599	8,667	9,155	9,506	72.4%
	Garfield (CO)	5,783	8,747	11,873	14,554	17,224	197.8%
	Gunnison (CO)	2,664	3,979	6,163	6,263	7,041	164.3%
	Mesa (CO)	22,275	29,506	42,466	43,106	48,064	115.8%
	Montrose (CO)	7,025	8,806	11,649	11,460	13,141	87.1%
	Pitkin (CO)	4,231	7,865	11,529	12,764	16,546	291.1%
	Grand (UT)	2,675	3,032	4,045	2,955	3,122	16.7%
		50,168	68,534	96,392	100,257	114,644	128.5%
Hanford	Adams (WA)	6,976	7,602	8,076	7,894	8,409	20.5%
	Benton (WA)	27,477	38,013	58,925	54,409	59,910	118.0%
	Franklin (WA)	12,743	15,528	18,414	17,177	21,129	65.8%
	Grant (WA)	18,323	22,333	23,340	23,904	26,950	47.1%
	Yakima (WA)	62,556	71,326	82,024	84,284	97,900	56.5%
		128,075	154,802	190,779	187,668	214,298	67.3%
INEL	Bannock (ID)	20,961	26,185	30,628	30,386	30,078	43.5%
	Bingham (ID)	12,362	14,051	15,150	15,679	16,758	35.6%
	Bonneville (ID)	22,232	26,706	31,452	33,436	38,092	71.3%
	Butte (ID)	4,287	5,347	6,625	7,054	7,934	85.1%
	Clark (ID)	463	539	602	584	679	46.7%
	Jefferson (ID)	4,221	4,953	5,603	5,470	6,151	45.7%
		64,526	77,781	90,060	92,609	99,692	54.5%
KCP	Cass (MO)	13,222	15,139	14,298	17,627	20,904	58.1%
	Clay (MO)	40,959	42,843	51,268	66,683	77,616	89.5%
	Jackson (MO)	385,262	390,795	424,126	430,173	441,174	14.5%
	Johnson (MO)	14,493	16,243	17,867	19,173	21,770	50.2%
	Lafayette (MO)	10,684	11,221	12,036	12,253	13,439	25.8%
	Ray (MO)	4,662	5,357	5,736	6,583	6,784	45.5%
	Johnson (KS)	70,399	98,553	141,148	185,482	242,894	245.0%
	Wyandotte (KS)	81,896	87,583	92,056	93,354	91,892	12.2%
		621,577	667,734	758,535	831,328	916,473	47.4%
KAPL-K	Fulton (NY)	18,714	18,882	19,715	20,262	21,167	13.1%
	Saratoga (NY)	30,254	35,894	44,418	54,378	68,058	125.0%
	Schenectady (NY)	71,461	75,442	75,567	75,564	79,628	11.4%
		120,429	130,218	139,700	150,204	168,853	40.2%
KAPL-N	Albany (NY)	179,332	183,478	203,657	225,005	256,215	42.9%
	Montgomery (NY)	22,062	20,904	22,387	23,284	24,092	9.2%
	Saratoga (NY)	30,254	35,894	44,418	54,378	68,058	125.0%
	Schenectady (NY)	71,461	75,442	75,567	75,564	79,628	11.4%
	Schoharie (NY)	7,799	8,514	8,656	9,267	10,655	36.6%
		310,908	324,232	354,685	387,498	438,648	41.1%
KAPL-W	Hartford (CT)	438,369	452,340	527,904	572,596	615,574	40.4%
	Litchfield (CT)	53,720	56,711	68,844	76,288	85,810	59.7%
	Middlesex (CT)	45,352	51,689	60,868	73,741	82,460	81.8%
	New Haven (CT)	337,150	345,124	380,393	414,784	444,307	31.8%
	Tolland (CT)	26,124	29,700	33,363	39,941	48,387	85.2%
	Hampden (MA)	202,106	198,347	220,977	229,234	240,374	18.9%
		1,102,821	1,133,911	1,292,349	1,406,584	1,516,912	37.5%

Table C.4-18. Baseline Employment Data—Continued

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
LEHR	Colusa (CA)	6,205	7,138	7,112	6,942	7,891	27.2%
	Lake (CA)	6,677	8,708	11,881	15,251	17,218	157.9%
	Napa (CA)	26,918	34,555	42,081	48,591	58,321	116.7%
	Sacramento (CA)	276,010	320,242	396,980	485,139	603,669	118.7%
	Solano (CA)	76,418	82,069	96,464	111,163	134,353	75.8%
	Sutter (CA)	15,427	19,256	22,441	22,643	26,725	73.2%
	Yolo (CA)	34,958	47,963	57,528	64,323	82,075	134.8%
		442,613	519,931	634,487	754,052	930,252	110.2%
LBL	Alameda (CA)	490,578	509,946	588,728	656,286	738,160	50.5%
	Contra Costa (CA)	170,808	202,758	262,043	321,605	396,508	132.1%
		661,386	712,704	850,771	977,891	1,134,668	71.6%
LLNL	Alameda (CA)	490,578	509,946	588,728	656,286	738,160	50.5%
	Contra Costa (CA)	170,808	202,758	262,043	321,605	396,508	132.1%
	San Joaquin (CA)	123,076	139,076	162,927	181,349	211,109	71.5%
	Stanislaus (CA)	81,872	98,597	121,735	132,122	166,656	103.6%
		866,334	950,377	1,135,433	1,291,362	1,512,433	74.6%
LANL	Los Alamos (NM)	8,802	10,950	14,010	16,831	18,066	105.2%
	Rio Arriba (NM)	6,505	7,006	8,303	9,377	10,341	59.0%
	Santa Fe (NM)	22,125	28,707	36,708	46,045	55,088	149.0%
		37,432	46,663	59,021	72,253	83,495	123.1%
Mare Island	Contra Costa (CA)	170,808	202,758	262,043	321,605	396,508	132.1%
	Lake (CA)	6,677	8,708	11,881	15,251	17,218	157.9%
	Marin (CA)	68,350	81,672	105,136	131,293	149,704	119.0%
	Mendocino (CA)	19,826	24,124	32,118	35,191	41,643	110.0%
	Napa (CA)	26,918	34,555	42,081	48,591	58,321	116.7%
	Sonoma (CA)	71,368	93,149	129,858	162,799	200,809	181.4%
		363,947	444,966	583,117	714,730	864,203	137.5%
Middlesex	Mercer (NJ)	152,536	163,220	180,825	197,963	218,289	43.1%
	Middlesex (NJ)	236,060	264,873	317,105	362,229	410,340	73.8%
	Monmouth (NJ)	156,505	173,172	205,799	247,685	278,379	77.9%
	Somerset (NJ)	73,129	87,696	110,237	138,071	162,850	122.7%
	Union (NJ)	289,170	276,194	298,539	312,241	298,021	3.1%
		907,400	965,155	1,112,505	1,258,189	1,367,879	50.7%
Mound	Butler (OH)	82,804	87,339	99,638	103,659	115,182	39.1%
	Clark (OH)	54,155	54,702	58,828	58,685	64,883	19.8%
	Darke (OH)	17,601	19,586	20,840	21,516	23,698	34.6%
	Greene (OH)	38,914	41,134	45,604	51,345	61,164	57.2%
	Miami (OH)	33,836	35,269	41,309	41,334	45,711	35.1%
	Montgomery (OH)	310,229	296,176	319,744	336,040	365,015	17.7%
	Preble (OH)	9,686	10,484	11,389	12,650	13,803	42.5%
	Warren (OH)	17,209	21,622	27,641	31,891	44,723	159.9%
		564,434	566,312	624,993	657,120	734,179	30.1%
NTS	Clark (NV)	131,904	171,122	261,135	301,329	441,267	234.5%
	Nye (NV)	7,140	5,794	7,819	11,071	12,763	78.8%
		139,044	176,916	268,954	312,400	454,030	226.5%
Norfolk	Chesapeake city (VA)	22,046	24,449	31,494	41,790	60,021	172.3%
	Hampton city (VA)	49,777	52,385	60,119	69,468	74,278	49.2%
	Newport News city (VA)	74,805	78,736	84,006	96,784	108,988	45.7%
	Norfolk city (VA)	209,849	211,839	225,741	245,270	256,042	22.0%
	Suffolk city (VA)	17,837	19,957	19,391	19,414	20,545	15.2%
	Virginia Beach city (VA)	64,219	77,602	106,903	151,809	182,932	184.9%
	Isle of Wight (VA)	9,222	9,781	11,791	11,380	12,346	33.9%
		447,755	474,749	539,445	635,915	715,152	59.7%
ORR	Anderson (TN)	20,457	24,385	30,785	32,310	39,083	91.1%
	Knox (TN)	123,389	143,530	174,676	187,012	212,347	72.1%
	Loudon (TN)	8,434	9,012	9,966	10,694	12,310	46.0%
	Roane (TN)	21,217	21,211	23,362	22,289	24,234	14.2%
		173,497	198,138	238,789	252,305	287,974	66.0%

Table C.4-18. Baseline Employment Data—Continued

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
PGDP	Ballard (KY)	3,139	3,344	3,812	3,603	3,868	23.2%
	Carlisle (KY)	1,911	1,814	1,768	1,798	1,802	-5.7%
	Graves (KY)	12,550	13,566	13,549	13,552	15,312	22.0%
	Marshall (KY)	9,121	9,125	10,705	10,901	12,773	40.0%
	McCracken (KY)	27,167	31,027	34,536	34,007	41,056	51.1%
	Massac (IL)	4,776	5,078	5,267	4,666	4,945	3.5%
		58,664	63,954	69,637	68,527	79,756	36.0%
Palos	Cook (IL)	2,780,014	2,742,358	2,873,797	2,885,969	3,080,458	10.8%
	Du Page (IL)	154,520	215,484	282,623	382,481	510,994	230.7%
	Kane (IL)	108,159	117,301	131,252	141,234	171,116	58.2%
	Lake (IL)	164,074	177,608	206,965	238,950	292,353	78.2%
	McHenry (IL)	41,314	46,505	55,262	65,007	81,866	98.2%
	Will (IL)	87,178	90,369	100,401	104,134	121,273	39.1%
	Lake (IN)	228,285	227,217	237,925	205,496	228,304	0.0%
		3,563,544	3,616,842	3,888,225	4,023,271	4,486,364	25.9%
Pantex	Carson (TX)	4,536	4,681	4,619	5,279	4,956	9.3%
	Potter (TX)	55,811	68,372	77,990	86,106	78,713	41.0%
	Randall (TX)	9,502	11,954	14,554	18,663	20,585	116.6%
		69,849	85,007	97,163	110,048	104,254	49.3%
Pearl H	Honolulu (HI)	354,084	400,793	454,443	474,056	540,449	52.6%
	Kauai (HI)	13,518	16,252	21,278	23,900	31,820	135.4%
	Maui (HI)	21,023	27,778	38,034	47,507	63,110	200.2%
		388,625	444,823	513,755	545,463	635,379	63.5%
Pinellas	Hillsborough (FL)	219,555	276,643	334,297	443,567	534,096	143.3%
	Pasco (FL)	17,603	30,096	46,570	66,730	83,624	375.1%
	Pinellas (FL)	185,693	232,451	307,786	400,674	457,517	146.4%
		422,851	539,190	688,653	910,971	1,075,237	154.3%
PORTS	Jackson (OH)	8,995	9,430	9,911	11,328	11,560	28.5%
	Pike (OH)	6,030	7,300	9,135	9,481	9,876	63.8%
	Ross (OH)	23,046	23,172	26,441	27,342	28,598	24.1%
	Scioto (OH)	26,467	24,934	26,633	25,617	27,772	4.9%
		64,538	64,836	72,120	73,768	77,806	20.6%
Ports Nav	Cumberland (ME)	97,734	107,768	126,806	151,907	183,271	87.5%
	Oxford (ME)	17,305	18,085	21,598	20,341	23,304	34.7%
	York (ME)	46,430	48,463	60,765	72,106	83,380	79.6%
	Carroll (NH)	8,070	10,525	14,020	18,809	23,172	187.1%
	Rockingham (NH)	49,342	60,202	89,598	117,970	134,660	172.9%
	Strafford (NH)	30,189	31,769	40,538	44,984	50,420	67.0%
		249,070	276,812	353,325	426,117	498,207	100.0%
PPPL	Burlington (NJ)	135,712	127,481	142,828	175,494	202,936	49.5%
	Hunterdon (NJ)	24,227	27,383	32,991	44,645	52,433	116.4%
	Mercer (NJ)	152,536	163,220	180,825	197,963	218,289	43.1%
	Middlesex (NJ)	236,060	264,873	317,105	362,229	410,340	73.8%
	Monmouth (NJ)	156,505	173,172	205,799	247,685	278,379	77.9%
	Somerset (NJ)	73,129	87,696	110,237	138,071	162,850	122.7%
	Bucks (PA)	137,592	163,917	199,483	234,165	266,078	93.4%
		915,761	1,007,742	1,189,268	1,400,252	1,591,305	73.8%
Puget So	Jefferson (WA)	3,628	4,405	6,183	7,114	9,117	151.3%
	King (WA)	537,408	605,581	804,356	901,911	1,131,447	110.5%
	Kitsap (WA)	44,510	50,766	66,838	78,435	95,238	114.0%
	Mason (WA)	6,919	8,067	10,767	11,274	13,333	92.7%
	Pierce (WA)	184,149	178,218	207,284	234,443	269,479	46.3%
		776,614	847,037	1,095,428	1,233,177	1,518,614	95.5%
RMI	Ashtabula (OH)	37,633	38,012	40,731	38,646	38,878	3.3%
	Geauga (OH)	15,640	18,878	23,400	28,035	32,720	109.2%
	Lake (OH)	62,584	72,178	86,842	90,650	103,431	65.3%
	Trumbull (OH)	95,326	102,895	107,783	102,098	105,424	10.6%
	Crawford (PA)	32,380	34,817	36,833	36,586	39,330	21.5%
	Erie (PA)	115,493	129,015	132,838	130,760	143,588	24.3%
		359,056	395,795	428,427	426,775	463,371	29.1%

Table C.4-18. Baseline Employment Data—Continued

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
RFETS	Adams (CO)	47,558	72,721	97,335	113,176	126,465	165.9%
	Arapahoe (CO)	48,565	87,125	132,994	191,619	218,287	349.5%
	Boulder (CO)	53,430	76,151	110,011	139,658	157,460	194.7%
	Denver (CO)	379,312	399,634	480,031	510,784	469,920	23.9%
	Jefferson (CO)	68,124	109,812	154,901	207,232	226,393	232.3%
		596,989	745,443	975,272	1,162,469	1,198,525	100.8%
SNL/NM	Bernalillo (NM)	135,635	176,533	219,901	266,864	304,985	124.9%
	Cibola (NM)	0	0	0	5,358	6,148	NA
	Sandoval (NM)	3,323	4,386	5,495	8,987	12,734	283.2%
	Santa Fe (NM)	22,125	28,707	36,708	46,045	55,088	149.0%
	Torrance (NM)	1,879	2,046	2,182	2,496	2,957	57.4%
	Valencia (NM)	9,110	12,208	17,661	9,695	11,486	26.1%
		172,072	223,880	281,947	339,445	393,398	128.6%
SRS	Aiken (SC)	35,181	38,587	45,585	52,476	73,012	107.5%
	Allendale (SC)	5,399	4,581	4,273	4,128	4,784	-11.4%
	Bamberg (SC)	6,327	6,268	6,691	6,118	6,139	-3.0%
	Barnwell (SC)	7,598	8,827	8,942	9,766	9,242	21.6%
	Burke (GA)	5,833	6,457	7,806	16,144	8,470	45.2%
	Columbia (GA)	21,949	15,829	22,958	26,033	28,284	28.9%
	Richmond (GA)	71,085	79,213	90,877	102,953	119,064	67.5%
	Screven (GA)	4,752	5,392	5,906	5,587	5,782	21.7%
		158,124	165,154	193,038	223,205	254,777	61.1%
SLAC	Alameda (CA)	490,578	509,946	588,728	656,286	738,160	50.5%
	Monterey (CA)	131,810	147,482	156,959	176,632	202,533	53.7%
	San Benito (CA)	7,902	9,020	10,481	11,808	15,212	92.5%
	San Mateo (CA)	227,090	259,528	313,958	349,819	396,533	74.6%
	Santa Clara (CA)	446,473	553,366	790,461	930,931	1,015,759	127.5%
	Santa Cruz (CA)	47,367	61,480	82,228	102,096	122,735	159.1%
	Stanislaus (CA)	81,872	98,597	121,735	132,122	166,656	103.6%
		1,433,092	1,639,419	2,064,550	2,359,694	2,657,588	85.4%
U of Mo	Audrain (MO)	12,400	12,868	13,518	12,386	12,779	3.1%
	Boone (MO)	39,057	46,023	56,810	63,584	75,366	93.0%
	Callaway (MO)	10,588	11,120	16,920	14,611	16,281	53.8%
	Cole (MO)	28,045	32,876	38,421	42,868	48,500	72.9%
	Cooper (MO)	6,488	6,913	6,965	7,026	7,097	9.4%
	Howard (MO)	4,866	4,555	4,190	4,364	4,421	-9.1%
	Moniteau (MO)	4,796	4,722	5,338	5,752	6,231	29.9%
	Randolph (MO)	8,977	9,883	11,321	12,350	12,666	41.1%
		115,217	128,960	153,483	162,941	183,341	59.1%
WIPP	Chaves (NM)	16,649	19,528	22,695	25,116	26,216	57.5%
	Eddy (NM)	15,825	18,410	21,374	22,298	21,748	37.4%
	Lea (NM)	20,607	23,894	29,280	30,095	25,009	21.4%
	Otero (NM)	19,079	20,526	22,626	25,681	24,956	30.8%
	Culberson (TX)	1,854	1,848	1,897	1,815	1,718	-7.3%
	Loving (TX)	102	175	131	123	60	-41.2%
		74,116	84,381	98,003	105,128	99,707	34.5%
WSSR	Franklin (MO)	19,479	22,207	27,656	31,825	38,233	96.3%
	Jefferson (MO)	19,773	21,857	29,787	38,875	47,635	140.9%
	St. Charles (MO)	23,441	29,902	40,985	66,107	83,286	255.3%
	St. Louis (MO)	355,947	393,919	477,764	610,547	695,600	95.4%
	Madison (IL)	97,430	96,639	100,691	99,640	112,247	15.2%
	Monroe (IL)	4,923	5,464	5,742	6,598	7,448	51.3%
	St. Clair (IL)	91,681	94,622	99,354	98,863	105,059	14.6%
		612,674	664,610	781,979	952,455	1,089,508	77.8%

Table C.4-18. Baseline Employment Data—Continued

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
WVDP	Cattaraugus (NY)	31,724	32,991	35,540	35,920	39,434	24.3%
	Erie (NY)	465,799	466,761	477,986	476,411	529,812	13.7%
		497,523	499,752	513,526	512,331	569,246	14.4%
UNITED STATES		89,753	97,177	112,257	123,176	137,160	52.8%

Notes: Ames = Ames Laboratory; ANL-E = Argonne National Laboratory-East; Bettis = Bettis Atomic Power Plant; BCL = Battelle Columbus Laboratories; BNL = Brookhaven National Laboratory; Charleston = Charleston Naval Shipyard; ETEC = Energy Technology Engineering Center; FEMP = Fernald Environmental Management Project; Fermi = Fermi National Accelerator Laboratory; GE = General Electric Vallecitos Nuclear Center; INEL = Idaho National Engineering Laboratory; KAPL-N = Knolls Atomic Power Laboratory (Niskayuna); LLNL = Lawrence Livermore National Laboratory; LANL = Los Alamos National Laboratory; GA = General Atomics; GJPO = Grand Junction Projects Office; KAPL-K = Knolls Atomic Power Laboratory (Kesselring); KAPL-W = Knolls Atomic Power Laboratory (Windsor); KCP = Kansas City Plant; LBL = Lawrence Berkeley National Laboratory; LEHR = Laboratory for Energy-Related Health Research; Mare Is = Mare Island Naval Shipyard; Middlesex = Middlesex Sampling Laboratory; Mound = Mound Plant; Norfolk = Norfolk Naval Shipyard; NTS = Nevada Test Site; ORR = Oak Ridge Reservation; Palos = Palos Forest; Pearl H = Pearl Harbor Naval Shipyard; PGDP = Paducah Gaseous Diffusion Plant; PORTS = Portsmouth Gaseous Diffusion Plant; Ports Nav = Portsmouth Naval Shipyard; PPPL = Princeton Plasma Physics Laboratory; Puget So = Puget Sound Naval Shipyard; RFETS = Rocky Flats Environmental Technology Site; RMI = Reactive Metals, Inc.; SLAC = Stanford Linear Accelerator System; SNL/NM = Sandia National Laboratories (New Mexico); SRS = Savannah River Site; UofMO = University of Missouri; WIPP = Waste Isolation Pilot Plant; WSSR = Weldon Spring Site Remedial Action Project; and WVDP = West Valley Demonstration Project.

Source: U.S. Department of Commerce (1992a).

C.4.5.3 Impacts Analysis Procedures

C.4.5.3.1 *Development of Regional Multipliers*

The economic impact analysis was conducted by first determining how responsive the National economy and the various regional economies were to a change in expenditures. The result of this determination was quantified in what is termed a "multiplier." Each site has a unique ROI (relevant counties as defined below) and each industry within that region has a unique degree of responsiveness to changes in the level of expenditures in the region. Multipliers for disposable income, output, and job-years were developed for 80 industries (industrial sectors) for the aggregate county regions of influence and the national economy. The multipliers were derived from an 80-sector model based on the Regional Input-Output Modeling System (RIMS II) approach developed by the U.S. Department of Commerce, Bureau of Economic Analysis (DOC, 1992b).

The procedure for developing the regional multipliers required establishing an economic ROI for each site. This was done by identifying those counties in the vicinity of the site where economic impacts would be expected to occur. Counties are unique in their ability to provide the labor and other resources necessary to any particular line of production. The demand for intermediate goods (i.e., goods that are used in the production of other goods) is a function of the demand for final goods. The technique used to measure a county's ability to satisfy production requirements was first to establish the relationships between industries

Table C.4-19. Baseline Personal Income

Total Personal Income ($ million)

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
Ames	Boone (IA)	98.6	168.7	261.4	324.0	402.3	308.1%
	Hamilton (IA)	74.5	128.7	190.3	246.3	314.7	322.6%
	Hardin (IA)	92.0	141.9	215.9	276.2	333.6	262.7%
	Jasper (IA)	142.1	228.1	356.8	485.9	634.1	346.2%
	Marshall (IA)	182.4	290.9	433.1	539.1	692.8	279.8%
	Polk (IA)	1,268.0	2,073.2	3,444.2	4,703.3	6,620.9	422.1%
	Story (IA)	210.3	354.0	633.2	879.5	1,180.8	461.6%
		2,067.9	3,385.5	5,534.9	7,454.2	10,179.3	392.3%
ANL-E	Cook (IL)	27,609.0	39,409.7	60,465.2	82,068.1	110,927.8	301.8%
	Du Page (IL)	2,611.0	4,636.8	9,007.3	13,480.1	21,043.2	706.0%
	Kane (IL)	1,169.8	1,863.4	3,117.7	4,490.1	6,914.2	491.0%
	Will (IL)	1,068.0	1,844.2	3,372.3	4,633.2	6,738.2	530.9%
		32,457.8	47,754.1	75,962.5	104,671.5	145,623.4	348.7%
BCL	Delaware (OH)	159.0	281.1	510.6	799.7	1,279.4	704.5%
	Fairfield (OH)	263.5	456.6	848.7	1,219.1	1,697.2	544.1%
	Franklin (OH)	3,449.1	5,284.4	8,639.7	12,854.9	18,376.0	432.8%
	Licking (OH)	374.3	617.4	1,088.2	1,566.7	2,109.6	463.6%
	Madison (OH)	100.3	169.6	275.1	385.7	580.5	478.6%
	Pickaway (OH)	135.1	221.6	354.5	488.5	666.3	393.2%
	Union (OH)	89.0	155.0	267.8	384.4	618.8	595.2%
		4,570.4	7,185.5	11,984.7	17,698.9	25,327.8	454.2%
Bettis	Allegheny (PA)	7,024.7	10,277.7	16,072.4	20,701.8	27,600.6	292.9%
	Armstrong (PA)	243.3	415.6	691.0	929.1	1,228.3	404.8%
	Beaver (PA)	742.2	1,236.9	2,061.3	2,261.5	2,816.5	279.5%
	Butler (PA)	474.9	785.4	1,384.4	1,834.4	2,626.3	453.0%
	Washington (PA)	759.5	1,246.5	2,066.4	2,584.4	3,396.7	347.2%
	Westmoreland (PA)	1,383.8	2,153.6	3,803.4	4,816.0	6,316.2	356.4%
		10,628.3	16,115.6	26,078.8	33,127.3	43,984.7	313.8%
BNL	Nassau (NY)	8,524.6	11,845.3	18,941.6	28,244.9	40,745.2	378.0%
	Suffolk (NY)	4,876.5	7,924.0	13,650.9	21,596.1	32,091.6	558.1%
		13,401.1	19,769.3	32,592.5	49,840.9	72,836.8	443.5%
Charleston	Berkeley (SC)	145.2	301.4	635.6	1,116.0	1,672.5	1051.5%
	Charleston (SC)	835.3	1,363.4	2,236.8	3,280.0	4,741.6	467.6%
	Colleton (SC)	65.6	110.9	196.7	282.0	407.9	521.6%
	Dorchester (SC)	95.5	201.6	461.7	769.4	1,175.2	1130.0%
		1,141.7	1,977.4	3,530.8	5,447.5	7,997.2	600.4%
Colonie	Albany (NY)	1,378.0	2,028.6	3,027.7	4,382.5	6,147.6	346.1%
	Columbia (NY)	194.8	325.4	564.1	846.2	1,239.0	536.0%
	Greene (NY)	123.8	204.4	341.3	496.2	735.9	494.4%
	Rensselaer (NY)	574.8	827.5	1,306.1	1,907.1	2,745.3	377.7%
	Saratoga (NY)	437.1	738.5	1,374.4	2,153.7	3,435.4	686.0%
	Schenectady (NY)	738.5	1,025.3	1,544.5	2,243.2	3,086.2	317.9%
	Schoharie (NY)	85.1	131.6	210.6	302.6	455.6	435.6%
		3,532.0	5,281.4	8,368.7	12,331.4	17,845.0	405.2%
ETEC	Kern (CA)	1,267.9	2,189.1	4,321.3	6,224.1	8,691.4	585.5%
	Los Angeles (CA)	35,043.2	50,436.0	88,053.0	130,394.8	185,131.4	428.3%
	San Luis Obispo (CA)	388.3	718.0	1,443.5	2,469.8	3,767.8	870.3%
	Santa Barbara (CA)	1,235.4	1,949.3	3,563.0	5,696.0	8,134.3	558.4%
	Ventura (CA)	1,589.4	2,901.8	5,940.7	9,495.6	14,428.4	807.8%
		39,524.2	58,194.3	103,321.5	154,280.3	220,153.3	457.0%

Table C.4–19. Baseline Personal Income—Continued

Total Personal Income ($ million)

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
Fermi	Cook (IL)	27,609.0	39,409.7	60,465.2	82,068.1	110,927.8	301.8%
	De Kalb (IL)	264.8	431.7	675.2	935.5	1,286.3	385.8%
	Du Page (IL)	2,611.0	4,636.8	9,007.3	13,480.1	21,043.2	706.0%
	Kane (IL)	1,169.8	1,863.4	3,117.7	4,490.1	6,914.2	491.0%
	Kendall (IL)	122.6	226.6	425.2	549.7	797.7	550.6%
	McHenry (IL)	519.0	895.6	1,677.4	2,509.2	4,032.9	677.1%
	Will (IL)	1,068.0	1,844.2	3,372.3	4,633.2	6,738.2	530.9%
		33,364.2	49,307.9	78,740.3	108,665.9	151,740.3	354.8%
FEMP	Butler (OH)	870.5	1,386.6	2,508.2	3,473.1	4,902.0	463.1%
	Hamilton (OH)	4,130.7	5,879.9	9,405.5	12,973.0	17,837.8	331.8%
	Warren (OH)	302.0	476.2	890.9	1,271.3	1,973.6	553.6%
	Dearborn (IN)	101.0	162.8	295.4	430.2	594.3	488.4%
		5,404.2	7,905.5	13,099.9	18,147.7	25,307.8	368.3%
GA	Imperial (CA)	299.6	527.9	888.2	1,085.6	1,595.3	432.4%
	Orange (CA)	7,013.6	12,242.3	25,407.5	40,169.6	59,190.7	743.9%
	Riverside (CA)	2,012.5	3,522.1	7,104.1	11,674.0	20,431.5	915.2%
	San Diego (CA)	6,163.1	10,294.5	19,917.7	32,190.3	49,344.3	700.6%
		15,488.9	26,586.7	53,317.4	85,119.4	130,561.8	742.9%
GE	Alpine (CA)	2.1	4.1	9.2	15.4	25.5	1093.0%
	Amador (CA)	49.0	89.4	188.3	292.7	456.0	830.6%
	Calaveras (CA)	51.6	86.1	184.4	294.0	442.3	757.8%
	San Joaquin (CA)	1,215.3	2,033.7	3,634.5	5,215.1	7,484.0	515.8%
	Stanislaus (CA)	766.1	1,335.7	2,577.1	3,743.3	5,699.3	644.0%
	Tuolumne (CA)	81.5	144.9	308.1	481.9	724.9	789.9%
		2,165.5	3,693.8	6,901.6	10,042.2	14,832.0	584.9%
GJPO	Delta (CO)	45.8	84.7	168.8	229.5	278.8	508.9%
	Garfield (CO)	56.6	115.9	236.2	335.4	486.7	759.5%
	Gunnison (CO)	18.1	36.2	80.5	109.7	139.9	674.4%
	Mesa (CO)	183.4	365.3	805.0	1,041.8	1,412.7	670.2%
	Montrose (CO)	53.3	97.5	186.2	253.7	350.9	558.6%
	Pitkin (CO)	36.0	79.9	169.4	249.0	412.7	1047.6%
	Grand (UT)	23.1	37.5	77.9	76.8	88.0	280.6%
		416.3	817.0	1,724.1	2,295.8	3,169.8	661.5%
Hanford	Adams (WA)	54.7	122.5	146.2	184.3	230.7	321.6%
	Benton (WA)	269.5	536.2	1,200.8	1,473.4	1,959.2	626.9%
	Franklin (WA)	98.0	197.9	358.6	409.2	553.1	464.6%
	Grant (WA)	148.4	296.4	444.2	601.8	853.8	475.2%
	Yakima (WA)	496.0	929.0	1,549.3	2,046.8	2,920.4	488.8%
		1,066.7	2,082.0	3,699.2	4,715.4	6,517.2	511.0%
INEL	Bannock (ID)	169.4	310.5	554.3	731.3	884.6	422.1%
	Bingham (ID)	93.5	161.6	266.2	353.4	512.5	448.0%
	Bonneville (ID)	189.5	339.7	588.5	837.4	1,203.7	535.2%
	Butte (ID)	9.5	14.0	28.2	32.2	45.8	380.6%
	Clark (ID)	4.7	6.1	10.1	12.7	20.2	327.9%
	Jefferson (ID)	34.6	61.4	106.7	136.6	212.2	512.8%
		501.3	893.2	1,554.0	2,103.7	2,879.0	474.3%
KCP	Cass (MO)	132.6	250.9	484.7	753.2	1,092.3	724.1%
	Clay (MO)	501.9	784.7	1,467.5	2,172.1	2,833.8	464.6%
	Jackson (MO)	2,825.6	4,181.1	6,531.9	9,141.2	11,798.7	317.6%
	Johnson (MO)	104.7	160.3	261.7	381.3	521.4	397.9%
	Lafayette (MO)	103.7	161.5	264.7	381.7	504.7	386.6%
	Ray (MO)	61.0	102.1	187.6	271.4	335.7	450.4%
	Johnson (KS)	1,151.1	1,940.2	3,776.0	5,973.0	9,355.4	712.7%
	Wyandotte (KS)	650.3	944.2	1,479.1	1,941.4	2,284.9	251.4%
		5,530.9	8,525.0	14,453.1	21,015.4	28,726.9	419.4%

Table C.4-19. Baseline Personal Income—Continued

Total Personal Income ($ million)

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
KAPL-K	Fulton (NY)	189.8	279.0	448.1	619.9	849.2	347.5%
	Saratoga (NY)	437.1	738.5	1,374.4	2,153.7	3,435.4	686.0%
	Schenectady (NY)	738.5	1,025.3	1,544.5	2,243.2	3,086.2	317.9%
		1,365.4	2,042.7	3,367.0	5,016.7	7,370.7	439.8%
KAPL-N	Albany (NY)	1,378.0	2,028.6	3,027.7	4,382.5	6,147.6	346.1%
	Montgomery (NY)	210.7	290.7	446.5	599.3	835.0	296.4%
	Saratoga (NY)	437.1	738.5	1,374.4	2,153.7	3,435.4	686.0%
	Schenectady (NY)	738.5	1,025.3	1,544.5	2,243.2	3,086.2	317.9%
	Schoharie (NY)	85.1	131.6	210.6	302.6	455.6	435.6%
		2,849.3	4,214.7	6,603.7	9,681.2	13,959.8	389.9%
KAPL-W	Hartford (CT)	4,109.6	5,812.0	9,720.2	14,610.2	21,209.3	416.1%
	Litchfield (CT)	689.5	1,053.0	1,876.1	2,905.6	4,391.3	536.9%
	Middlesex (CT)	535.9	837.8	1,452.3	2,279.9	3,462.3	546.0%
	New Haven (CT)	3,509.0	5,060.5	8,305.2	12,501.4	17,872.5	409.3%
	Tolland (CT)	412.0	622.6	1,167.7	1,826.0	2,831.8	587.3%
	Hampden (MA)	1,866.9	2,696.5	4,323.7	6,220.6	8,706.2	366.4%
		11,122.9	16,082.3	26,845.1	40,343.8	58,473.4	425.7%
LEHR	Colusa (CA)	73.5	143.5	178.3	205.3	278.4	278.7%
	Lake (CA)	77.1	150.6	349.4	559.9	789.4	924.2%
	Napa (CA)	362.2	638.6	1,145.6	1,712.0	2,519.8	595.8%
	Sacramento (CA)	2,766.4	4,513.4	8,310.2	12,912.8	19,873.9	618.4%
	Solano (CA)	695.7	1,252.9	2,402.7	3,749.2	5,935.3	753.2%
	Sutter (CA)	187.1	346.9	557.4	743.3	1,032.1	451.7%
	Yolo (CA)	407.3	734.0	1,239.1	1,775.7	2,801.9	588.0%
		4,569.1	7,779.8	14,182.8	21,658.2	33,230.9	627.3%
LBL	Alameda (CA)	5,187.3	7,674.5	13,092.7	20,275.5	28,453.8	448.5%
	Contra Costa (CA)	2,774.2	4,452.6	8,785.0	13,924.1	20,647.5	644.3%
		7,961.5	12,127.2	21,877.7	34,199.6	49,101.3	516.7%
LLNL	Alameda (CA)	5,187.3	7,674.5	13,092.7	20,275.5	28,453.8	448.5%
	Contra Costa (CA)	2,774.2	4,452.6	8,785.0	13,924.1	20,647.5	644.3%
	San Joaquin (CA)	1,215.3	2,033.7	3,634.5	5,215.1	7,484.0	515.8%
	Stanislaus (CA)	766.1	1,335.7	2,577.1	3,743.3	5,699.3	644.0%
		9,942.9	15,496.5	28,089.2	43,157.9	62,284.6	526.4%
LANL	Los Alamos (NM)	78.1	124.7	221.4	364.4	505.8	547.8%
	Rio Arriba (NM)	53.8	92.1	163.6	240.3	312.1	480.0%
	Santa Fe (NM)	192.8	352.3	677.2	1,140.1	1,704.0	784.0%
		324.7	569.1	1,062.1	1,744.8	2,521.9	676.8%
Mare Is	Contra Costa (CA)	2,774.2	4,452.6	8,785.0	13,924.1	20,647.5	644.3%
	Lake (CA)	77.1	150.6	349.4	559.9	789.4	924.2%
	Marin (CA)	1,229.1	1,945.1	3,813.8	6,056.3	8,657.2	604.3%
	Mendocino (CA)	195.4	329.5	650.2	900.8	1,301.1	565.8%
	Napa (CA)	362.2	638.6	1,145.6	1,712.0	2,519.8	595.8%
	Sonoma (CA)	921.5	1,694.7	3,430.8	5,556.0	8,628.9	836.4%
		5,559.5	9,211.0	18,174.8	28,709.0	42,543.9	665.3%
Middlesex	Mercer (NJ)	1,475.4	2,314.5	3,647.9	5,707.3	8,491.9	475.6%
	Middlesex (NJ)	2,751.4	4,303.7	7,057.0	11,558.7	16,761.1	509.2%
	Monmouth (NJ)	2,120.8	3,380.2	6,038.3	10,105.8	15,178.4	615.7%
	Somerset (NJ)	1,055.7	1,604.0	2,919.1	4,991.5	8,009.3	658.7%
	Union (NJ)	3,002.8	4,035.9	6,505.8	9,621.6	12,943.0	331.0%
		10,406.1	15,638.3	26,168.1	41,984.8	61,383.7	489.9%

Table C.4-19. Baseline Personal Income—Continued

Total Personal Income ($ million)

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
Mound	Butler (OH)	870.5	1,386.6	2,508.2	3,473.1	4,902.0	463.1%
	Clark (OH)	588.0	853.4	1,331.4	1,832.4	2,461.8	318.7%
	Darke (OH)	175.2	277.8	463.8	641.3	864.6	393.4%
	Greene (OH)	502.0	750.2	1,243.6	1,742.3	2,490.0	396.0%
	Miami (OH)	337.8	502.0	860.2	1,171.6	1,585.3	369.3%
	Montgomery (OH)	2,630.1	3,625.9	5,742.2	7,999.6	10,577.1	302.2%
	Preble (OH)	123.9	188.0	320.9	444.0	598.6	383.0%
	Warren (OH)	302.0	476.2	890.9	1,271.3	1,973.6	553.6%
		5,529.5	8,060.0	13,361.3	18,575.6	25,453.1	360.3%
NTS	Clark (NV)	1,335.2	2,337.6	5,123.0	7,843.2	14,087.5	955.1%
	Nye (NV)	27.6	44.6	100.3	167.9	273.9	892.9%
		1,362.8	2,382.2	5,223.3	8,011.0	14,361.4	953.8%
Norfolk	Chesapeake city (VA)	296.6	537.7	1,025.5	1,672.3	2,593.7	774.4%
	Hampton city (VA)	420.2	648.9	1,006.2	1,513.1	1,979.0	371.0%
	Newport News city (VA)	490.8	753.8	1,281.5	1,985.1	2,613.3	432.5%
	Norfolk city (VA)	1,111.8	1,610.3	2,339.9	3,389.0	4,280.1	285.0%
	Suffolk city (VA)	139.3	244.5	407.5	635.0	878.2	530.3%
	Virginia Beach city (VA)	690.0	1,354.7	2,707.1	4,745.4	7,024.8	918.0%
	Isle of Wight (VA)	57.0	105.1	191.2	313.7	451.6	692.2%
		3,205.7	5,255.0	8,958.9	14,253.5	19,820.6	518.3%
ORR	Anderson (TN)	203.2	346.8	586.1	801.7	1,121.1	451.6%
	Knox (TN)	923.2	1,562.5	2,788.6	4,045.7	5,844.4	533.1%
	Loudon (TN)	66.9	117.2	218.8	293.0	433.5	547.5%
	Roane (TN)	110.5	199.2	395.6	527.8	727.5	558.2%
		1,303.9	2,225.7	3,989.2	5,668.2	8,126.4	523.2%
PGDP	Ballard (KY)	27.8	41.9	70.6	88.7	122.9	342.3%
	Carlisle (KY)	13.9	22.9	37.5	52.9	66.1	374.1%
	Graves (KY)	93.0	150.4	266.5	355.9	482.0	418.4%
	Marshall (KY)	61.7	107.4	215.1	287.2	398.7	545.8%
	McCracken (KY)	209.4	335.7	588.6	777.3	1,099.4	425.1%
	Massac (IL)	41.4	71.8	113.5	151.3	195.3	372.3%
		447.2	730.2	1,291.8	1,713.3	2,364.5	428.8%
Palos	Cook (IL)	27,609.0	39,409.7	60,465.2	82,068.1	110,927.8	301.8%
	Du Page (IL)	2,611.0	4,636.8	9,007.3	13,480.1	21,043.2	706.0%
	Kane (IL)	1,169.8	1,863.4	3,117.7	4,490.1	6,914.2	491.0%
	Lake (IL)	1,980.9	3,214.4	5,837.8	8,946.3	14,211.2	617.4%
	McHenry (IL)	519.0	895.6	1,677.4	2,509.2	4,032.9	677.1%
	Will (IL)	1,068.0	1,844.2	3,372.3	4,633.2	6,738.2	530.9%
	Lake (IN)	2,159.4	3,257.7	5,187.4	5,916.4	7,758.7	259.3%
		37,117.1	55,121.9	88,665.1	122,043.4	171,626.2	362.4%
Pantex	Carson (TX)	27.2	67.5	63.0	99.1	117.7	332.1%
	Potter (TX)	315.2	512.3	958.9	1,357.7	1,589.1	404.1%
	Randall (TX)	233.3	448.3	768.8	1,295.3	1,598.0	585.0%
		575.7	1,028.2	1,790.7	2,752.0	3,304.7	474.0%
Pearl H	Honolulu (HI)	3,194.4	5,090.3	8,293.1	11,815.8	17,880.7	459.8%
	Kauai (HI)	121.2	207.8	374.4	515.8	884.1	629.5%
	Maui (HI)	193.9	371.9	710.5	1,068.6	1,876.8	867.7%
		3,509.5	5,670.1	9,377.9	13,400.2	20,641.6	488.2%
Pinellas	Hillsborough (FL)	1,683.7	3,130.5	5,593.9	9,497.0	14,177.8	742.1%
	Pasco (FL)	249.7	650.0	1,562.5	2,703.0	3,960.7	1486.4%
	Pinellas (FL)	2,189.0	4,014.7	7,710.5	12,857.5	18,483.7	744.4%
		4,122.3	7,795.2	14,866.9	25,057.5	36,622.1	788.4%

Table C.4-19. Baseline Personal Income—Continued

Total Personal Income ($ million)

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
PORTS	Jackson (OH)	72.1	119.0	201.6	279.2	347.6	382.2%
	Pike (OH)	48.3	81.3	146.2	219.3	291.7	503.6%
	Ross (OH)	194.9	300.8	529.4	737.0	935.8	380.1%
	Scioto (OH)	247.0	364.1	608.4	788.9	1,017.3	311.9%
		562.3	865.1	1,485.6	2,024.4	2,592.4	361.0%
Ports Nav	Cumberland (ME)	766.5	1,192.3	2,041.5	3,270.8	5,211.5	579.9%
	Oxford (ME)	139.9	216.5	391.7	528.2	786.0	462.0%
	York (ME)	399.4	629.7	1,187.1	1,896.6	2,960.5	641.2%
	Carroll (NH)	73.7	134.3	267.1	461.5	780.8	959.5%
	Rockingham (NH)	536.8	904.9	1,957.5	3,566.5	5,369.4	900.3%
	Strafford (NH)	245.0	368.3	735.1	1,195.7	1,794.5	632.5%
		2,161.3	3,446.0	6,580.0	10,919.3	16,902.6	682.1%
PPPL	Burlington (NJ)	1,326.0	2,172.7	3,897.1	6,067.2	9,106.0	586.7%
	Hunterdon (NJ)	344.2	600.8	1,139.9	2,043.2	3,276.3	852.0%
	Mercer (NJ)	1,475.4	2,314.5	3,647.9	5,707.3	8,491.9	475.6%
	Middlesex (NJ)	2,751.4	4,303.7	7,057.0	11,558.7	16,761.1	509.2%
	Monmouth (NJ)	2,120.8	3,380.2	6,038.3	10,105.8	15,178.4	615.7%
	Somerset (NJ)	1,055.7	1,604.0	2,919.1	4,991.5	8,009.3	658.7%
	Bucks (PA)	1,754.2	2,875.8	5,280.3	8,132.8	12,250.6	598.3%
		10,827.6	17,251.7	29,979.6	48,606.4	73,073.7	574.9%
Puget So	Jefferson (WA)	39.3	71.1	156.3	226.7	329.2	738.1%
	King (WA)	5,583.1	8,507.6	16,470.2	23,445.3	36,181.4	548.1%
	Kitsap (WA)	430.4	761.3	1,485.0	2,232.2	3,262.1	657.9%
	Mason (WA)	75.2	135.1	279.3	390.6	547.2	628.0%
	Pierce (WA)	1,654.8	2,561.0	4,738.9	6,764.8	9,583.1	479.1%
		7,782.8	12,036.2	23,129.8	33,059.5	49,903.0	541.2%
RMI	Ashtabula (OH)	347.8	526.1	875.2	1,102.7	1,337.9	284.7%
	Geauga (OH)	256.8	415.1	826.7	1,164.4	1,688.0	557.4%
	Lake (OH)	823.6	1,276.0	2,270.5	3,096.8	4,249.0	415.9%
	Trumbull (OH)	935.6	1,494.9	2,400.7	2,937.9	3,673.6	292.7%
	Crawford (PA)	281.0	443.6	715.2	937.7	1,241.6	341.8%
	Erie (PA)	1,015.4	1,623.4	2,544.8	3,358.2	4,499.4	343.1%
		3,660.2	5,779.1	9,633.2	12,597.8	16,689.5	356.0%
RFETS	Adams (CO)	659.4	1,151.3	2,288.6	3,461.4	4,274.6	548.2%
	Arapahoe (CO)	805.9	1,704.1	3,826.3	6,567.0	8,850.0	998.2%
	Boulder (CO)	556.8	1,005.4	2,125.7	3,479.2	4,843.5	769.9%
	Denver (CO)	2,469.1	3,830.5	6,029.7	8,610.0	10,334.9	318.6%
	Jefferson (CO)	1,081.0	2,119.6	4,484.6	7,245.9	9,230.5	753.9%
		5,572.1	9,810.9	18,754.9	29,363.5	37,533.5	573.6%
SNL/NM	Bernalillo (NM)	1,158.1	2,088.6	3,895.3	6,168.0	8,450.7	629.7%
	Cibola (NM)	0.0	0.0	0.0	175.4	195.2	NA
	Sandoval (NM)	40.1	102.1	227.3	488.0	832.9	1974.7%
	Santa Fe (NM)	192.8	352.3	677.2	1,140.1	1,704.0	784.0%
	Torrance (NM)	13.4	25.7	52.6	76.1	107.9	703.1%
	Valencia (NM)	97.1	179.2	436.2	369.9	532.2	448.0%
		1,501.5	2,747.9	5,288.6	8,417.4	11,822.9	687.4%

Table C.4-19. Baseline Personal Income—Continued

Total Personal Income ($ million)

Site	County/State	1970	1975	1980	1985	1990	Percent Change 1970-1990
SRS	Aiken (SC)	306.6	484.2	860.5	1,359.6	2,172.4	608.6%
	Allendale (SC)	21.5	35.1	59.3	88.5	127.5	493.5%
	Bamberg (SC)	36.6	59.8	92.7	134.5	177.3	384.8%
	Barnwell (SC)	46.3	84.1	129.4	209.5	285.8	517.2%
	Burke (GA)	44.7	76.7	120.3	199.7	231.1	417.4%
	Columbia (GA)	70.8	131.7	339.9	694.8	1,120.6	1483.3%
	Richmond (GA)	500.3	820.7	1,369.8	2,233.2	3,023.5	504.3%
	Screven (GA)	28.7	52.3	80.7	130.8	165.9	477.2%
		1,055.4	1,744.5	3,052.6	5,050.6	7,304.0	592.0%
SLAC	Alameda (CA)	5,187.3	7,674.5	13,092.7	20,275.5	28,453.8	448.5%
	Monterey (CA)	1,167.5	1,915.6	3,178.0	4,826.1	6,954.0	495.6%
	San Benito (CA)	73.5	124.1	246.3	391.9	600.5	716.6%
	San Mateo (CA)	3,277.2	4,970.5	8,595.9	13,341.5	18,789.9	473.4%
	Santa Clara (CA)	5,220.4	8,610.2	16,910.5	27,071.3	37,882.5	625.7%
	Santa Cruz (CA)	541.6	1,011.8	2,087.0	3,323.7	5,085.9	839.1%
	Stanislaus (CA)	766.1	1,335.7	2,577.1	3,743.3	5,699.3	644.0%
		16,233.6	25,642.4	46,687.6	72,973.3	103,465.8	537.4%
UofMO	Audrain (MO)	91.1	139.7	224.2	288.2	355.5	290.3%
	Boone (MO)	269.9	474.9	890.4	1,320.1	1,935.4	617.1%
	Callaway (MO)	84.6	131.5	268.3	368.3	487.9	476.6%
	Cole (MO)	172.1	286.7	507.7	745.4	1,038.5	503.3%
	Cooper (MO)	51.6	77.6	115.8	161.5	202.6	292.3%
	Howard (MO)	33.8	47.1	72.3	103.1	129.9	284.8%
	Moniteau (MO)	34.2	56.4	97.2	138.3	190.8	458.0%
	Randolph (MO)	73.0	117.4	187.8	266.2	330.5	353.0%
		810.2	1,331.1	2,363.8	3,391.0	4,670.9	476.5%
WIPP	Chaves (NM)	135.7	240.6	416.7	626.9	821.6	505.5%
	Eddy (NM)	130.7	225.6	409.7	585.9	688.8	427.1%
	Lea (NM)	167.1	289.6	558.2	778.5	744.5	345.6%
	Otero (NM)	125.1	200.2	322.4	520.4	651.7	421.0%
	Culberson (TX)	11.1	16.0	27.3	32.5	38.0	242.8%
	Loving (TX)	0.4	1.1	2.1	2.1	2.7	507.2%
		570.1	973.1	1,736.3	2,546.3	2,947.3	417.0%
WSSR	Franklin (MO)	189.3	316.9	614.9	956.8	1,323.3	598.9%
	Jefferson (MO)	350.2	549.8	1,271.3	1,923.6	2,737.9	681.7%
	St. Charles (MO)	372.9	606.0	1,454.9	2,610.8	4,036.8	982.5%
	St. Louis (MO)	4,885.5	7,329.9	11,901.7	17,713.2	24,097.6	393.2%
	Madison (IL)	995.1	1,470.2	2,459.0	3,350.6	4,487.0	350.9%
	Monroe (IL)	66.2	109.7	212.4	307.2	465.9	603.5%
	St. Clair (IL)	1,013.4	1,480.5	2,373.8	3,275.2	4,257.3	320.1%
		7,872.7	11,862.9	20,287.9	30,137.3	41,405.8	425.9%
WVDP	Cattaraugus (NY)	269.9	405.5	633.5	850.3	1,152.5	327.1%
	Erie (NY)	4,669.4	6,608.2	10,002.6	13,224.0	17,712.0	279.3%
		4,939.2	7,013.7	10,636.1	14,074.2	18,864.5	281.9%
UNITED STATES		825,534.0	1,308,482.0	2,254,076.0	3,317,545.0	4,664,057.0	465.0%

Source: U.S. Department of Commerce, Bureau of Economic Analysis (1992a).

for the National economy, and then to estimate the proportion of relationships that are attributable to the regional economy under analysis. The technique involves matrix multiplication of the Bureau of Economic Analysis' 1987 *Use and Make Tables* (DOC, 1994) that results in a *National Direct Requirements Table*, as shown in the following example:

$$A_N = [USE_N] \times [MAKE_N]$$

where:

A_N = National Direct Requirements Table,

USE_N = 1987 U.S. Use Table, and

$MAKE_N$ = 1987 U.S. Make Table.

By using the Consumer Price Index (CPI) and the Producer Price Index (PPI), the 1987 data was updated to 1990 dollar terms. (The detailed PPI was used to update manufacturing and wholesale trade sectors, while the detailed CPI was used to update service and retail sectors.)

Once the interindustry relationships were identified in the *National Direct Requirements Table*, they were regionalized by calculating the location quotient for earnings (i.e., income to labor). The location quotient for output is given by:

$$LQ^R_i = [(X^R_i/X^R)/(X^N_i/X^N)]$$

where:

LQ^R = Location quotient for region "R" and industry "i,"

X^R_i and X^R = output for industry "i" and total industry output in the region, and

X^N_i and X^N = National output for industry "i" and total output for the country (Miller and Blair, 1985).

Similarly, the income (earnings) location quotient matrix for industry "i" in region "R" is given by:

$$LQ^R_i = [(Y^R_i/Y^R)/(Y^N_i/Y^N)]$$

where:

LQ^R = Location quotient for region "R" and industry "i,"

Y^n and Y^n = national income for industry "i" and total income for the Nation, and

Y^R_i and Y^R = income for industry "i" and total industry income in the region.

The *National Direct Requirements Table* (from above) was then multiplied by the vector of location quotients for a given region to derive a regional *Direct Requirements Table*. This process was repeated for each ROI.

The regional *Direct Requirements Table* is therefore:

$$A_R = [LQ_R] \times [A_N]$$

where:

A_R = regional Direct Requirements Table for region "R," and

LQ_R = Matrix of location quotients for region "R".

The following calculation resulted in the final matrix of impacts for a given region:

$$M_R = [I - A_R]^{-1}$$

where:

M_R = matrix of output multipliers for region "R," and

I = the "identity" matrix (a matrix of zeros with ones on the diagonal).

The resulting 80-by-80-sector output multiplier table was then totaled across its rows (except for row 80) to produce a vector of output multipliers. Row 80 is the sum of earnings paid to households and is already incorporated in the multipliers for the first 79 sectors. Therefore, row 80 contains the earnings multipliers for a given region.

A final step was required to determine the employment multipliers for a region. Using County Business Pattern data for the Nation as a whole (DOC, 1993), the relationships between employment and output for all industries were derived.

The standard procedure in applying regional impact models is to calculate the specific multipliers (employment, income, and output as described above) for each of the 80 sectors individually, then multiply each industry multiplier by the costs anticipated for each industry sector. The difficulty with this approach is in transforming the data from an lump sum engineering cost estimate into the 80 industry classifications. The procedure used in this economic impact analysis was to assume that the individual multipliers are normally distributed. The mean multiplier for employment, income, and output was calculated for each

region and multiplied by the initial costs. The product is the change in employment, income, and output. Given a sample size of 80 sectors that are normally distributed, the sample size is large enough to approximate a standard normal distribution.

The advantage in using individual multipliers is their ability to trace impacts on the economic variables through individual industrial sectors. However, because the objective of this analysis was to look at marginal changes in total employment, income, and output—not at the changes in specific industrial sectors—such a detailed analysis was considered unwarranted.

The employment, income, and output multipliers for each region were then applied to the initial waste management project costs for each site under each waste-type alternative. As discussed above, the cost data were broken out into construction, operations, and transportation phases. When changes in employment and income were calculated for each waste-type alternative, they were weighted by the number of years involved for construction and operations activities. The percent change in employment and income is equal to the total time-weighted dollar change in the variable divided by the 1990 value of the variable, multiplied by 100.

The National-level impacts of waste management activities were calculated by using the National RIMS II multipliers. These impacts help to account for the leakage in expenditures that would occur at the regional level when purchases of goods and services must be made outside a particular ROI due to the inability of the regional economy to provide those goods or services. For example, steel is manufactured only in certain parts of the U.S. When steel is required by a site that is in an ROI that does not have a steel plant, the steel must be brought in from outside of the ROI. This purchase causes money "leakage" out of that ROI to somewhere else in the National economy. The National economy analysis is thus able to "capture" economic activity that is otherwise lost to the individual site ROIs.

Since the transportation expenditures would be made throughout the country, the National multipliers were also used to determine the impacts of transportation expenditures.

The next step was to multiply the respective grand mean multipliers for employment, income, and output respectively by the initial expenditure anticipated for each site and waste type alternative. The product of the initial cost and the multipliers gave the estimated change in personal income, job-years, and output.

C.4.5.3.2 *Analysis Assumptions*

This section identifies the assumptions used in developing the baseline conditions and impacts for the various waste types.

C.4.5.3.3 *Multiplier Analysis*

Baseline conditions for the impacts analysis used a two-tier ROI. The first tier included the 17 sites that contain the vast majority of DOE waste. A detailed ROI was developed based on the residence patterns of the site employees. Counties were included if they contained 5% or more of the site employees, until the counties selected accounted for 90% or more of the site employees. Contiguous counties were included by exception if there was reason to believe that excluding them might preclude a site-specific determination of where on a site a waste management facility could be located.

The second ROI tier included 37 sites that are anticipated to have relatively low expenditures, irrespective of the waste type or the Alternative. In most cases the second tier sites were waste donor sites. Since these sites will experience small impacts (due to little or no planned activity) they were not given the extensive treatment that the major sites received. The ROIs for each second tier site consists of the host and contiguous counties only.

As indicated above, multipliers were assembled for each of the ROIs associated with each site. The simplifying assumption regarding these multipliers holds that the average (mean) multiplier is an unbiased and efficient estimator of the any of the 80 multipliers.

Each waste type was analyzed using specific timing assumptions. Further, the HLW analysis used different timing assumptions for each alternative. The time frames identified in Table C.4–20 and employed in the analysis should be viewed as representative. Representative time cycles are used to show what would happen if a similar cycle were actually used. The time frame is required to annualize the changes in income and employment both to provide the absolute change in the variable and the percent change over the 1990 baseline. The time frames are proxies for any time period and are not intended to imply that a particular time frame has been selected.

Table C.4-20. Duration in Years of WM Activity Phases Assumed for Waste Type Economic Analysis

Waste Type	Construction Phase[a]	Operations Phase	Transportation
LLMW	4	15 (No Action = 25)	10 (No Action = 20)
LLW	4	15 (No Action = 25)	10 (No Action = 20)
TRUW	4	15 (No Action = 25)	10 (No Action = 20)
HLW	3	17 to 43[b]	34
HW	4	12	10

[a] Assumes 4 years of actual construction activity within a 10-year time frame to plan and implement facility construction.
[b] Varies with site and alternative.

In addition, it was assumed that an additional five years will elapse before the full economic impacts of any given or phase of the operation will occur. The time frame used to calculate impacts then includes the time over which the action is planned to occur plus five years.

The economic impact analysis was based on standard Keynesian economic theory. This theory holds that aggregate demand is a function of income. When income is generated in the form of a wage, several deductions are made reducing the amount of money that is available for respending. These deductions are given in Table C.4-21.

A coefficient of variance was calculated for the grand mean multipliers of the ROIs for the 47 sites. The coefficient of variance is equal to the standard deviation of the grand mean multiplier divided by the grand mean multiplier.

The grand mean multipliers and the multipliers' coefficient of variance for the 47 ROIs are reported in Table C.4-22 and Table C.4-23, respectively.

Table C.4-21. Wage Deductions Used in the Income Multiplier Analysis

Deduction	Percentage of Deduction
Federal income tax	18.0
Social security tax	7.6
State unemployment tax	1.5
Benefits (health and life insurance)	2.0
Personal savings	5.0
Total unavailable for respending	34.1
Total available for respending	65.9

C.4.5.3.4 *Limitations of the Multiplier Analysis*

The use of the input-output (I-O) system for estimating multipliers has several limitations, including:

- No explicit recognition of prices. Relative prices between industries change, and the prices are not updated. The most complete table in use today uses 1987 prices; price adjustments are made uniformly and do not capture changes in relative prices within an industry.
- Linear homogeneous production function. If any scale economies or diseconomies exist, they are not captured; expansion of one industry will not have the impacts on downstream industries that the I-O model assumes.
- Constant I-O formation ignores the possibility that capacity will be reached with the effect of changing relative prices and input substitutions.

While these limitations are important, the use of the multipliers is to show relative changes, i.e., what would happen if you did a similar thing in different places. While the limitations prevent the determination of the absolute changes in the magnitude of the economic variables, they are instrumental in identifying relative changes.

Table C.4-22. Grand Mean Multipliers

Site	Output (1)	Earnings (2)	Employment (3)
Ames	1.8968398	0.2686351	26.1
ANL-E	1.8992364	0.2794387	24.1
BCL	2.0945444	0.2963150	27.2
Bettis	2.0854729	0.2955736	26.8
BNL	1.8928028	0.2825461	24.9
Charleston	1.8486995	0.2632758	24.2
Colonie	1.9521110	0.2755395	26.0
ETEC	2.0860979	0.2918617	26.9
Fermi	2.1277356	0.3000036	27.1
FEMP	2.0115936	0.2992522	26.2
GA	1.9761869	0.2793827	26.2
GE	1.8819248	0.2698297	26.0
GJPO	1.8788433	0.2628304	25.5
Hanford	1.7345193	0.2606101	24.4
INEL	1.6539740	0.2501210	23.2
KCP	2.0661073	0.2920600	26.9
KAPL-K	1.6542548	0.2492809	22.1
KAPL-N	1.8803463	0.2665589	25.2
KAPL-W	2.0211218	0.2872877	26.0
LEHR	1.8814520	0.2667942	25.2
LBL	2.1162016	0.3093407	26.8
LLNL	2.1480631	0.3114184	28.2
LANL	1.7278235	0.2566492	23.6
Mare Is	2.0097511	0.2841494	26.5
Middlesex	2.0560625	0.2908983	26.2
Mound	1.7815385	0.2537604	23.7
NTS	1.7526830	0.2633199	23.4
Norfolk	1.7882339	0.2551058	23.9
ORR	2.0175825	0.3014903	26.7
PGDP	1.7091768	0.2612092	23.9
Palos	2.1394955	0.3019226	27.2
Pantex	1.8058253	0.2664281	24.8
Pearl H	1.8166110	0.2560974	24.3
Pinellas	1.9382666	0.2750944	25.8
PORTS	1.7395320	0.2644895	24.8
Ports Nav	2.0104574	0.2857046	26.3
PPPL	2.0962324	0.2967151	26.8
Puget So	1.9194054	0.2736098	25.3
RMI	1.8073449	0.2559203	23.4
RFETS	1.9088693	0.2832914	25.2
SNL/NM	1.8358633	0.2730185	24.9
SRS	1.8961558	0.2789010	25.8
SLAC	1.7502934	0.2507150	23.3
UMo	1.7537006	0.2497958	24.0
WIPP	1.7094931	0.2559931	23.7
WSSR	2.1302335	0.3014761	27.3
WVDP	2.1326031	0.3170268	27.8
National	3.0829564	0.8324667	36.8

Table C.4–23. Multipliers' Coefficient of Variance[a]

Site	Output	Earnings	Employment
Ames	0.1282514	0.3232824	0.7017540
ANL-E	0.1514593	0.4842782	0.6223096
BCL	0.1335457	0.3108199	0.5816449
Bettis	0.1423880	0.3197699	0.5657588
BNL	0.1076392	0.4656121	0.6015071
Charleston	0.1350718	0.3236767	0.6538367
Colonie	0.1183233	0.3023482	0.6448926
ETEC	0.1194562	0.3069452	0.5785328
Fermi	0.1395721	0.3117937	0.5540122
FEMP	0.1212080	0.4434402	0.5735707
GA	0.1184384	0.3187351	0.6262334
GE	0.1310743	0.3253468	0.7018351
GJPO	0.1458825	0.3387602	0.7130032
Hanford	0.1291553	0.4987933	0.7501411
INEL	0.1174174	0.5183568	0.7851976
KCP	0.1249323	0.3062415	0.5880993
KAPL-K	0.1055506	0.5082354	0.6985579
KAPL-N	0.1108195	0.3142466	0.6520623
KAPL-W	0.1330296	0.3176867	0.5789079
LEHR	0.1195645	0.3213139	0.6552262
LBL	0.1336941	0.4379207	0.5548303
LLNL	0.1299192	0.4302718	0.6280589
LANL	0.1234926	0.5115640	0.7293250
Mare Is	0.1336816	0.3163528	0.6208246
Middlesex	0.1337611	0.3137265	0.5703249
Mound	0.1183593	0.3377189	0.7091450
NTS	0.1305871	0.5074167	0.6517835
Norfolk	0.1225205	0.3380128	0.6498472
ORR	0.1279087	0.4467180	0.5916954
PGDP	0.1297143	0.5055180	0.7517458
Palos	0.1399090	0.3116253	0.5491915
Pantex	0.1236165	0.4922549	0.7415270
Pearl H	0.1267270	0.3324984	0.6697828
Pinellas	0.1146860	0.3179148	0.6247028
PORTS	0.1408416	0.5007350	0.7359551
Ports Nav	0.1414415	0.3262595	0.5881818
PPPL	0.1343447	0.3116302	0.5635358
Puget So	0.1342005	0.3296160	0.6086124
RMI	0.1327751	0.3383731	0.6790840
RFETS	0.1261521	0.4754906	0.6146155
SNL/NM	0.1197497	0.4900238	0.6760818
SRS	0.1370186	0.4650688	0.7017991
SLAC	0.1079955	0.3308188	0.6862206
U of Mo	0.1305158	0.3448562	0.7495700
WIPP	0.1205319	0.5070867	0.7579089
WSSR	0.1401402	0.3130342	0.5595690
WVDP	0.1362926	0.4282287	0.5648346
National	0.1816865	0.2830192	0.3542612

[a] The coefficient of variance is equal to the standard deviation of the mean multiplier divided by the mean.

C.4.5.3.5 *Analysis Data*

Most of the baseline data used in this analysis are from the Bureau of Economic Analysis whose "Regional Economic Information System" provides historical data on employment and personal income.

The cost figures used in the analysis include the fully loaded costs of setting up a business to build and operate the WM facilities. They also include a set of linear scaler modules that can be assembled on the basis of the type of waste and waste volume. The modules can be placed in any part of the country and either scaled to accommodate the volume of waste, or adjusted in terms of the number of operating years to accommodate different waste volumes. The cost figures include a 30% contingency.

C.4.5.3.6 *Evaluation Techniques*

The economic model outputs included changes in income, output, and job-years. When the timing assumptions were applied, the job-years variable was divided by the number of years to give the number of direct, indirect, and induced jobs in an ROI. All of the ROIs that were evaluated are anticipated to experience an increase in expenditures resulting in increases in employment, income, and output; therefore, all impacts are expected to be positive.

The primary evaluation technique is to identify the magnitude of the change. All of the impact categories are first measured in absolute terms. Then, income and employment inputs are calculated with respect to changes in the baseline income and employment.

C.4.5.3.7 *Presentation of Results*

Data from the analysis are presented in several places in the WM PEIS document. Chapter 4 provides affected environment data for the 17 major sites in text and tables. The additional sites are presented in the *Technical Report on Affected Environment for the DOE Sites Considered in the DOE Waste Management Programmatic Environmental Impact Statement* (DOE, 1995b). Chapters 6 through 10 present the results of the impacts analysis for each of the waste types and for each alternative. The primary variable in these chapters is the percent change in the number of jobs. Changes in personal income are also presented. Both

variables are presented in terms of absolute numbers as well as percent changes over the 1990 baseline. A 1% change in the number of jobs is considered a substantial positive benefit to the regional or National economy.

C.4.6 POPULATION IMPACTS

The analysis examined the potential for the waste management alternatives to cause the types of impacts that could result when any large industrial or public works project attracts workers and their families to an area.

C.4.6.1 Regions of Influence

The ROI included the geographic area surrounding the site that would be subject to the changes traditionally associated with large-scale industrial projects (such as changes in employment and demographics). The site-level ROI was defined, as an aggregate of whole counties to include the host county (or counties), any contiguous counties, and other counties within the region that contain at least 5% of the total site workforce (both DOE and contractor personnel). Where these counties did not represent at least 90% of the total site workforce, counties with progressively lower percentages were included until the 90% threshold was met.

The site ROI population was assumed to represent the affected community at each site. It was considered reasonable to expect that the effects of in-migration to a region would be experienced in existing, nearby communities that have the infrastructure and established community support networks necessary for social life.

The analysis quantified population changes that constitute or that may in turn cause a number of related changes in community characteristics and that are likely to affect community services and resources. The likelihood of these latter effects is inferred from the size of the expected temporary and permanent population changes during the construction and operations phases of the waste management projects and the general characteristics of the communities at each site.

C.4.6.1.1 *Potential Impacts of WM Project Labor Requirements*

Population increases and settlement patterns associated with worker in-migration to the ROI are the source of most social effects of the construction and operation of an industrial project. (Halstead et al., 1984; Canter, 1977). Sources of change include the introduction of new people into a region in response to new employment; loss of residents in response to a perceived diminished quality of life or loss of employment opportunities; or retention of residents, who might otherwise have left the area, as a result of improvement or enhancement of some social factor.

The construction and operation of waste management facilities can be expected to have some influence on the growth of the population in the regions surrounding the sites. This growth will raise important concerns based on the potential for changes to certain community characteristics such as size, diversity, stability, and the ability to provide necessary or locally desirable social services. Though the description of the precise nature and detail of these changes is dependent on site specific information regarding the location of any proposed facility, the size and characteristics of the inmigrating workforces and the number of existing site personnel actually employed on the project, some preliminary estimates can be made on the basis of the more general information available at the programmatic level.

C.4.6.1.1.1 Community Characteristics—Size, Diversity, Stability

Conventional effects associated with large industrial facilities include: the economic effects of increased local employment, the demographic effects of increased population growth, the fiscal effects of increased demands for social services, and social effects of perceived changes in the quality of life (Finley, 1983). These changes will usually result in other changes in community life. The temporary in-migration of construction workers and their families and the more permanent settlement of workers during the operations phase of the proposed action are relevant to this analysis.

The central impetus for change rests in the differences, both real and perceived, between the incoming population and those who already reside in the ROI. Important demographic characteristics that could change include age, sex, ethnic and racial composition, and income distribution. Potential disruptions to settlement patterns and relocation of local population are also important (Canter, 1993). Consequential

changes in the patterns of interaction of local residents also can be anticipated (Gramling and Freudenburg, 1992).

Other associated changes include: the level of diversity and complexity—affected when the number and types of social groups in the community are increased; and community cohesion—potentially affected by anything that decreases the desirability of the community itself or the desirability of associating or identifying with the community (Finsterbusch, 1980).

C.4.6.1.1.2 Community Services and Resources

Local community resources and especially the provision of services (health, education, and public safety services) to community residents are susceptible to any change in the size and composition of the local population (Canter, 1993). Along with community social and welfare services, these social services constitute primary resources to the populations of the affected communities. The mechanisms for providing these services can be disrupted by population growth or change in composition or location of the population. Other social resources, such as available housing and recreational and cultural resources, may also be affected by temporary or long-term in-migration. Project related growth is expected to increase demands for services provided by local and State governments in the affected regions.

Although it is not feasible to collect data on the capabilities of individual community service delivery systems without specific information regarding the physical location of the designated facility and the corresponding distribution of new population in the ROI, some qualitative prediction of impacts can be made on the basis of general population estimates. Impacts to social services and resources can be inferred from the direct and indirect labor requirements and associated changes in population size and mix anticipated for each of the alternatives. Impacts may be predicted on the basis of the potential for altering service provider to recipient ratios, such as student/teacher or doctor/patient ratios; decreased availability of facilities such as hospital beds or schoolroom seats; or the loss of services to segments of the community as a result of overcrowding or population relocation. A sudden need to provide resources to expand services or an increased capability to provide resources based on an increased population would cause fiscal impacts.

C.4.6.1.2 *Method of Population Analysis*

Because the factors that influence in-migration are multiple and complex, it was impossible to precisely predict the number of in-migrants at each site for the proposed alternatives. However, an estimate was made for each site based on total waste management project workforce requirements. Although this number is not a specific prediction of the actual in-migration into a site's ROI, it provides a basis for comparing potential changes in population across alternatives.

This analysis considered three types of in-migration associated with new requirements for (1) direct construction labor; (2) O&M labor; and (3) secondary labor resulting from new employment at the sites. The level of in-migration would be indirectly influenced by several factors: the current level of unemployment in the region; the economic conditions and the demands for labor (both within the region and in adjacent areas); the ability of the local workforce to provide the necessary skills; the presence and success of worker retraining programs; characteristics of workers and their families; and individual preferences for location and type of residence. The location and the personnel requirements of contractors who work on the project would also be factors; some may already be located in the region with available staff to meet the work requirement, while others may be located outside the region.

Other factors that would influence in-migration include the size of the project and proximity of the region to urban centers. Indirect employment and induced employment (additional employment in the region that is not directly connected to the project but results from increased expenditures in the region) would also contribute to changes in the resident population and to the general social character of the region.

This approach assumed that the following factors remain constant for all alternatives: worker family characteristics, residential locations, composition of the local workforce, and labor shortages among specific occupational groups in the region. No attempt was made to estimate the potential for in-migration that exceeds the number of jobs provided; only estimates of actual employment, direct and multiplier-based, are used. Estimates of peak employment or singular shortages of particular labor categories at particular sites are not included. The success rates of retraining programs at individual sites may affect the availability of labor, but this factor cannot be correctly appraised for this assessment.

The potential for the cumulative effect of this action and the other planned or foreseeable projects at the site to cause a rapid increase in population migration to the region of influence is a serious consideration for

the analysis of site-level impacts. The assessment of population impacts is therefore based on a conservative approach intended to highlight those actions and alternatives that could cause a rapid-change effect. This is especially important during the construction phase when peak periods for many projects may cause a sudden sharp increase in temporary employment at the site. Because the actual timing of future peak employment periods is not known, only a very general discussion is possible at the programmatic level. However, peak-period employment is provided in *Waste Management Environmental and Socioeconomic Impacts Methods and Results* (DOE, 1996a) as a guide to later site-specific analyses.

The actual number of in-migrants during any phase of the waste management project could not be precisely determined, but the literature provides some base assumptions and empirical data that were used in developing percentage estimators for the WM project phases based on the phases of similar projects:

- The percentage of construction jobs filled by in-migrants would be expected to range from 30 to 60% (Halstead et al., 1984). The actual figures for specific projects vary according to the following factors:
  - Size of the project
  - Proximity to urban centers
  - Local labor force
  - Requirement for specialized skills and crafts
  - Table C.4–24 lists the percentages for each of the 17 major sites based on the characteristics of the site ROI
- Job duration during the construction phase was assumed to be approximately four years, and most (85%) of in-migrant construction workers who are directly related to the project are phased out after this period.
- Local workers occupy 40 to 60% of new O&M jobs. Training or retraining programs may encourage local hiring. Because DOE has plans for a retraining program, it is assumed that no fewer than 40% of the available jobs will go to retrainees, 30% will go to other local workers, and 30% will go to in-migrants.
- Of all induced labor associated with the project, 50% will be hired from the local workforce.

For the quantitative estimate of population in-migration and associated characteristics, impacts are presented in the waste-type chapters for those sites where ROI population increases (including new workers and their families) were estimated to be 1% or greater than the 1990 population. This criterion assumes a minimum 1% surplus capacity in public service delivery systems, infrastructure, and other health and welfare services. An increase of less than 1% would also not normally be expected to change the general

Table C.4-24. Percentage of Construction Workers Expected to In-Migrate to Each of the 17 Major DOE Sites

Percentage	Sites
30	BNL
40	ANL-E, FEMP, LLNL, ORR, RFETS, SNL/NM, WVDP
45	Hanford, NTS
60	INEL, LANL, PGDP, Pantex, PORTS, SRS, WIPP

distribution of demographic characteristics within the population as a whole (e.g., change the character of the population by changing the percentage of the population in a given category such as gender, marital status, etc.). These sites are assumed by the analysis to experience a greater potential for change to the social environment as a result of the proposed action. Additionally, sites with estimated population increases over one-half of 1% were assumed to have a potential for minor impacts to social characteristics and the provision of social services and are noted in the discussion where appropriate.

Because the precise location of new facilities at a site and the subsequent preferred residential location of in-migrating workers are not known, this assessment serves only as an estimate for the purpose of comparing impacts. Noticeable effects may occur at much lower levels than 1%, if in-migration is concentrated in one or two communities.

C.4.7 Environmental Justice Impacts

In accordance with the requirements of Executive Order 12898, DOE evaluated the potential for the WM PEIS program alternatives to cause disproportionately high and adverse human health or environmental effects on minority and low-income populations. DOE identified minority and low-income populations residing within 50 miles of the 17 major sites, then reviewed the human health effects and environmental impacts associated with alternatives for the five waste types at those sites. The review included potential impacts under each of the major scientific disciplines evaluated for the waste-type alternatives—human health risk, air quality, water resources, ecology, economics, population impacts, land use, infrastructure, and cultural resources impacts. Regarding health effects, normal facility operations were examined, with accident scenarios evaluated in terms of the risk to the public.

Environmental justice analysis for specific transportation routes was not done because specific routes were not analyzed in the transportation risk analyses. While a disproportionate share of minorities in the population resides near interstate highways and railroads, the major risks to the public from truck transportation are to travelers on the highways from the physical impact of accidents and routine exposure during rest stops. In both cases, on the interstate highways where these major risks would be incurred, the same minorities are found to be disproportionately lower in representation (DOT, 1992). Therefore, minorities are not expected to be receiving a disproportionately higher share of the truck transportation risks.

For rail shipments, the primary risks to the public are from radiological exposure during classification in railyards, primarily at the start and end of each shipment, and from emissions of diesel exhaust from trains in urban areas. Although adverse impacts could occur in the unlikely event of a high-consequence accident, any potential disproportionality with respect to any population—minority, low income and/or American Indian populations included—is subject to the randomness of the combination of factors that can produce such impacts.

C.4.7.1 Environmental Justice Overview

Environmental justice means the fair treatment of people of all races, cultures, and income levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (EPA, 1994a). Environmental justice impacts refer to adverse effects that result when one or more of a broad range of factors tends to place disproportionate adverse environmental impacts on minority (specifically including Native American) and low-income populations.

A Word About Equity and Economics

The environmental justice analyses presented in this document look only at risk and population characteristics near sites. The analyses do not attempt to weigh positive economic effects associated with increased treatment, storage, and/or disposal against associated risk.

C.4.7.1.1 *Issuance of the Executive Order on Environmental Justice*

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*, became effective when signed on February 11, 1994. The Executive Order requires all Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. The Executive Order also requires federal agencies to provide minority and low-income communities access to information and public participation in matters relating to environmental justice. Additionally, to the extent practicable and appropriate, agencies must examine consumption patterns of fish and wildlife where they may be affected by agency activities. Risks inherent in such consumption must be communicated to at-risk populations.

EPA has convened an interagency Federal Working Group on Environmental Justice to provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority and low-income populations, and to serve as an information clearinghouse, coordinate research and data collection, disseminate existing data and studies, provide public participation, organize interagency model projects, and deal with other environmental justice issues that require cooperation among Federal agencies. DOE is a member of the Working Group.

Under the Executive Order, agencies are required to develop agency-wide environmental justice strategies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of the agency's programs, policies, and activities on minority and low-income populations. Using the strategy, the agency is required to conduct its programs, policies, and activities that "substantially affect human health or the environment" in a manner that insures that they do not subject persons (including populations) to discrimination.

Federal agencies are required to implement the Executive Order consistent with and "to the extent permitted by existing law." However, the Executive Order is intended only to improve the internal management of the Executive branch and does not create "any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, its officers, or any person." The Executive Order is not to be construed to create any right to judicial review involving the compliance or noncompliance of the United States, its agencies, its officers, or any other person. A memorandum for the heads of all departments and agencies, circulated with the Executive Order,

underscored the application of Title VI of the Civil Rights Act of 1964, NEPA, the Freedom of Information Act, the Sunshine Act, and the Emergency Planning and Community Right-to-Know Act as existing law particularly applicable to environmental justice (Office of the President, 1994).

"Minority and low-income populations" are not defined under the Executive Order. Consequently, U.S. Bureau of Census definitions, which appear in a variety of documents examining environmental justice impacts, were used. Generally, as defined by the U.S. Department of Commerce, Bureau of Census, minority populations include Black, American Indian, Asian-Pacific, and Hispanic racial and ethnic categories. Native American populations are specifically identified under the Order. Low-income populations are those whose income level is below the poverty level, also as defined by the Bureau of Census (DOC, 1992c,d). A more comprehensive definition of these two groups is presented in Section C.4.7.2.1.1.

C.4.7.1.2 *Status of Guidance on Environmental Justice*

Although the Working Group has not issued final guidance on the approach to be used in analyzing environmental justice, it has issued draft definitions of terms in the *Draft Guidance for Federal Agencies on Key Terms in Executive Order 12898*, dated November 28, 1994. These definitions, with slight modifications, were used in the PEIS environmental justice analysis. Further, in coordination with the Working Group, the Council on Environmental Quality issued Draft Guidance on May 24, 1996. DOE is also in the process of preparing internal guidance for the implementation of the Executive Order. Because both DOE and the Working Group are still in the process of developing final guidance, the approach used in this analysis might depart somewhat from whatever guidance is eventually issued.

C.4.7.2 Approach to WM PEIS Consideration of Environmental Justice Impacts

Any assessment of environmental justice concerns rests on an examination of the composition of the population potentially affected by a given project or action. The potential of a given project or action to unfairly or "disproportionally" affect one segment of the population can be measured, in part, by determining the proportion of the potentially affected population that is minority or low-income. Once minority and low-income proportions of an affected population are identified, any potential impact or

human health effect from a given project or action that is determined to be potentially adverse can be examined in the context of its likelihood to disproportionately affect one or both of these population groups.

For the environmental justice assessment, the following effects, based on definitions by the Working Group, were evaluated for alternatives under each of the five waste types:

- Disproportionately high and adverse human health effects—Any human health effect from exposure to environmental hazards that exceeds generally accepted levels of risk and affects minority and low-income populations at a rate that appreciably exceeds the rate for the general population. Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts to human health.
- Disproportionately high and adverse environmental impacts—A deleterious environmental impact determined to be unacceptable or above generally accepted norms. A disproportionately high impact refers to an environmental hazard with a risk or rate of exposure for a low-income or minority population that appreciably exceeds the risk or rate of exposure for the general population.

C.4.7.2.1 *Identification and Mapping of Minority and Low-Income Populations*

In order to determine the degree or existence of disproportionality, demographic information obtained from the U.S. Bureau of the Census was integrated into a geographic information system to identify minority and low-income populations residing in a zone of potential impact surrounding each of the sites under consideration. This zone was defined as a circle with a 50-mile radius, and whose center was either at the site center for the smaller DOE sites or at an existing waste management location for the six larger DOE sites (Hanford, INEL, LANL, NTS, ORR, and SRS). This 50-mile radius was selected because it was judged to encompass virtually all of the human health risks and environmental impacts that may occur. It was used to capture the offsite population at risk in the human health risk assessment of airborne dispersion of waste management facility emissions. It also encompasses the majority of communities that would be affected socioeconomically by waste management program actions.

C.4.7.2.1.1 Definitions

The following definitions were used to analyze the composition of populations residing around each site and to generate the maps presented in this appendix (see Figures C.4-7 through C.4-40, presented after Section C.4.7.2.3).

- A ***census tract*** is an area defined for the purpose of monitoring census data that is usually comprised of between 2,500 and 8,000 persons. When first delineated, census tracts are designed to be homogenous with respect to population characteristics, economic status, and living conditions. Census tracts do not cross county boundaries. The spatial size of census tracts varies widely depending on the density of settlement. Census tract boundaries are delineated with the intention of being maintained over a long period of time so that statistical comparisons can be made from census to census. For census tracts that were only partially inside the 50-mile radius, an even population distribution was assumed for the tract area and population was calculated as a proportion of the tract area inside the 50-mile radius (i.e., if 40% of the tract area was inside the 50-mile radius, 40% of the tract population was counted).
- A ***minority population*** is a group of people and/or community experiencing common conditions of exposure or impact that consists of persons classified by the U.S. Bureau of the Census as Negro/Black/African-American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, or other nonwhite, based on self-classification by the people according to the race with which they most closely identify. In order to avoid double-counting minority Hispanic persons (Hispanics can be of any race), only white Hispanics were included in the tabulation of racially based minorities. Nonwhite Hispanics had already been counted under their respective minority racial classifications (e.g., Black, American Indian). For purposes of this analysis, a minority population consists of any census tract within the 50-mile zone of impact with a minority population proportion greater than the national average of 24.4%.
- A ***low-income population*** consists of persons of low-income status. Low-income status is based on U.S. Census Bureau data definitions of individuals living below the poverty line. The poverty line is defined by a statistical threshold that considers family size and income. For 1990, the poverty line threshold for a family unit consisting of four individuals, based on 1989 income, was $12,674. For purposes of this analysis, a low-income population consists of any census tract within the 50-mile zone of impact at each site that has a low-income population proportion greater than the national average of 13.1%.

C.4.7.2.1.2 Mapping Procedures

For each of the 17 major WM sites, demographic maps were generated through a geographic information system that utilized 1990 census data available from the U.S. Bureau of the Census. Maps of the minority and low-income populations residing within 50 miles of the DOE sites are shown in Figures C.4–7 through C.4–40, which follow Section C.4.7.2.3. Federally recognized Native American tribal lands within 50 miles of each site were also identified and mapped and are included in this appendix (see Figures C.4–7 through C.4–23). These maps are based on 1990 U.S. Bureau of the Census Tiger Line files, which contain political boundaries and geographical features, and Summary Tape Files 1 and 3, which contain demographic information (DOC, 1992c,d). Data were resolved to the census tract group level.

C.4.7.2.2 *Review of High and Adverse Health Risks and Environmental Impacts*

The environmental justice analysis presented in each waste-type chapter is based on a review of the findings of the risk assessment for public health effects from proposed WM activities at each site and from transportation of wastes. If the PEIS human health risk assessment findings indicated that risks to the general population residing within 50 miles of each site would be low, then it was reasonable to conclude that no segment of the population would experience disproportionately high and adverse health risks, including any minority or low-income populations.

DOE has not evaluated the human health risk to subpopulations that may derive a portion of their food supply from native plants and animals that live near the DOE sites. The results of such a complex analysis would likely vary widely both within and among sites, depending on the assumptions used for such parameters as locations of waste management facilities on the sites, routes of exposure, and dietary habits. Thus, the results would not help to clarify the programmatic decision. The risk to human health for ingesting native plants and animals cannot be fully analyzed with confidence until the locations of facilities on the sites are known, the routes of exposure explicitly defined, and the dietary habits of affected subpopulations quantified. Therefore, analysis of health effects from subsistence consumption of fish, wildlife, and native plant species is not included in the WM PEIS but may be considered in sitewide or project-specific NEPA documents.

The analysis also reviewed environmental impacts, focusing on such effects as air quality, where adverse environmental effects could lead to adverse health effects. Once again, disproportionately high and adverse

impacts on minority or low-income groups would not be expected where the risks to the general population from environmental impacts would be low. Where risks or environmental impacts were found to be adverse, mitigation measures are described that could minimize impacts and thus eliminate the potential for disproportionately high impacts to any minority or low-income populations that might be affected.

C.4.7.2.3 *Analysis of Risk and Environmental Justice Impacts*

The following screening criteria, based on the WM PEIS risk analysis, were used to determine which WM sites would be analyzed for potential environmental justice concerns (generally over a 20-year operating period):

- A population risk greater than or equal to one latent cancer fatality from incident-free treatment facility operations
- A nonworker MEI cancer fatality probability of 1×10^{-6} or greater from incident-free treatment facility operations (*Risk Assessment Guidance for Superfund* [EPA, 1989])

If a WM site had projected health risks greater than or equal to the conditions described in either of the two screening criteria, regardless of waste type or WM program alternative, further analysis was justified. Conversely, an analysis of potential environmental justice impacts at a particular site was not warranted if health risks were projected to be lower than those described in both criteria. If a particular alternative did not generate health effects exceeding these screening criteria, no disproportionately high and adverse health effects would be expected. Consequently, no environmental justice impacts would be expected, even if the population surrounding a site had minority or low-income proportions greater than the national average.

For the analysis of potential environmental justice impacts from treatment facilities operations, screening (at least one latent cancer fatality) was used to identify sites and alternatives needing further analysis. For sites with projected health effects associated with a specific waste type exceeding the screening limits, a sector block analysis was conducted. A grid consisting of 16 pie-shaped sectors (see Figure C.4–7) positioned 360° around the centroid of a site and 10 concentric circles (with interval sizes of 1, 5, and 10 miles) radiating outward from the centroid to the outer edge of the ROI was used to break down the ROI into sectors and blocks. A block consisted of the portion of a sector bounded by (or located between) concentric circles. The WM PEIS risk analysis was used to derive a sector block dose value (or unit concentration), which was distributed to each tract within a sector block. For tracts that crossed sector block

boundaries, the dose value was weighted according to the fraction of the tract occupying the sector block. After a dose value was assigned to each tract, the tract was classified as either minority or not (or low-income or not). An examination of the tracts receiving the highest doses was conducted to determine the proportion of these tracts that were minority or low-income. If the proportion of minority or low-income tracts receiving higher doses was higher than the proportion of minority or low-income tracts in the general population, an environmental justice impact was declared. Two additional analytical steps were performed. The same analysis was performed using only the census tracts receiving the upper 10% of the dose. In addition, the statistical correlations for dose and percentage minority and low income were calculated for LANL, the only site meeting the selection criterion for population risk.

To determine whether impacts to a nonworker MEI at WM sites under the various waste type alternatives could be disproportionate, a screening criterion (a nonworker MEI cancer fatality probability of 1×10^{-6} or greater from incident-free operations) was used to identify sites requiring further analysis. Once these sites were identified, WM PEIS risk modeling was reviewed to locate the sector block containing the nonworker MEI for each selected site. A demographic analysis of the MEI sector block was then conducted to determine the composition of the census tract population. If the MEI sector block was composed of minority or low-income census tracts, a finding of potential for disproportionate health effects was included in the discussion of impacts for the relevant waste type and alternative. In most cases where more than one census tract was located in the MEI sector block, the tract located closest to the site was used to determine potential disproportionality. This approach was conservative and did not take credit for the possibility that, proportionately, the aggregate population of the MEI sector block may not exceed the national average for minority or low-income populations.

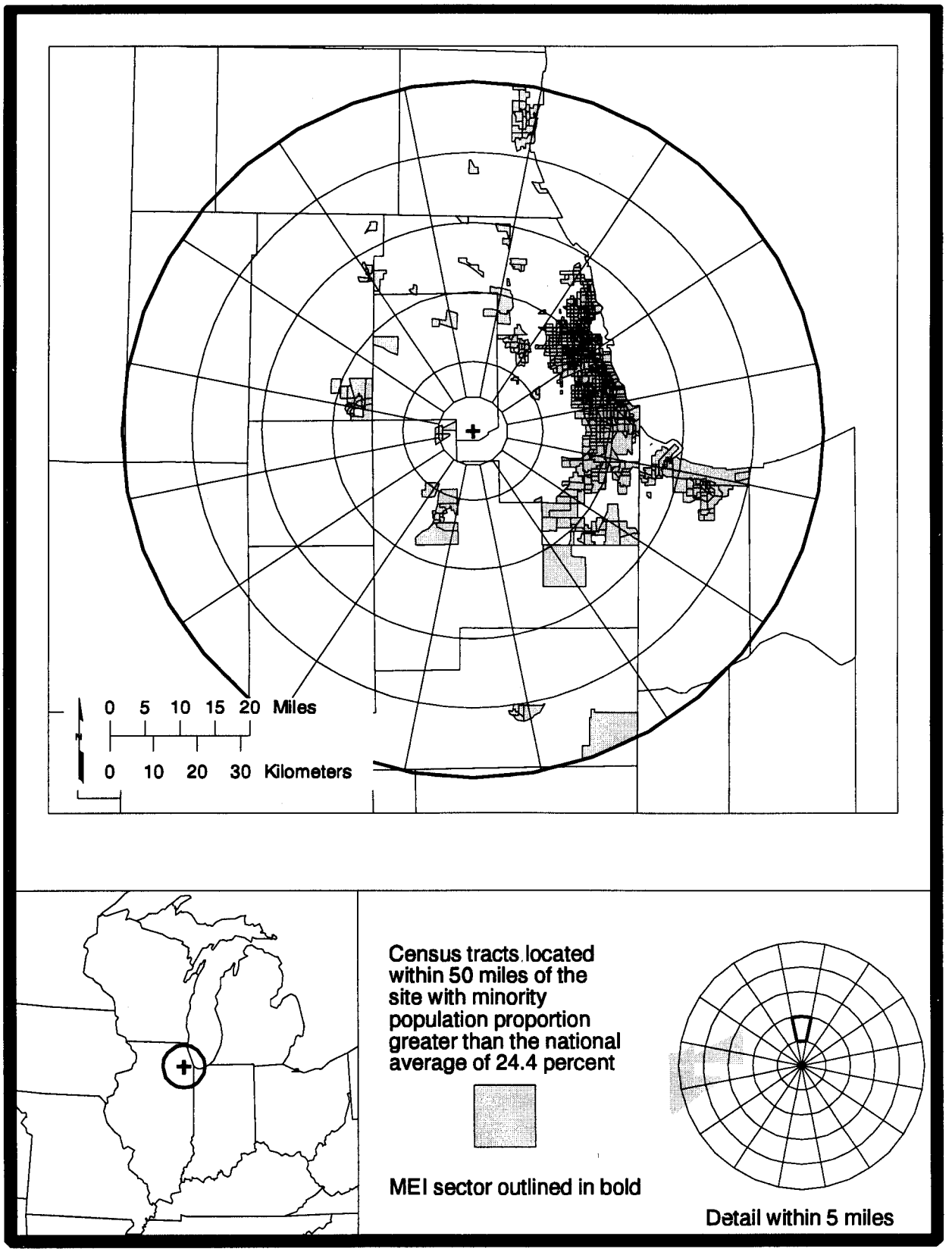

Figure C.4–7. Distribution of Minority Populations at Argonne National Laboratory-East.

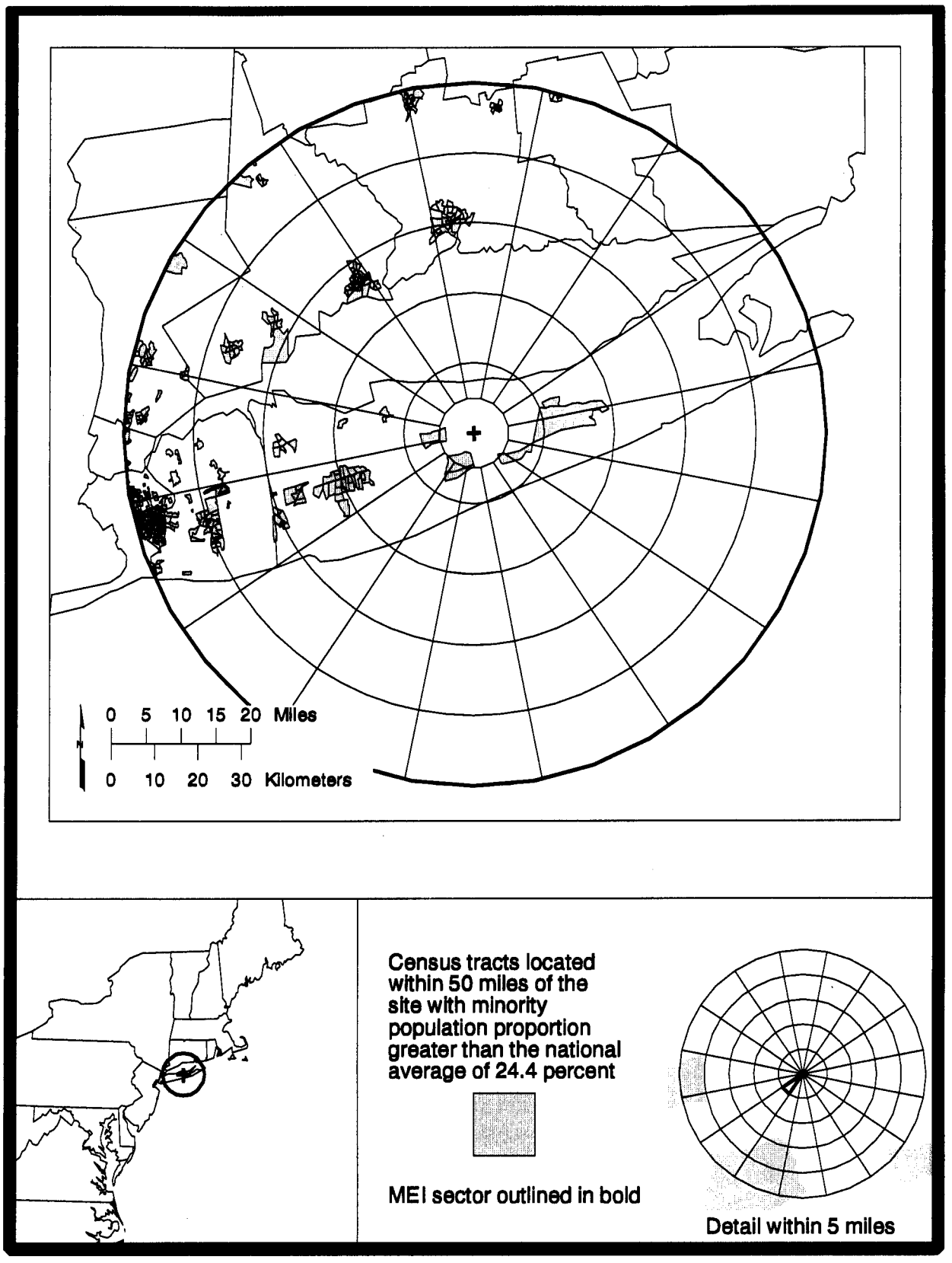

Figure C.4-8. Distribution of Minority Populations at Brookhaven National Laboratory.

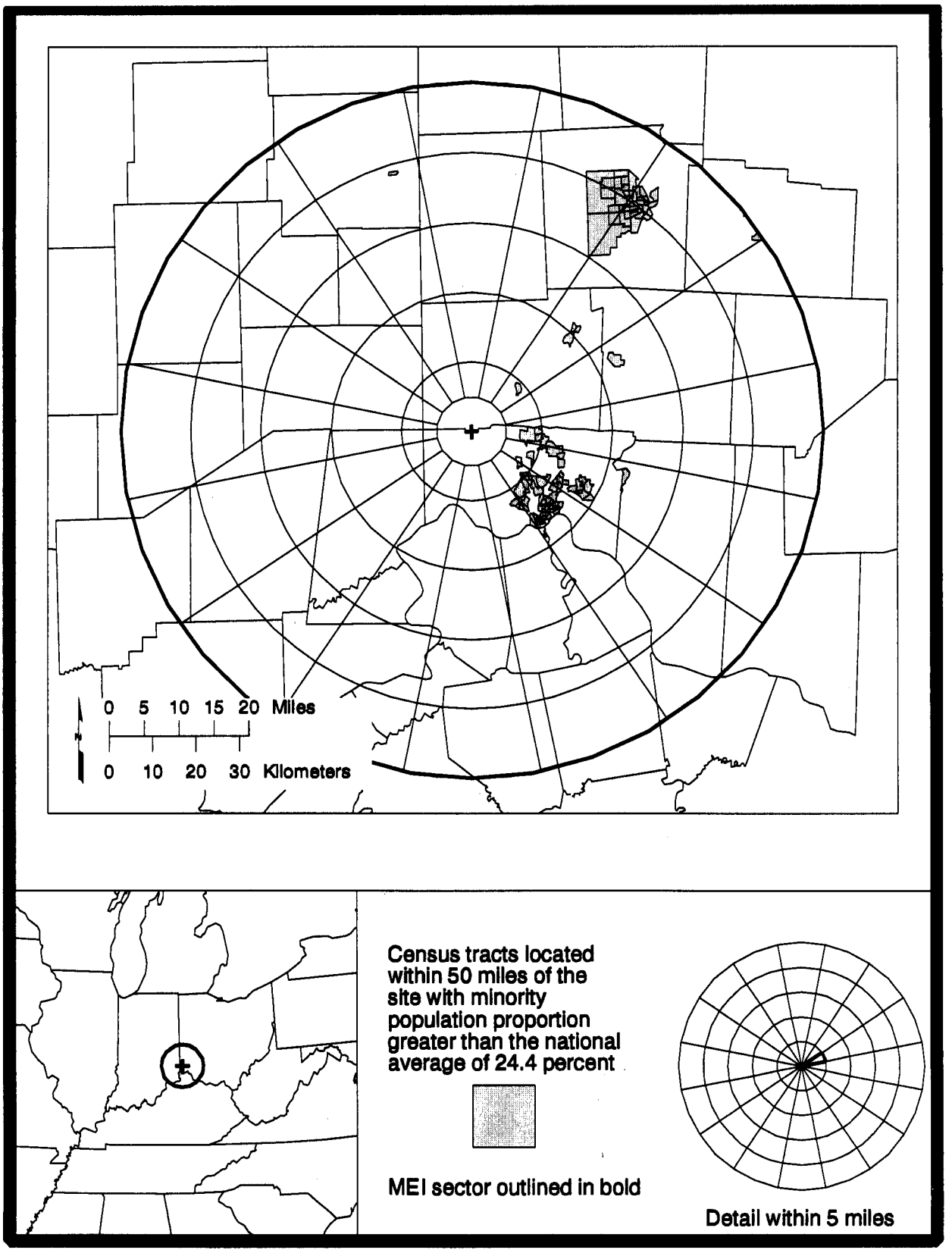

Figure C.4-9. Distribution of Minority Populations at Fernald Environmental Management Project.

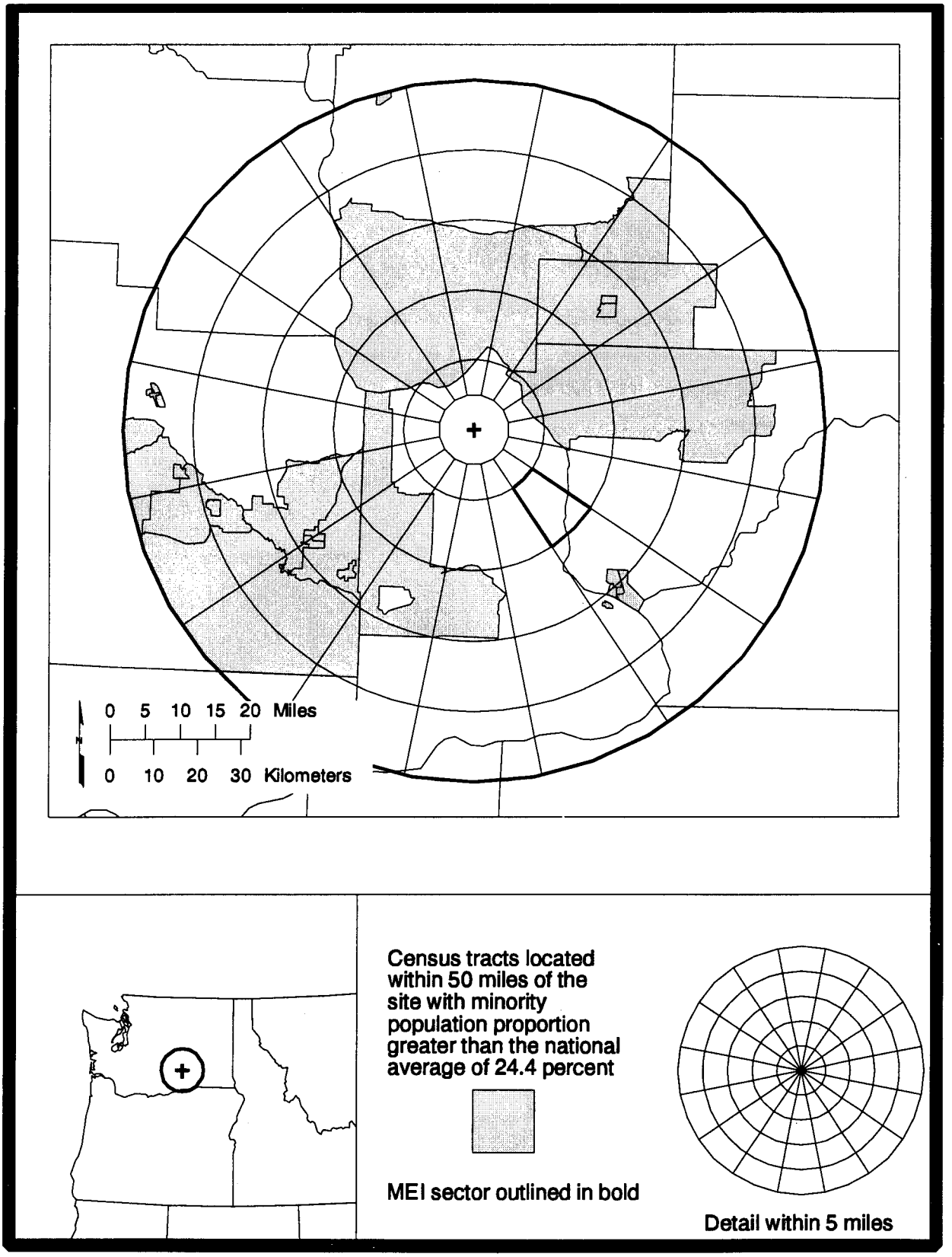

Figure C.4–10a. Distribution of Minority Populations at the Hanford Site.

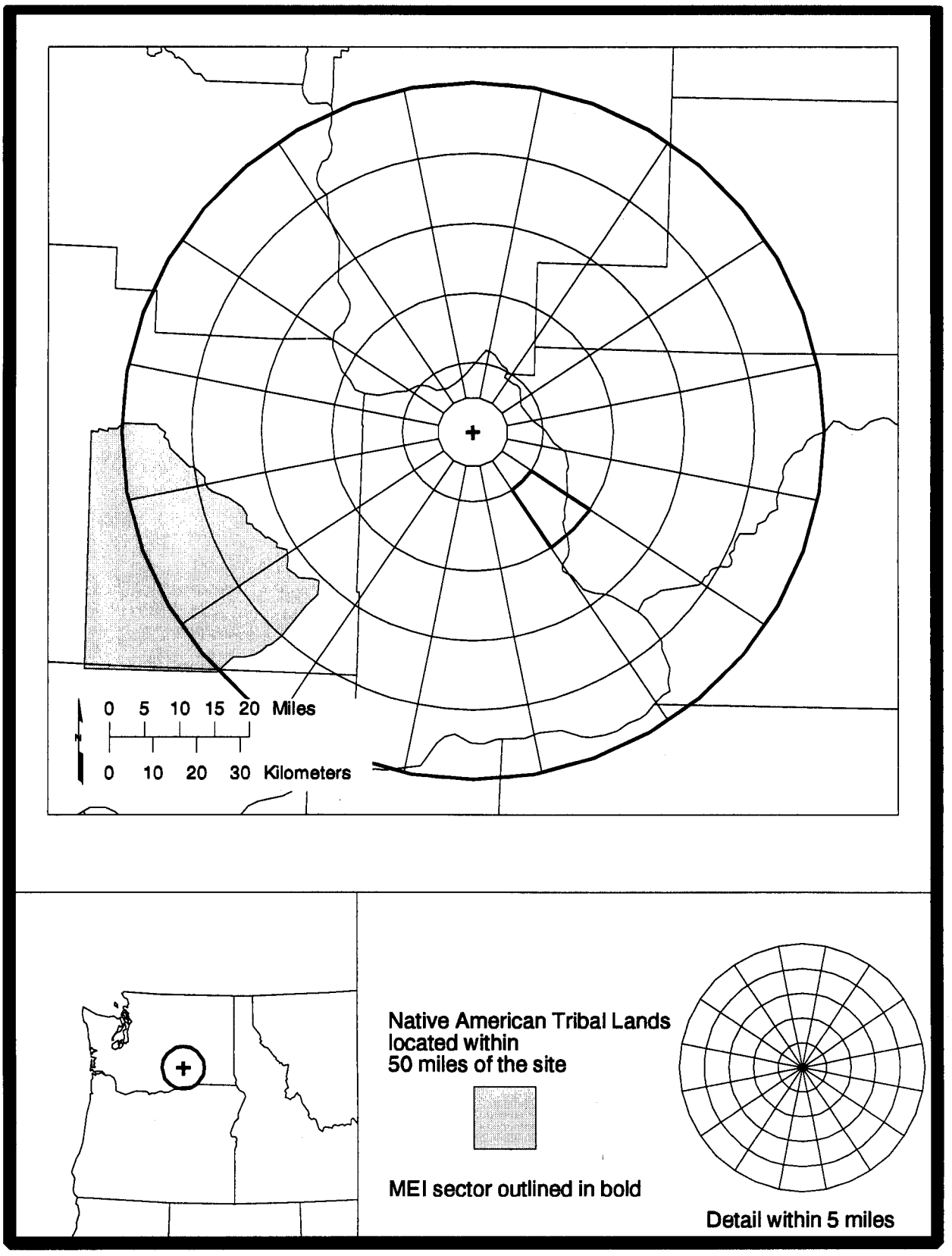

Figure C.4–10b. Location of Tribal Lands at the Hanford Site.

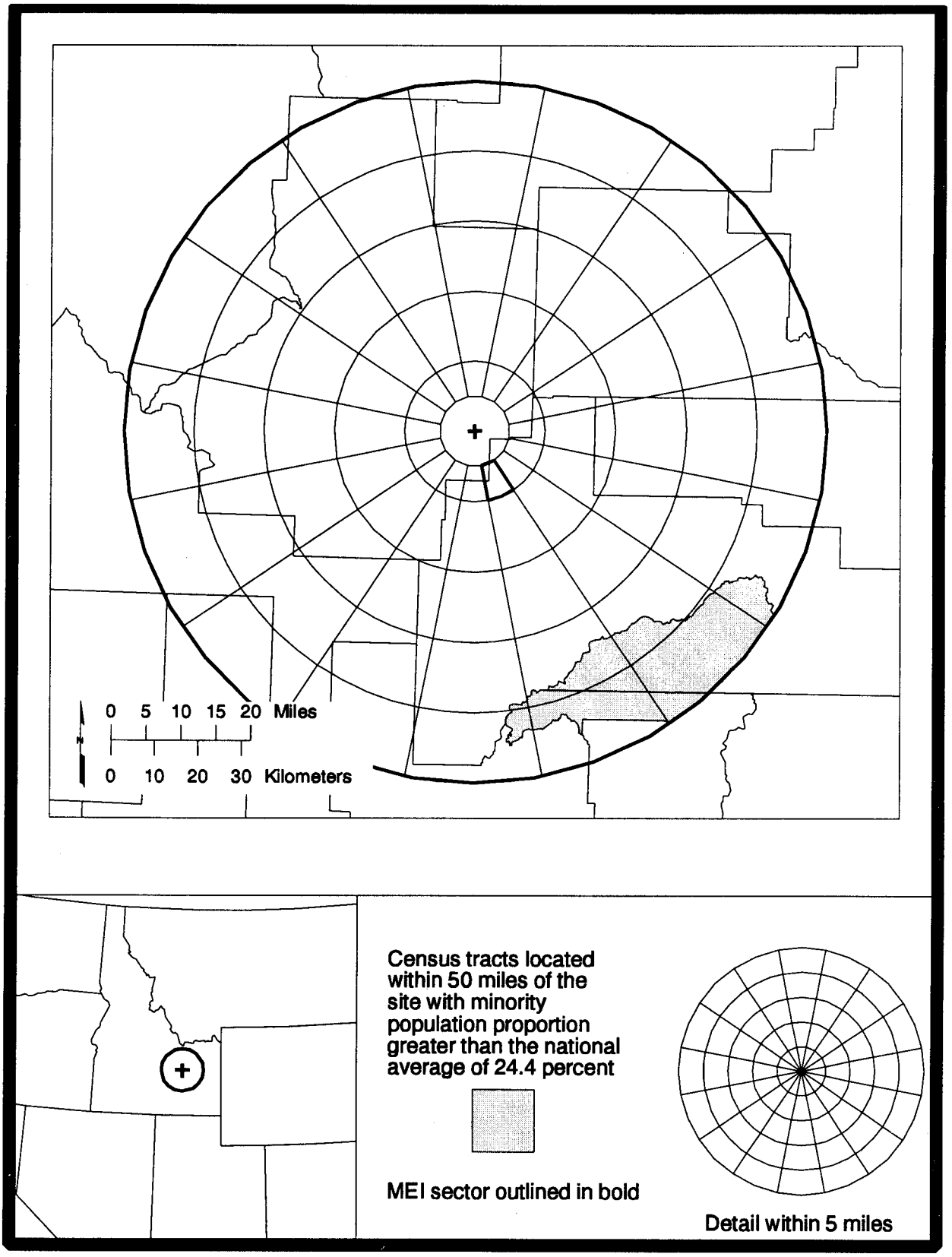

Figure C.4-11a. Distribution of Minority Populations at Idaho National Engineering Laboratory.

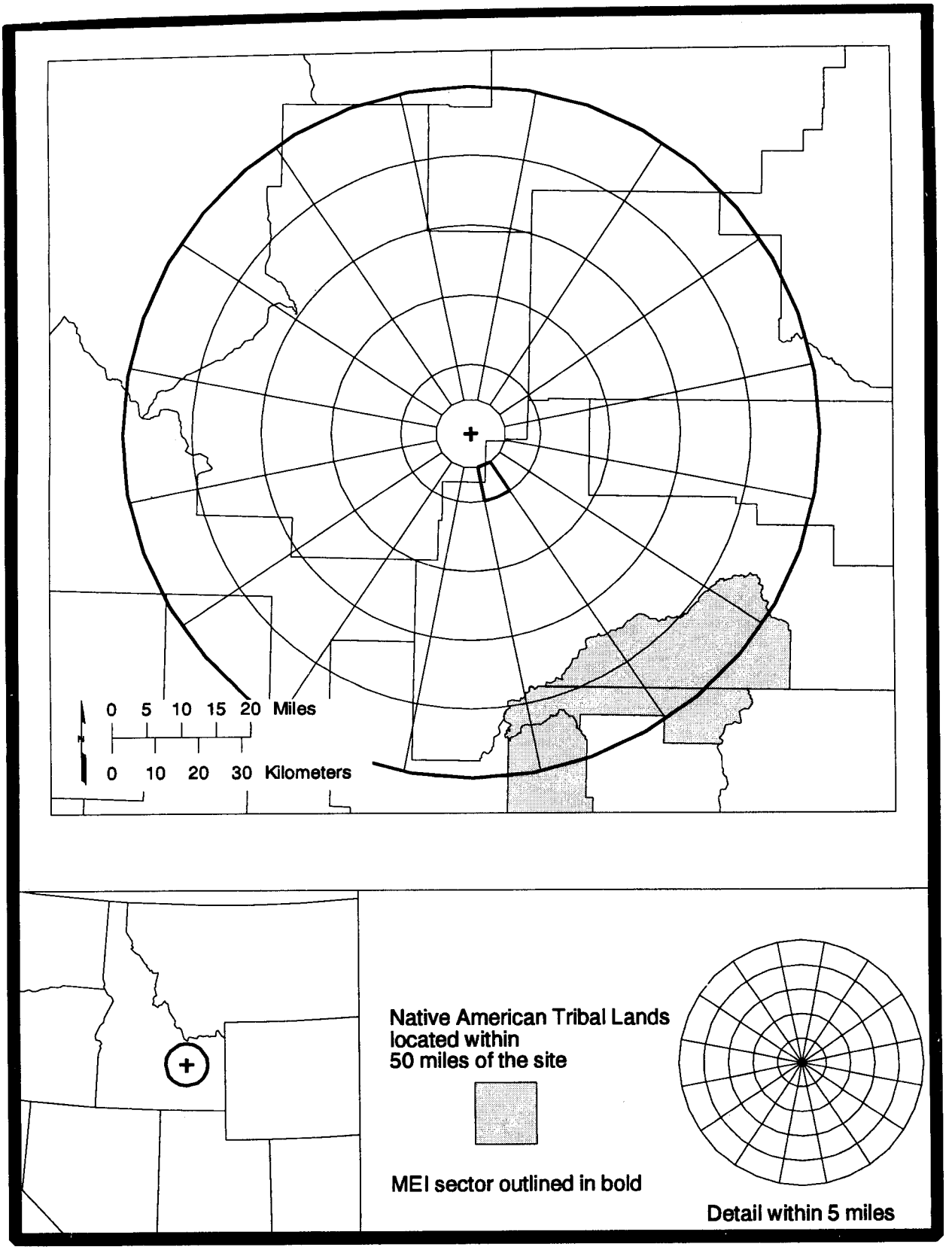

Figure C.4–11b. Location of Tribal Lands at Idaho National Engineering Laboratory.

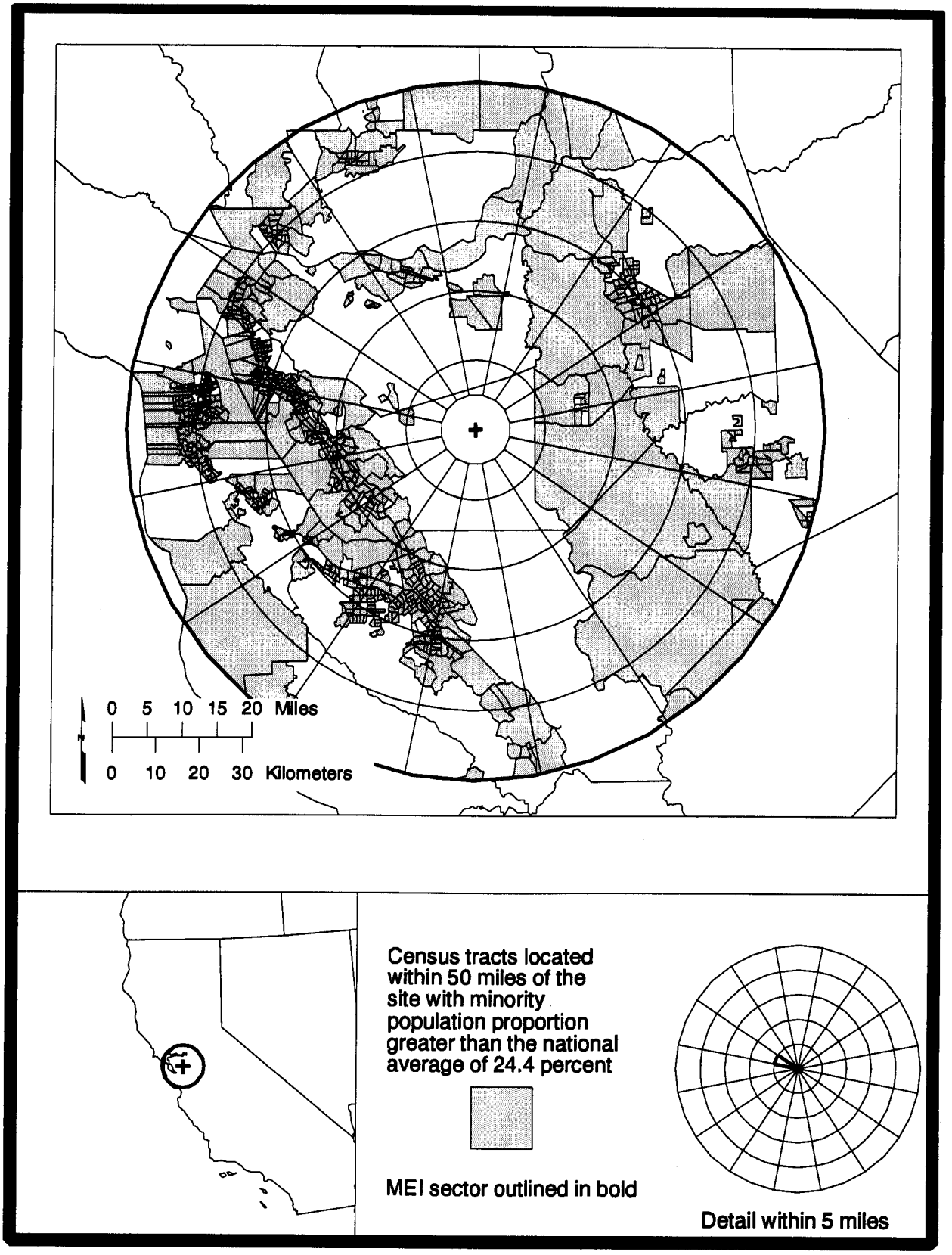

Figure C.4-12. Distribution of Minority Populations at Lawrence Livermore National Laboratory.

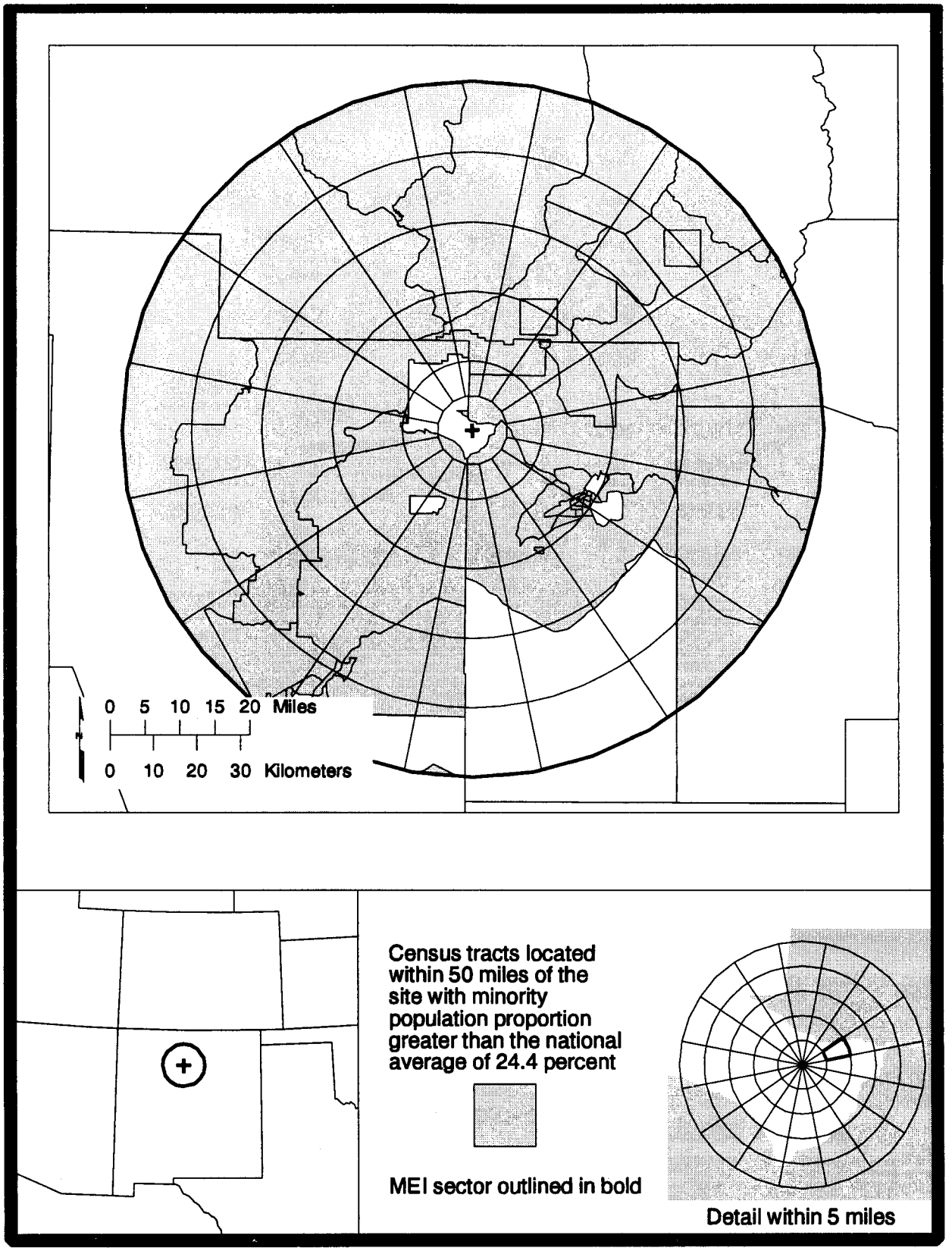

Figure C.4-13a. Distribution of Minority Populations at Los Alamos National Laboratory.

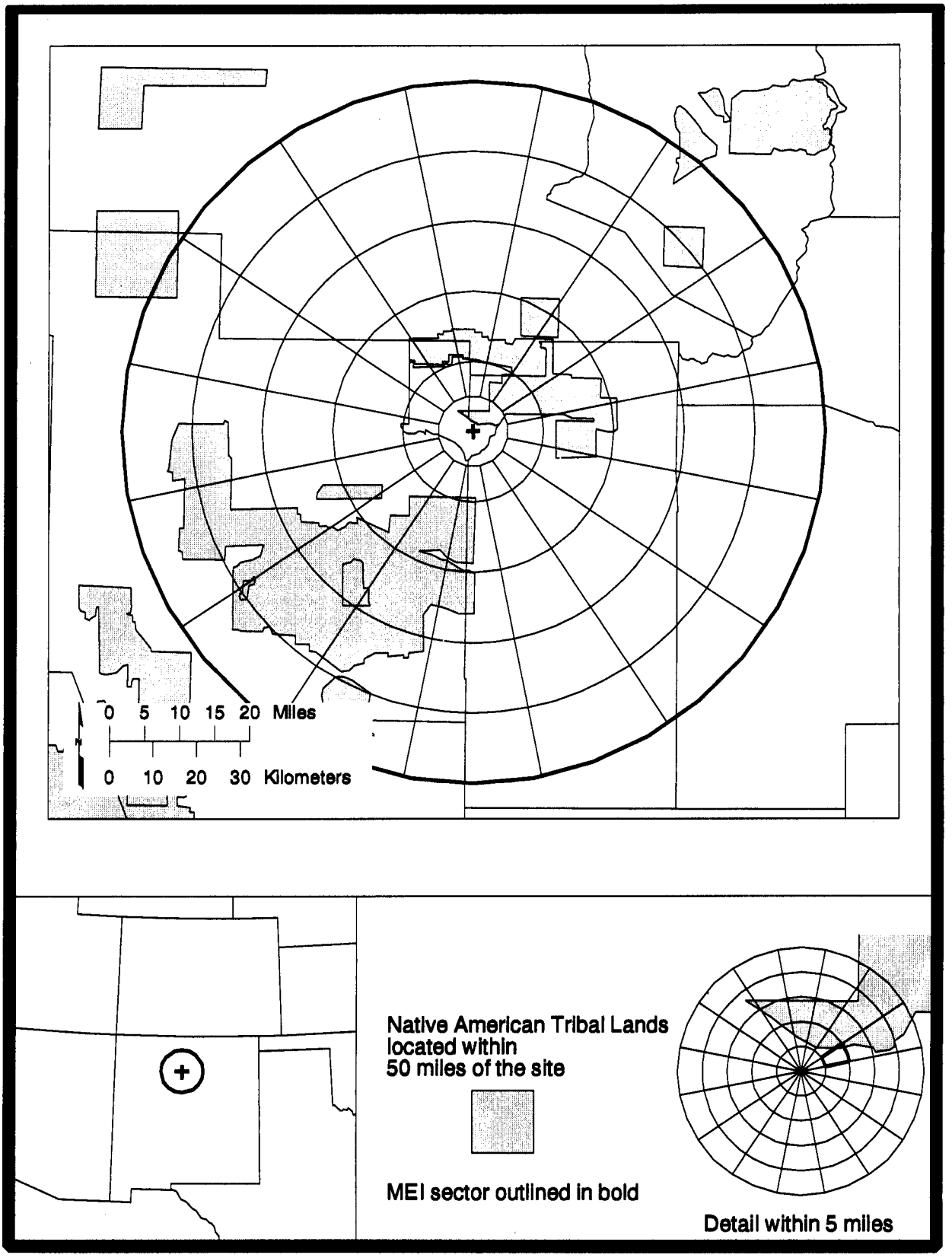

Figure C.4-13b. Locations of Tribal Lands at Los Alamos National Laboratory.

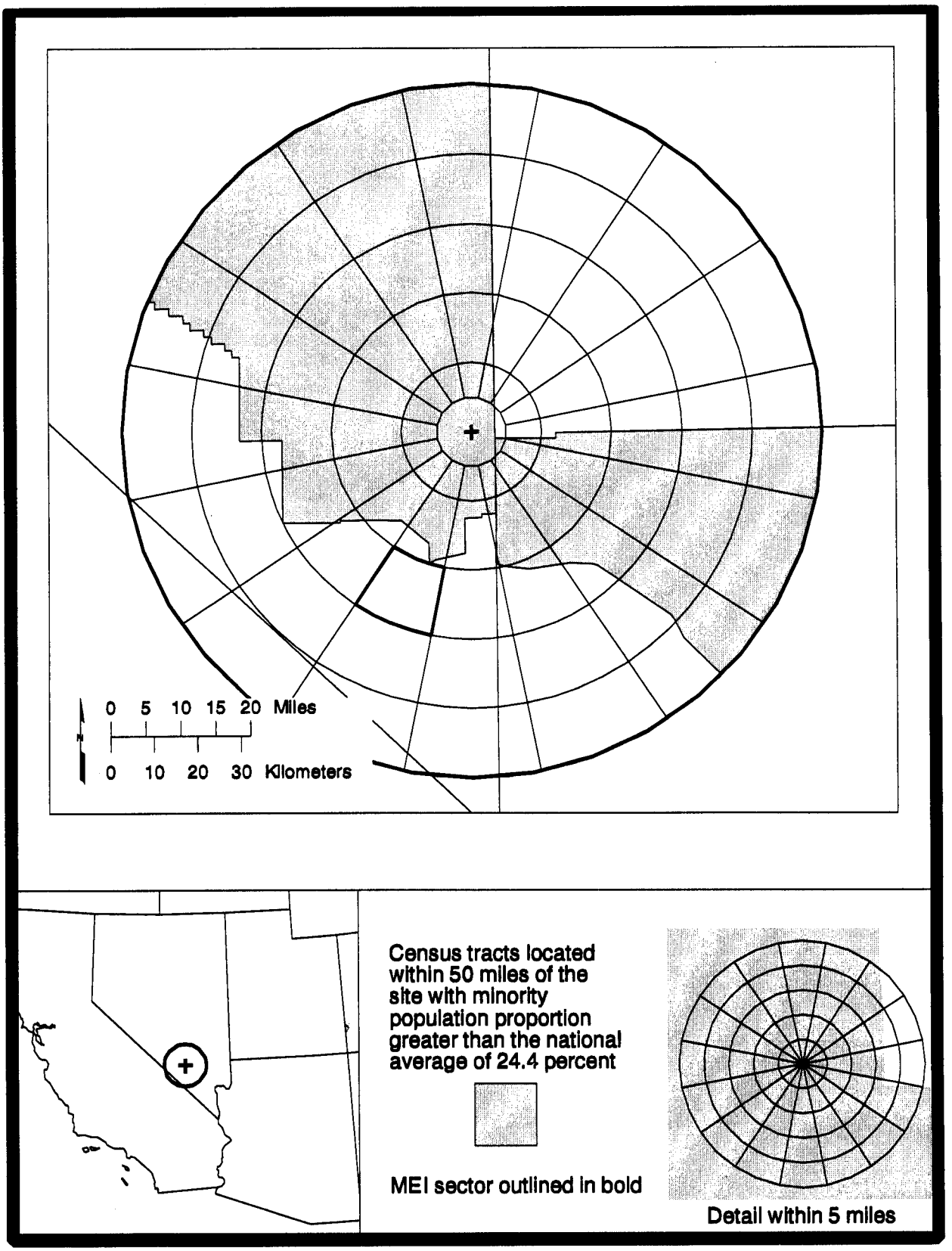

Figure C.4-14. Distribution of Minority Populations at the Nevada Test Site.

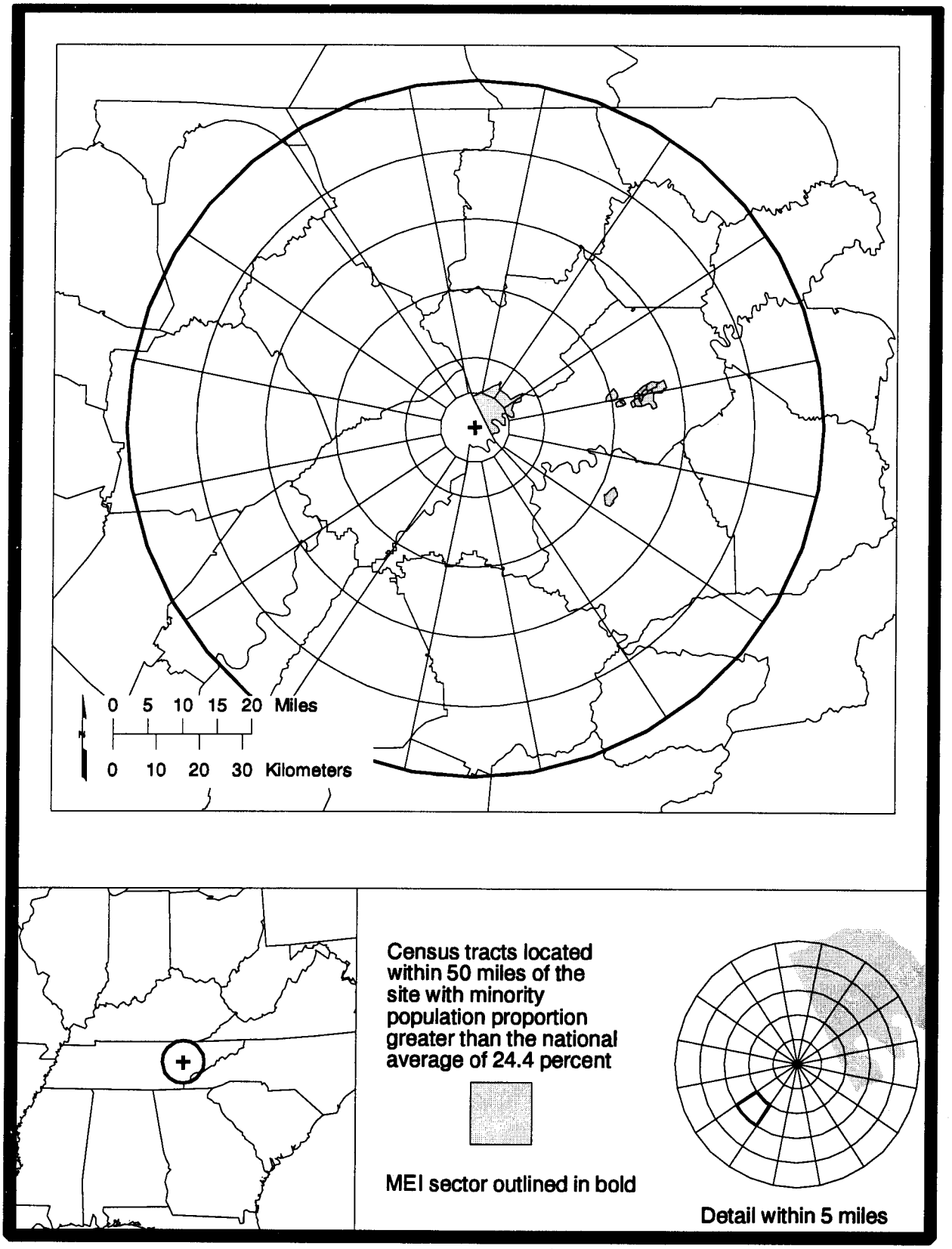

Figure C.4-15. Distribution of Minority Populations at the Oak Ridge Reservation.

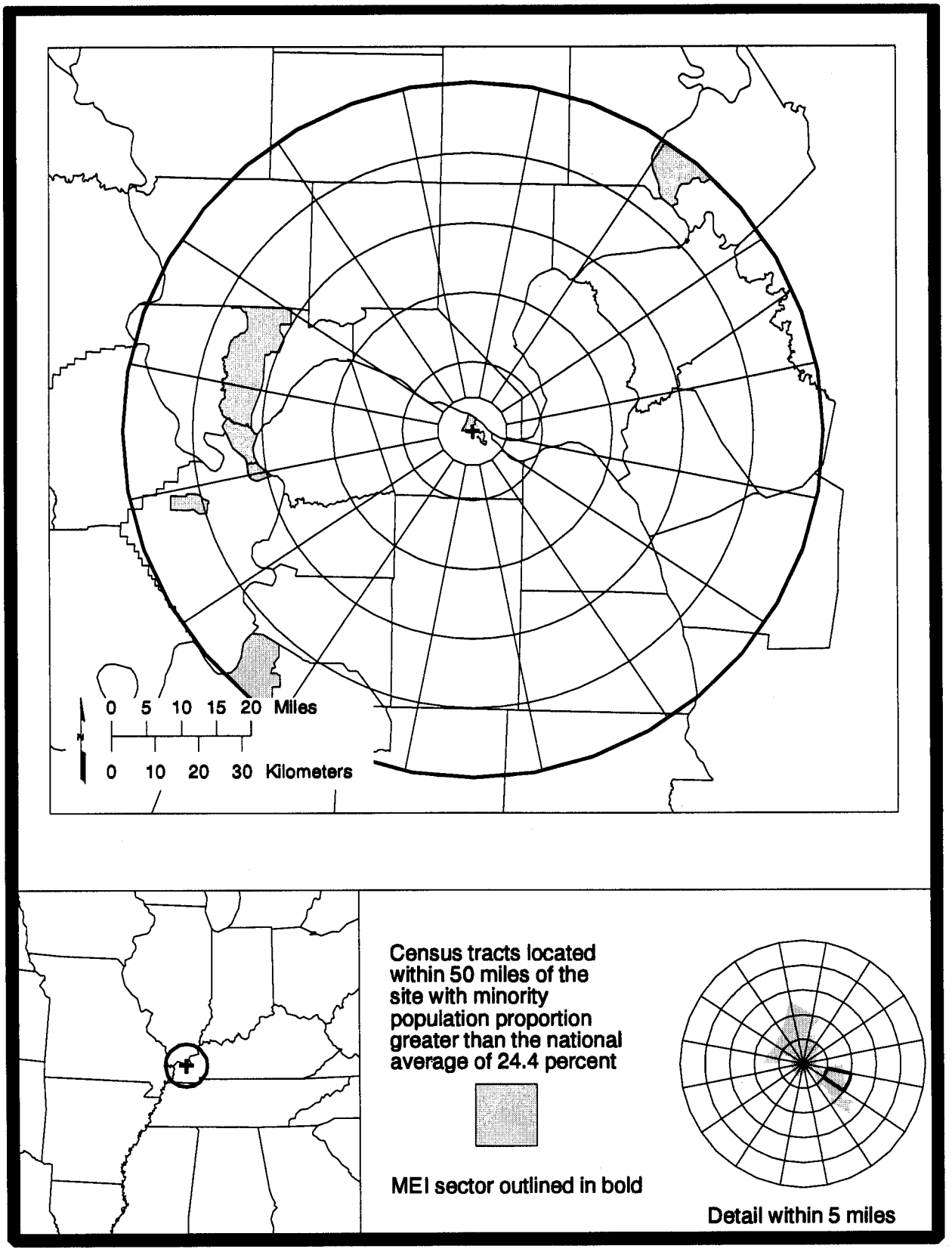

Figure C.4–16. Distribution of Minority Populations at the Paducah Gaseous Diffusion Plant.

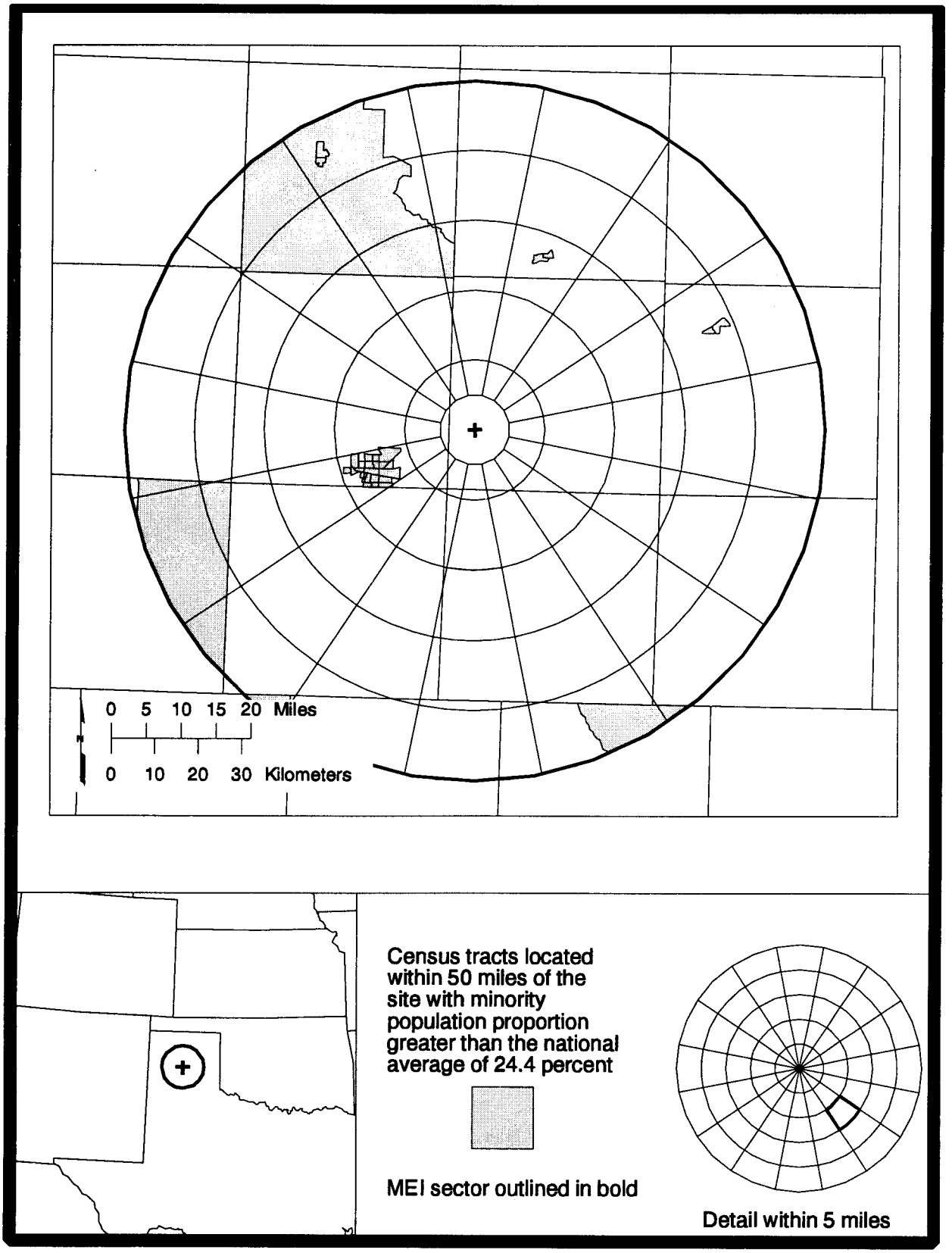

Figure C.4–17. Distribution of Minority Populations at the Pantex Plant.

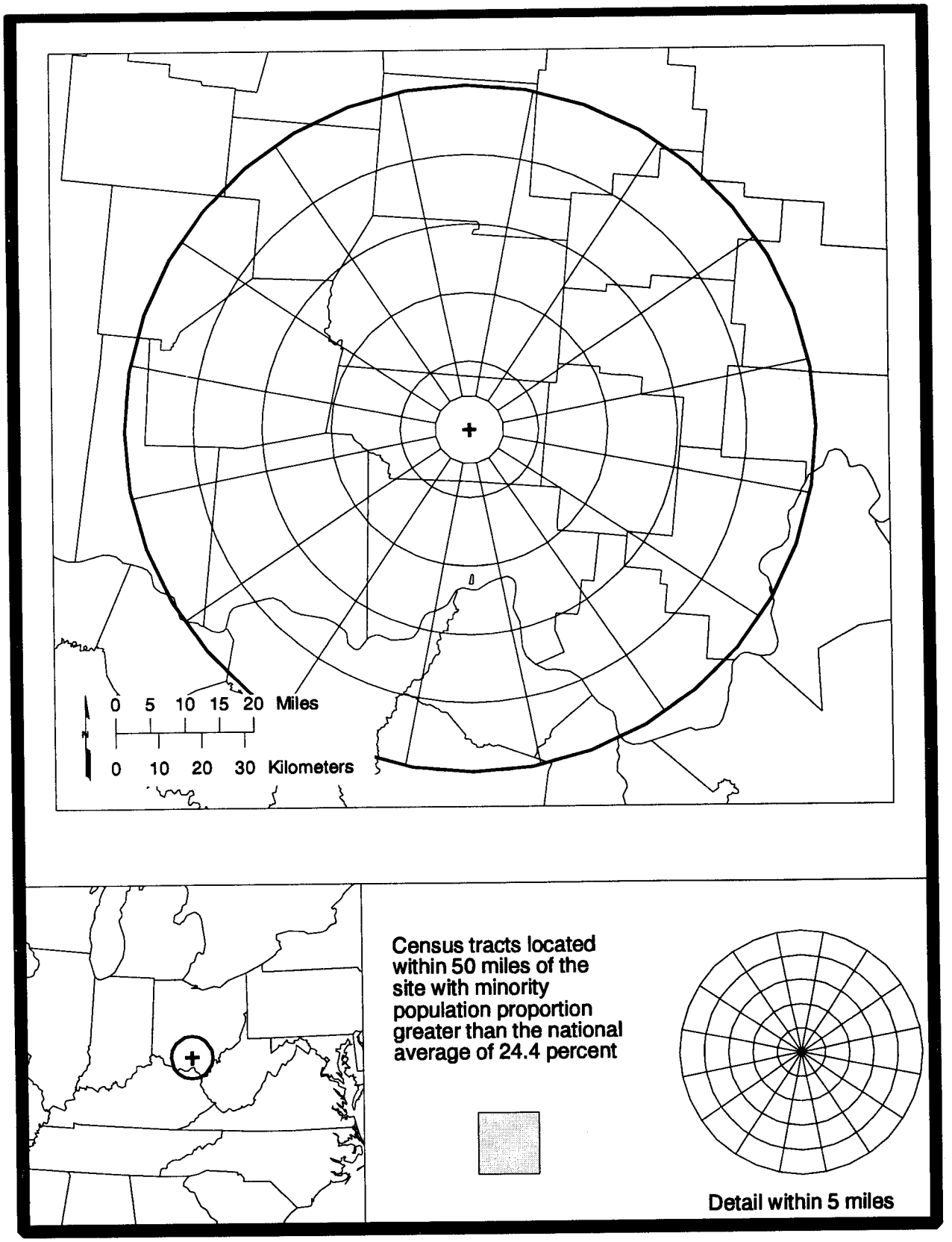

Figure C.4–18. Distribution of Minority Populations at the Portsmouth Gaseous Diffusion Plant.

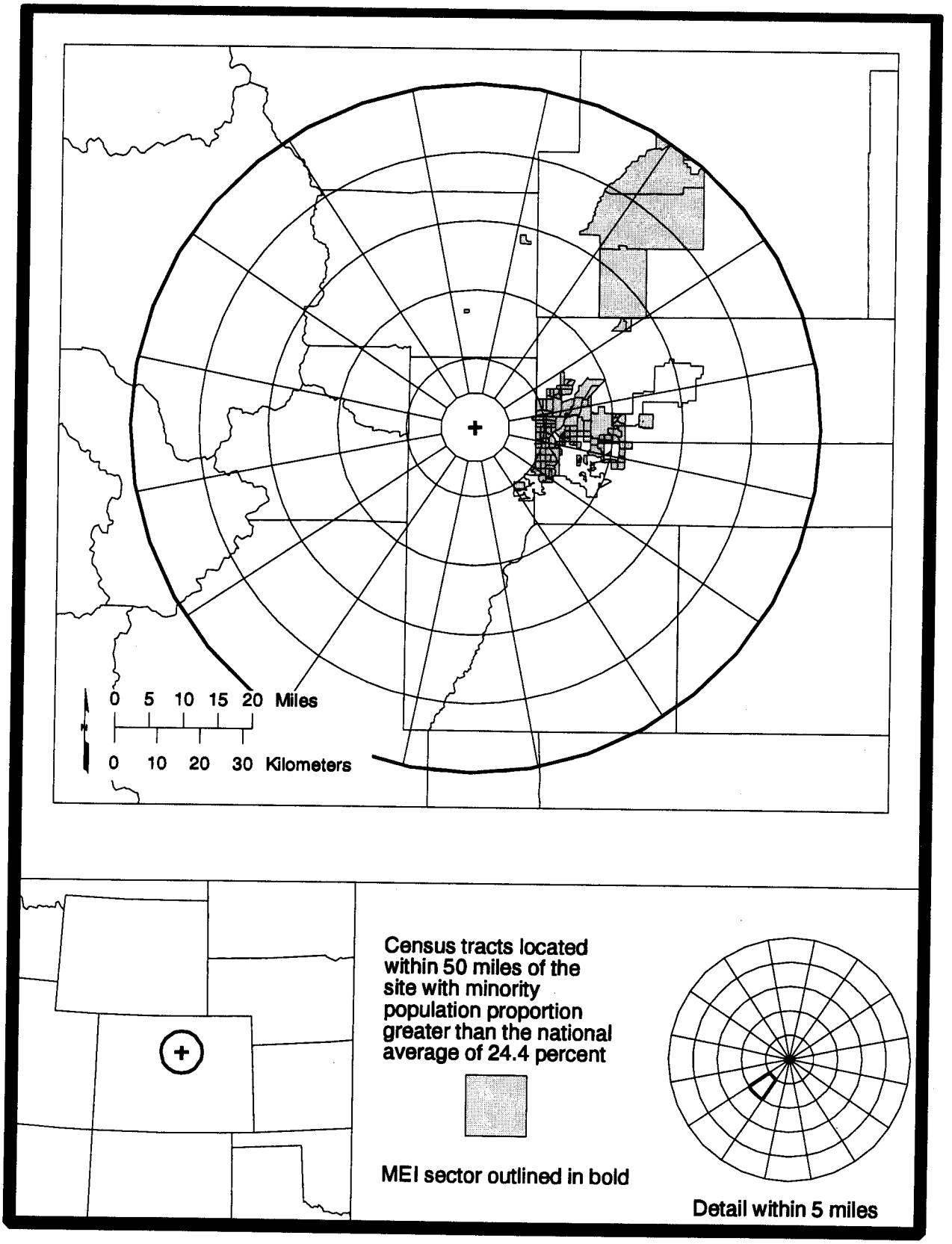

Figure C.4-19. Distribution of Minority Populations at Rocky Flats Environmental Technology Site.

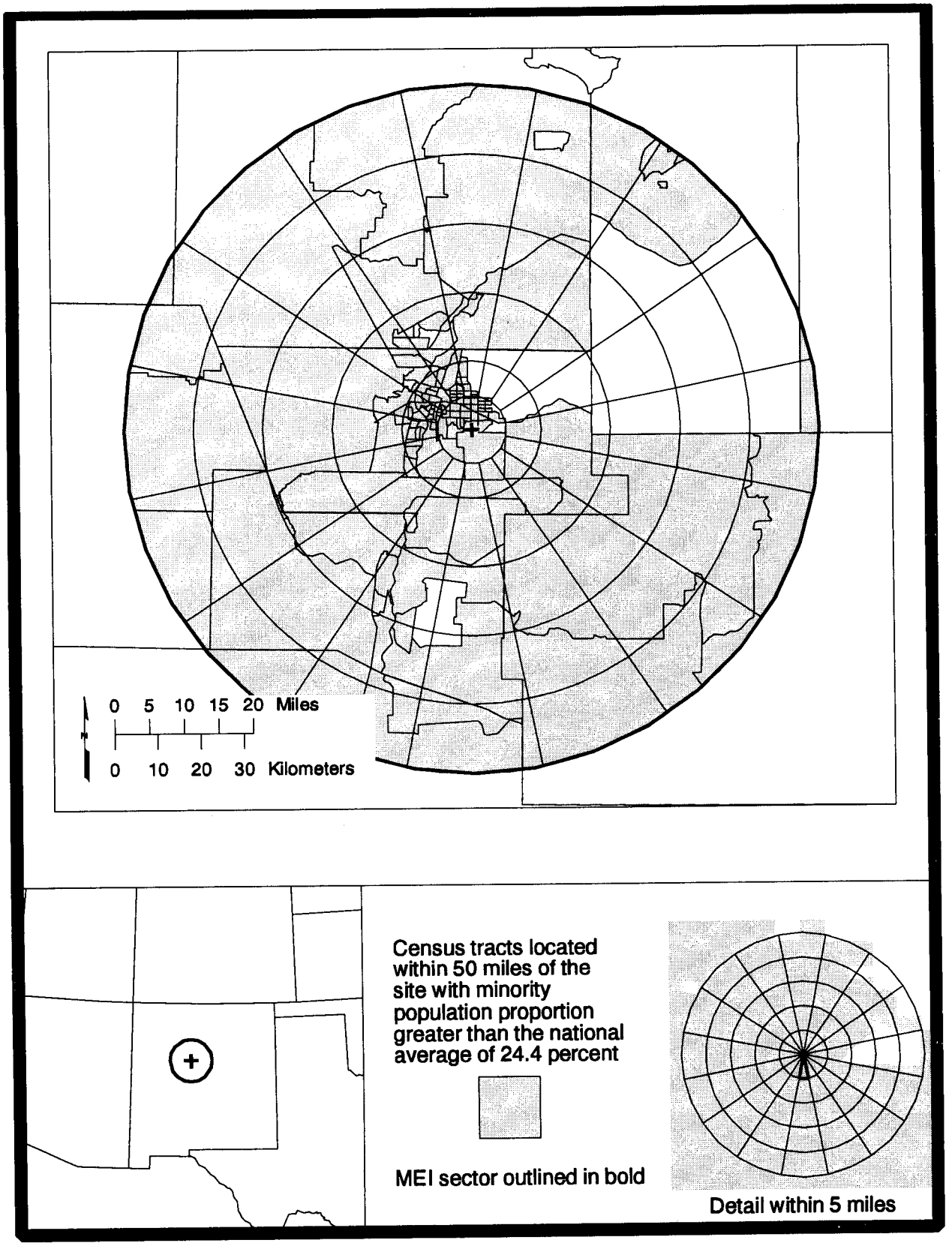

Figure C.4–20a. Distribution of Minority Populations at Sandia National Laboratories-New Mexico.

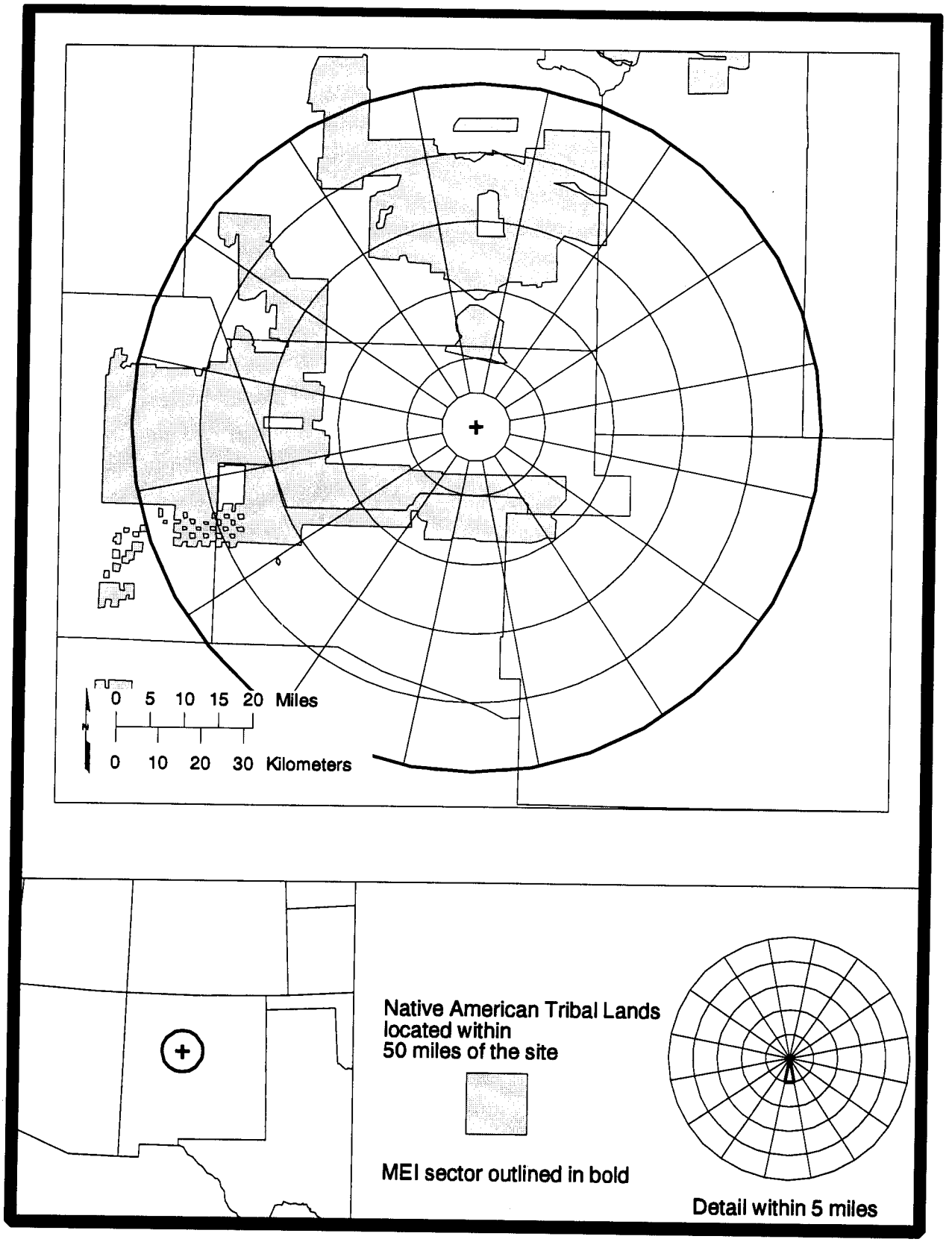

Figure C.4-20b. Locations of Tribal Lands at Sandia National Laboratories-New Mexico.

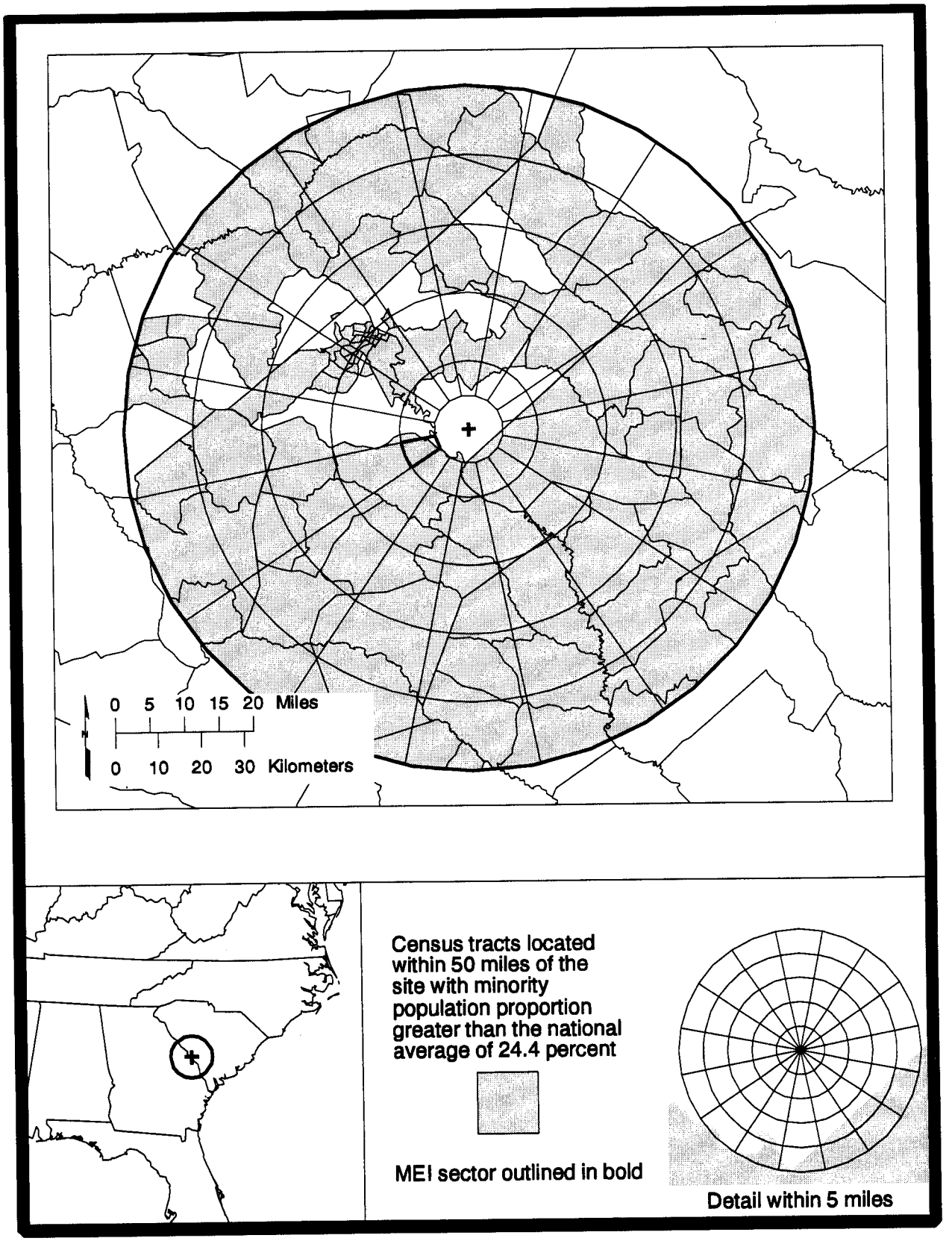

Figure C.4-21. Distribution of Minority Populations at the Savannah River Site.

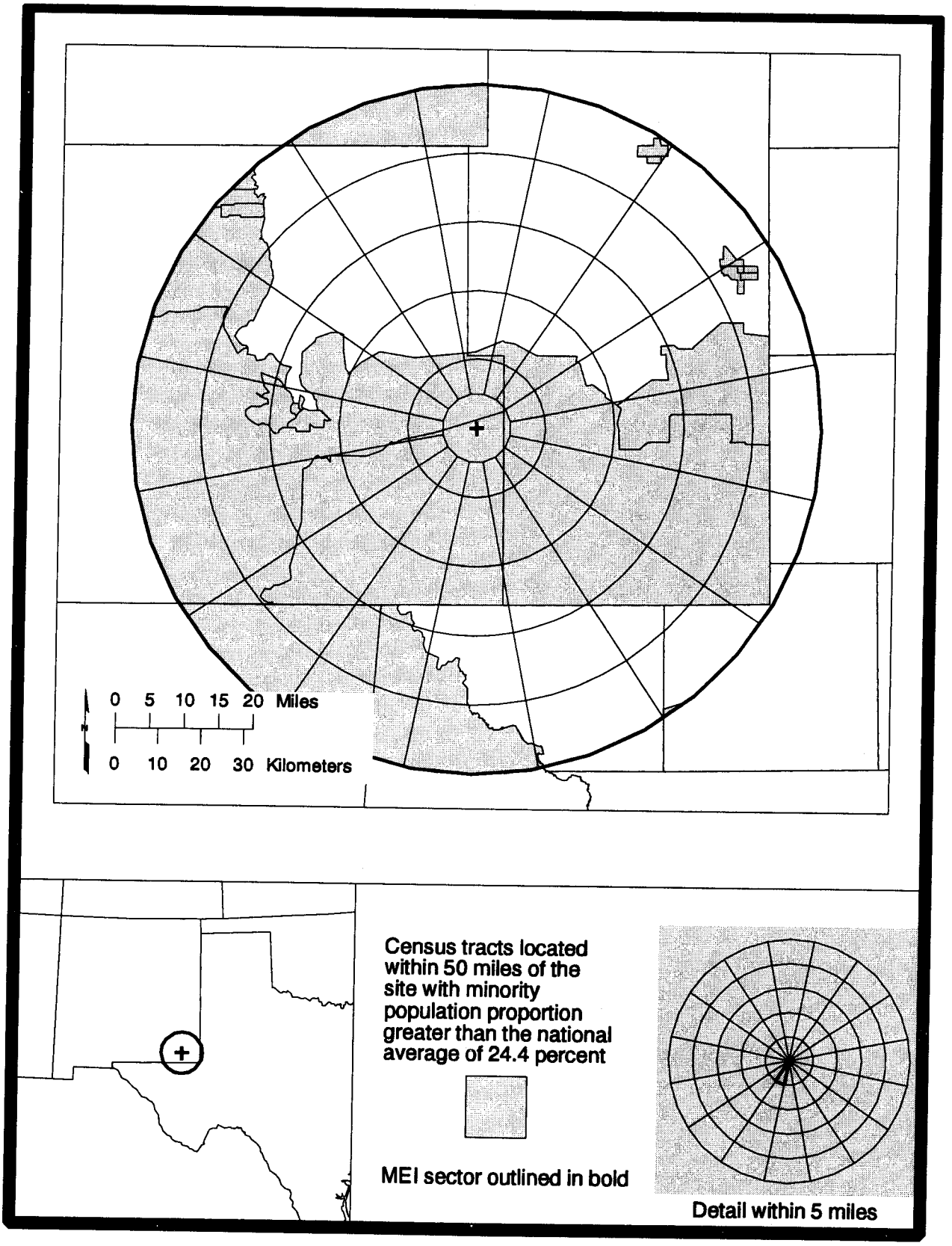

Figure C.4-22. Distribution of Minority Populations at the Waste Isolation Pilot Plant.

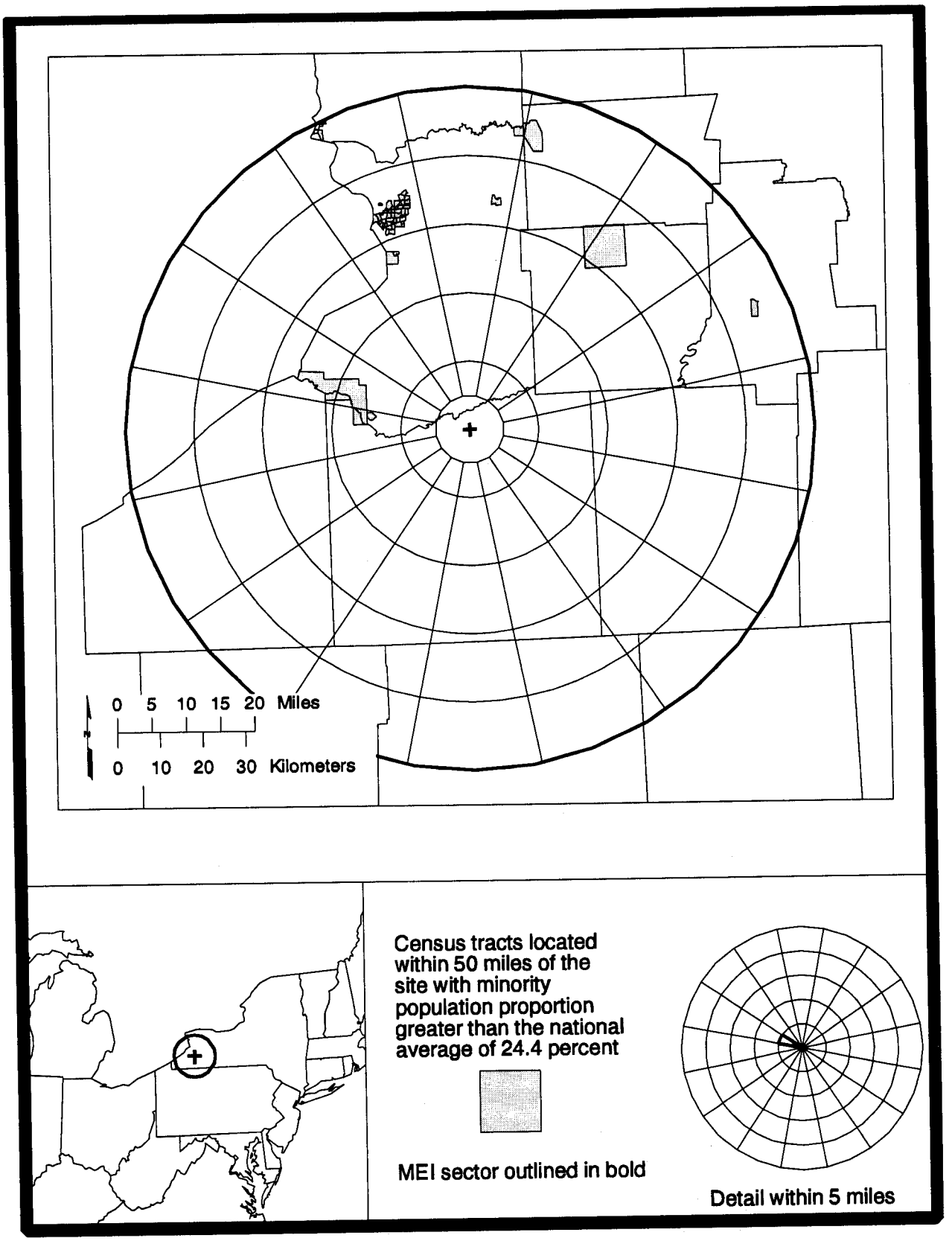

Figure C.4-23a. Distribution of Minority Populations at the West Valley Demonstration Plant.

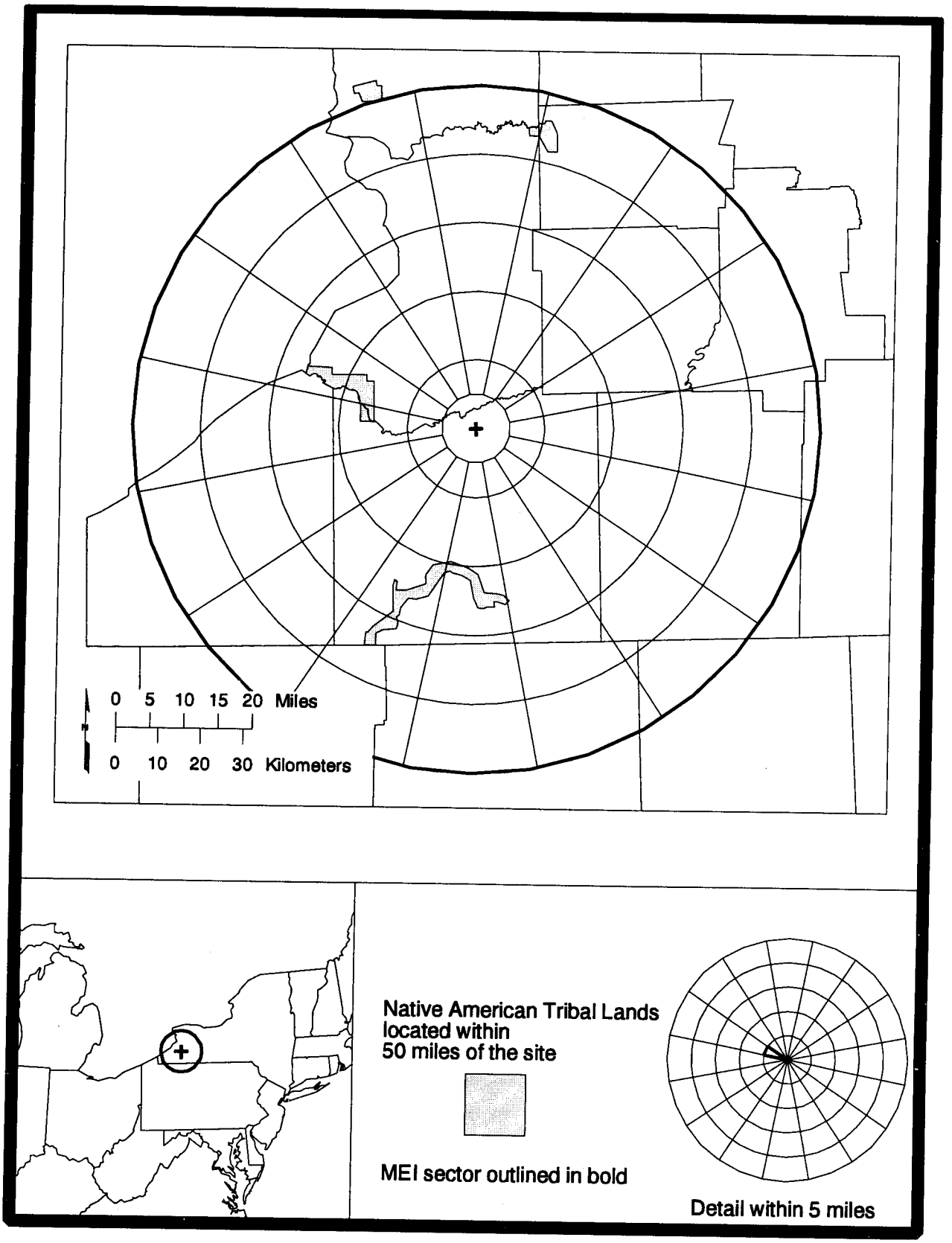

Figure C.4-23b. Locations of Tribal Lands at the West Valley Demonstration Project.

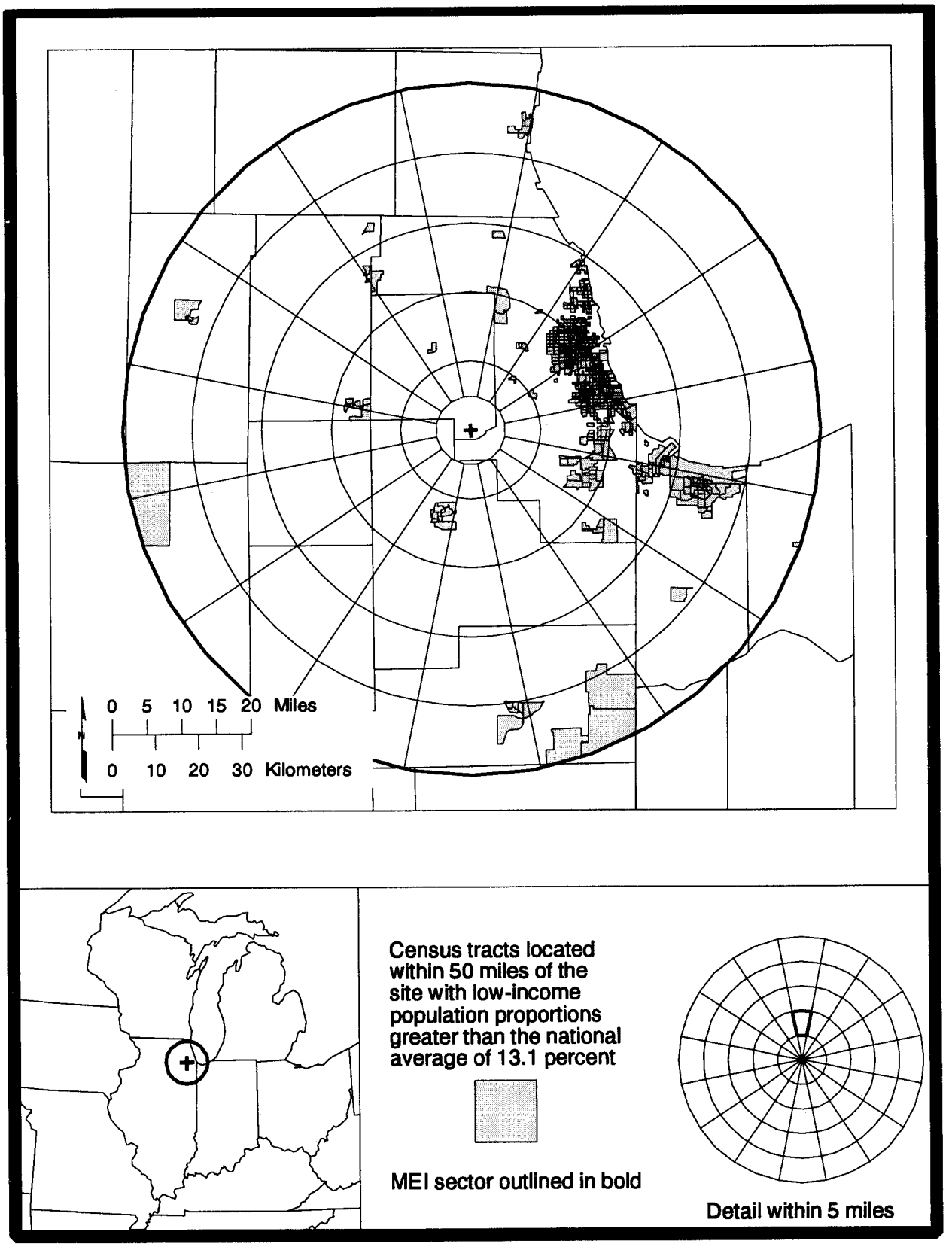

Figure C.4–24. Distribution of Low-Income Populations at Argonne National Laboratory-East.

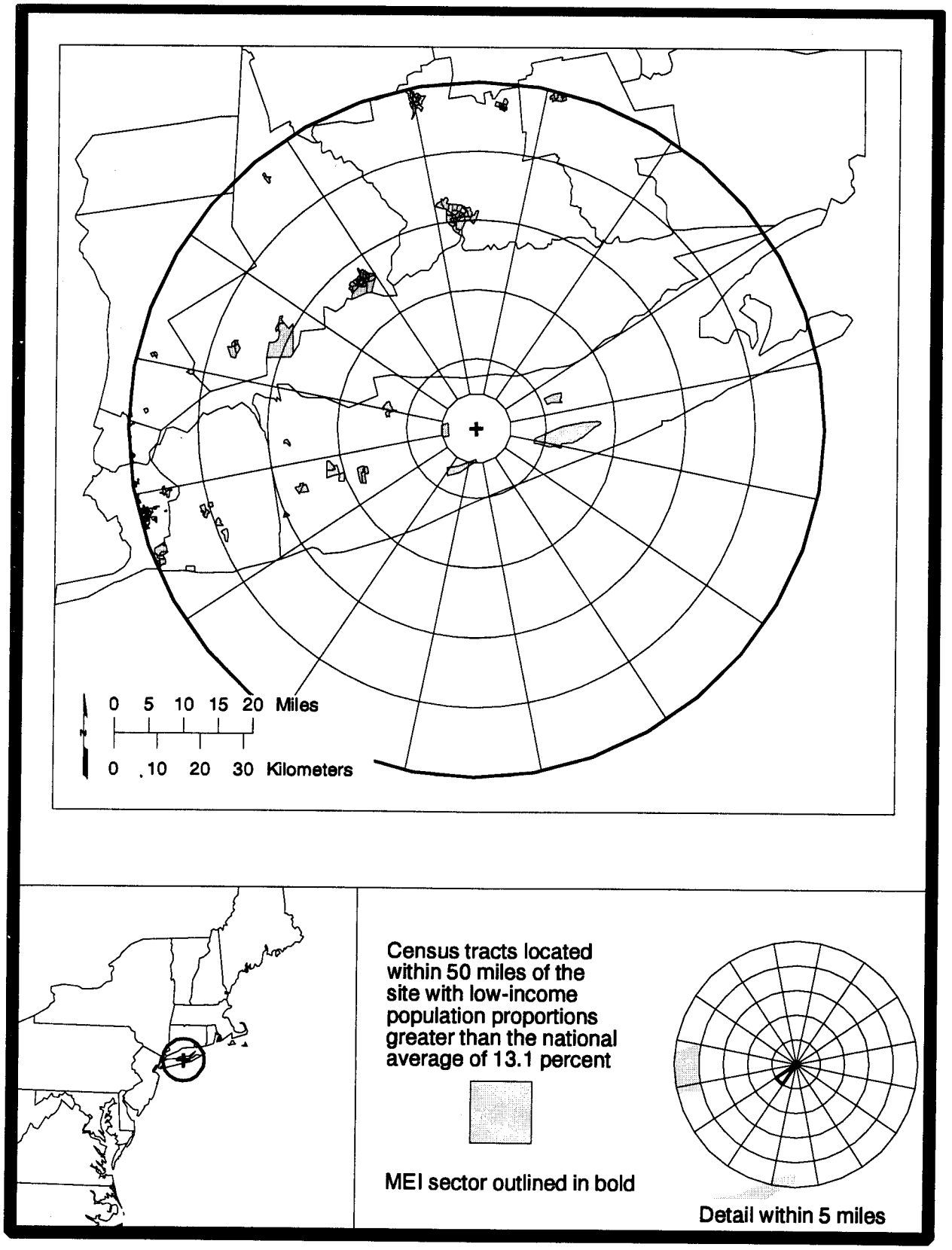

Figure C.4-25. Distribution of Low-Income Populations at Brookhaven National Laboratory.

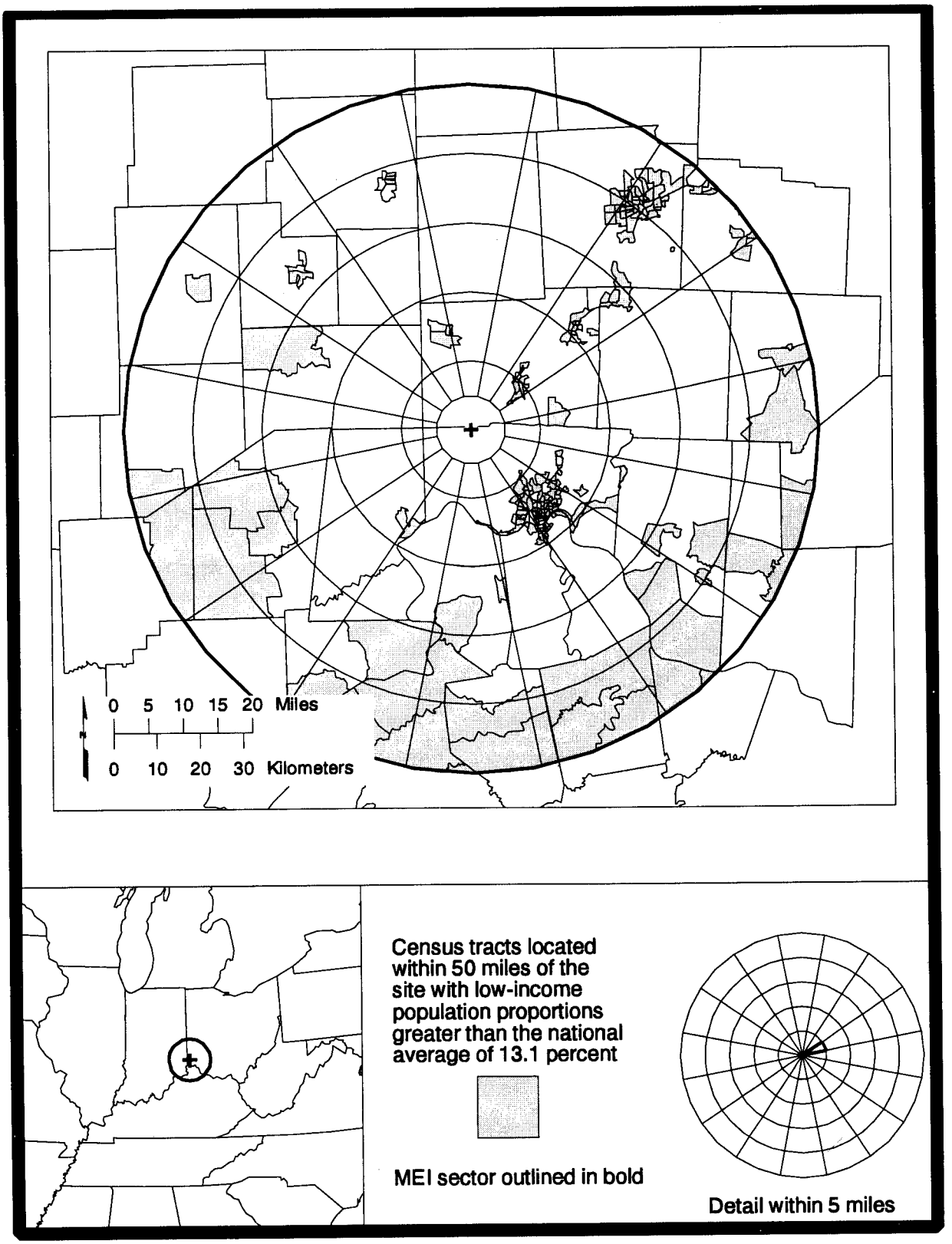

Figure C.4–26. Distribution of Low-Income Populations at Fernald Environmental Management Project.

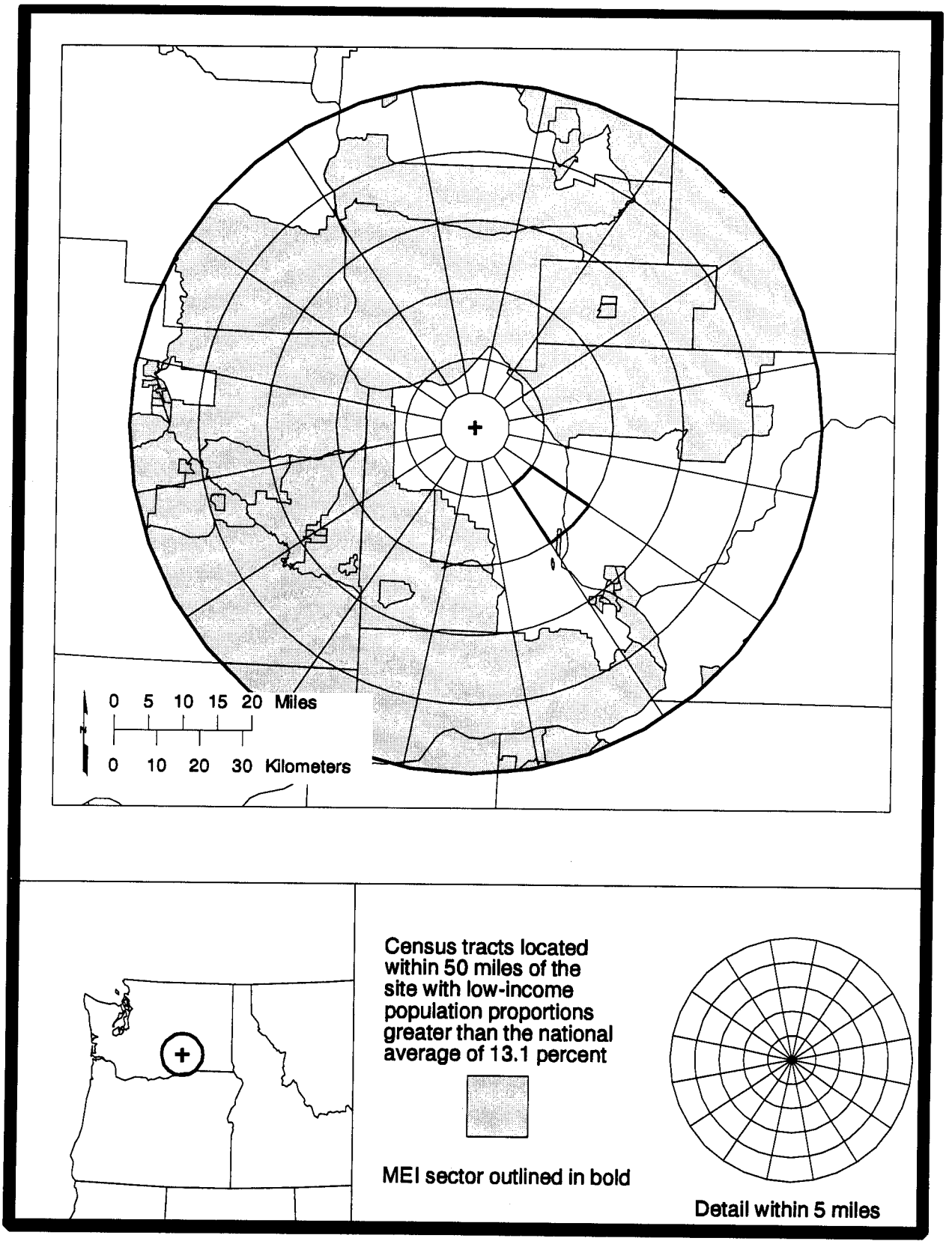

Figure C.4-27. Distribution of Low-Income Populations at the Hanford Site.

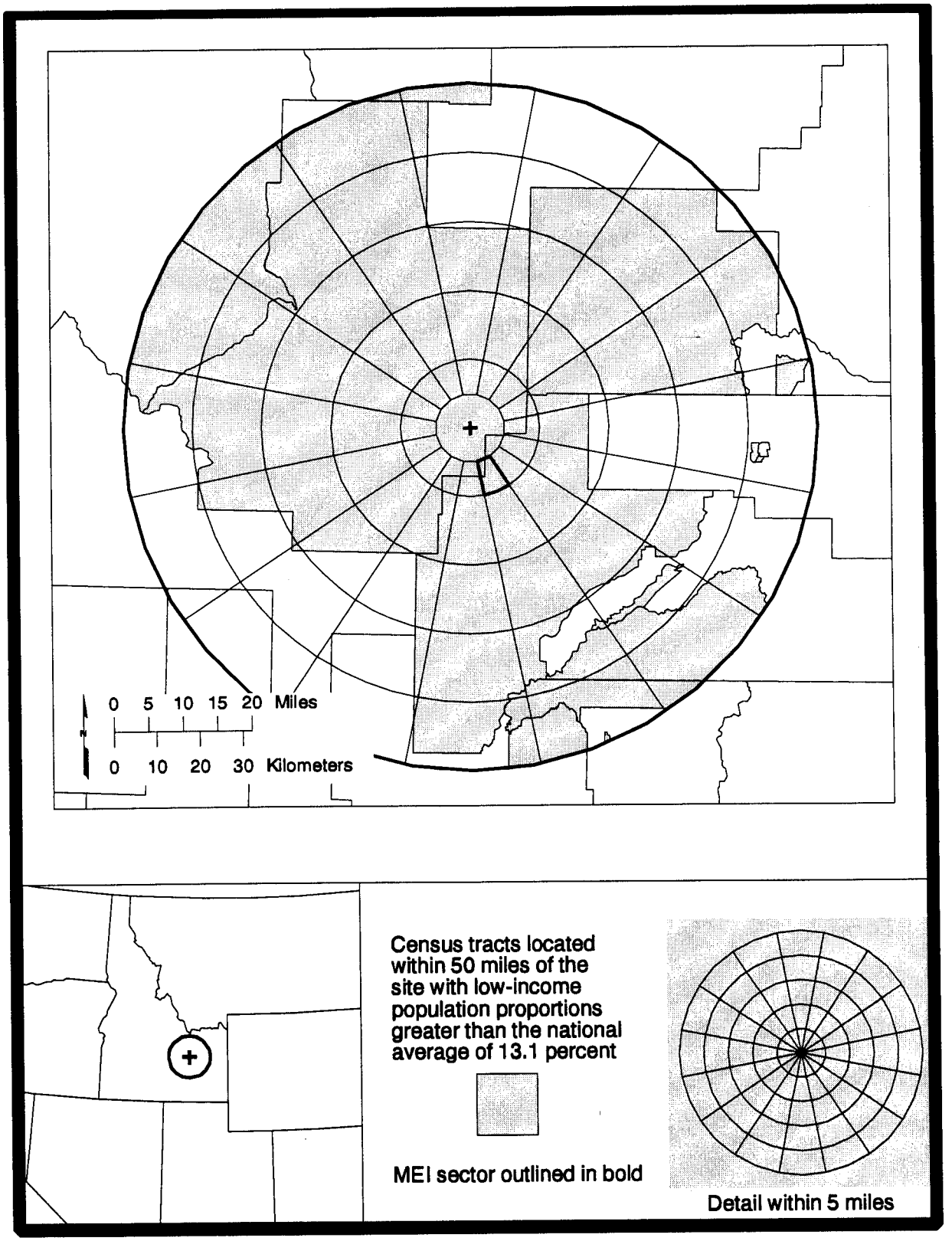

Figure C.4-28. Distribution of Low-Income Populations at Idaho National Engineering Laboratory.

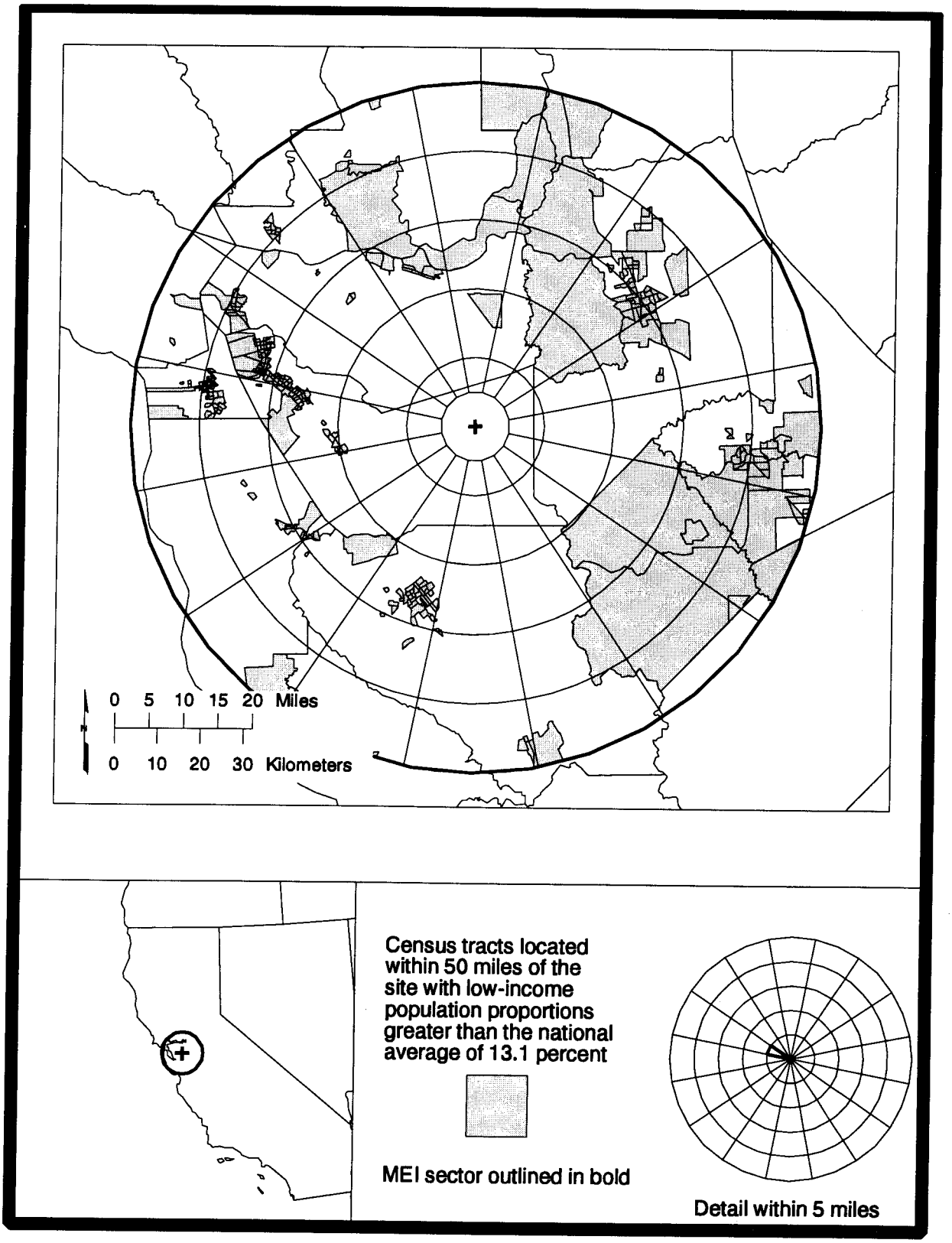

Figure C.4–29. Distribution of Low-Income Populations at Lawrence Livermore National Laboratory.

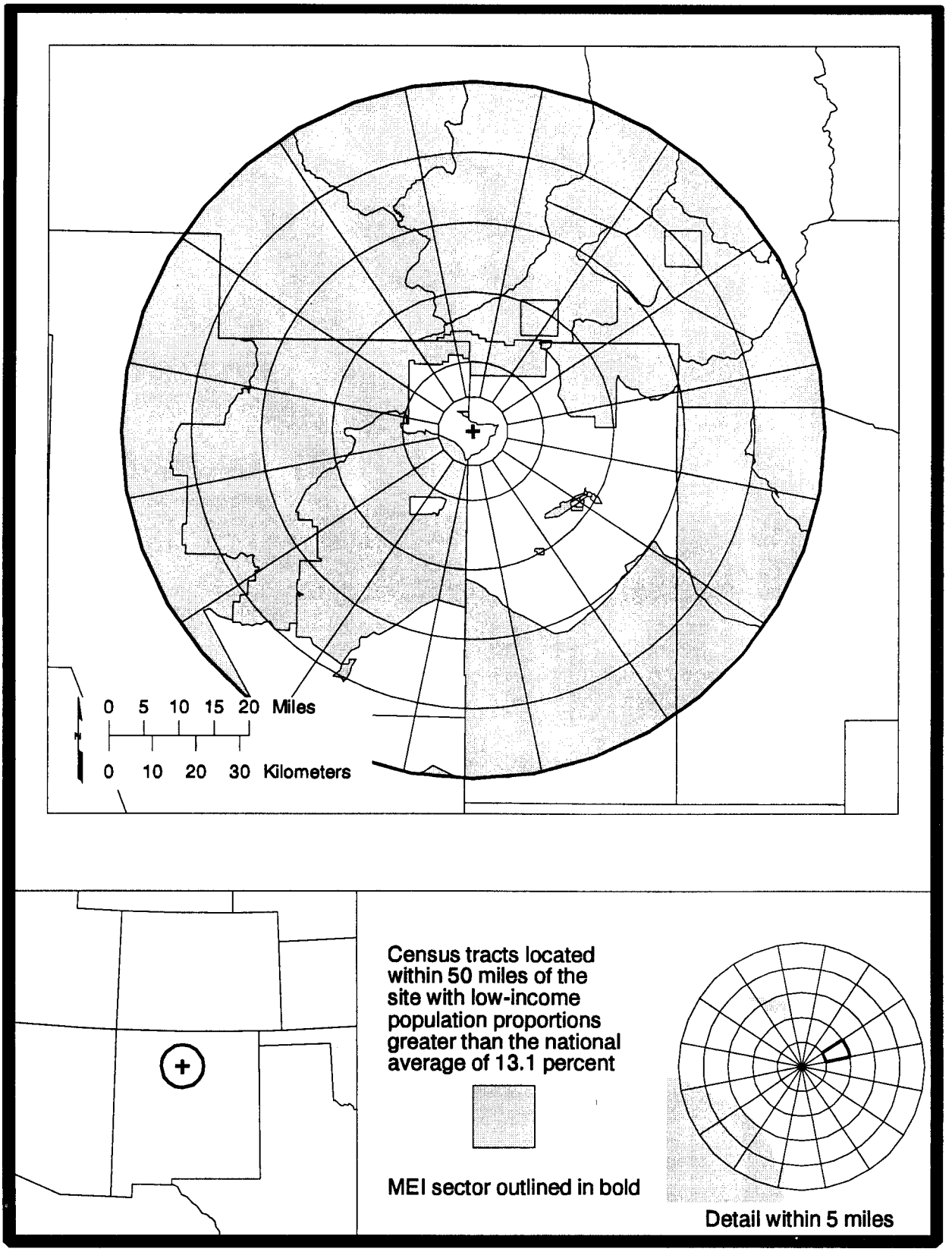

Figure C.4–30. Distribution of Low-Income Populations at Los Alamos National Laboratory.

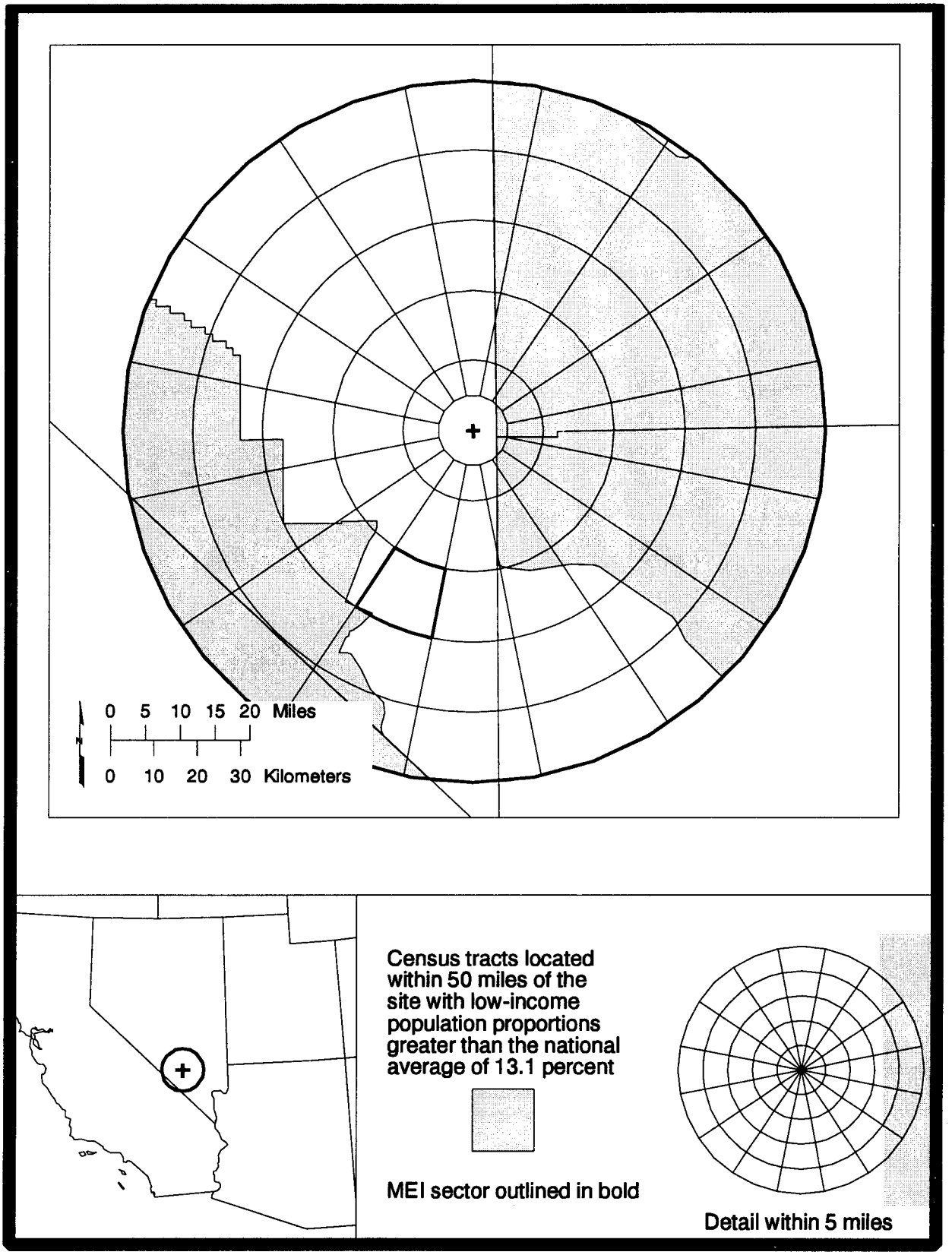

Figure C.4-31. Distribution of Low-Income Populations at the Nevada Test Site.

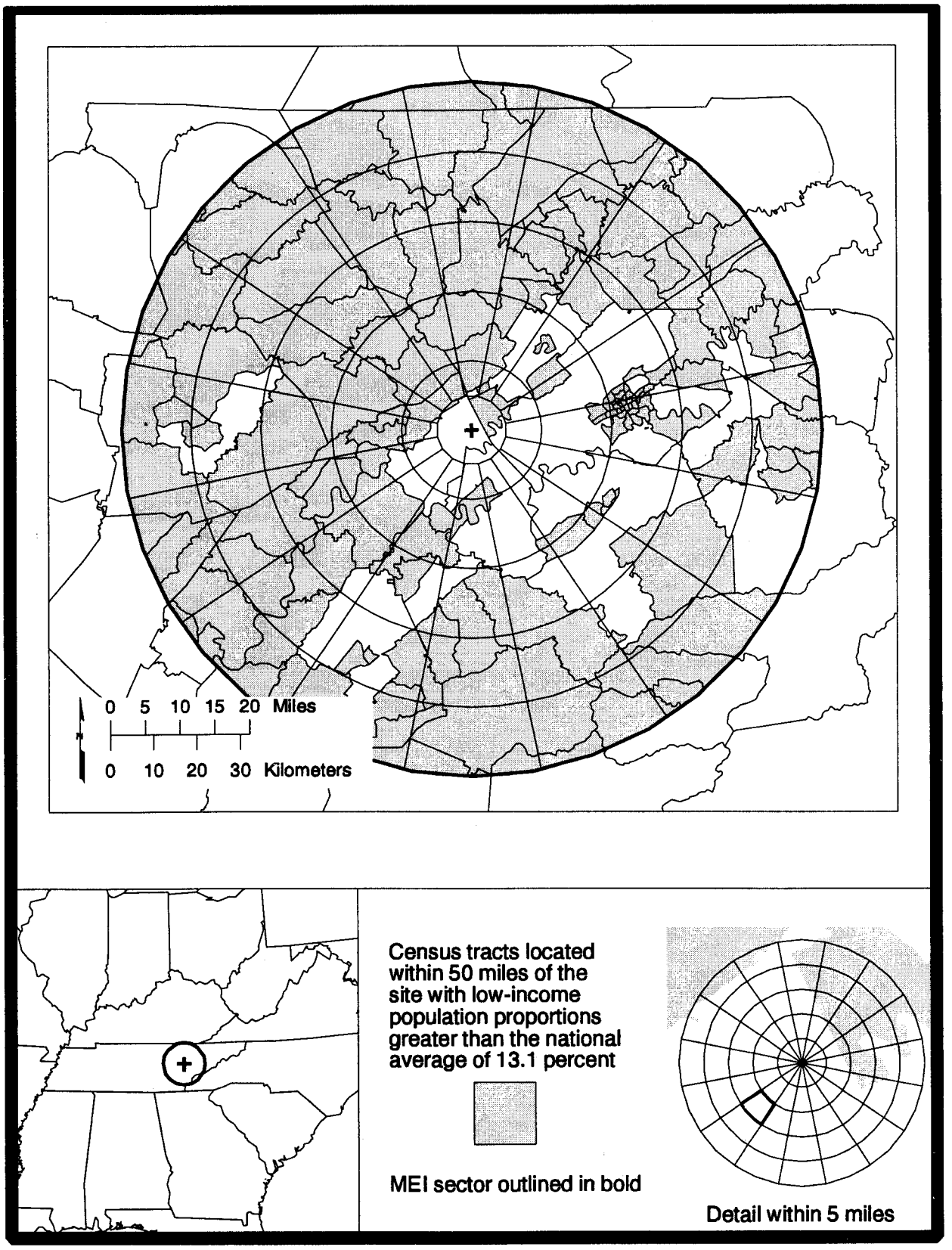

Figure C.4–32. Distribution of Low-Income Populations at the Oak Ridge Reservation.

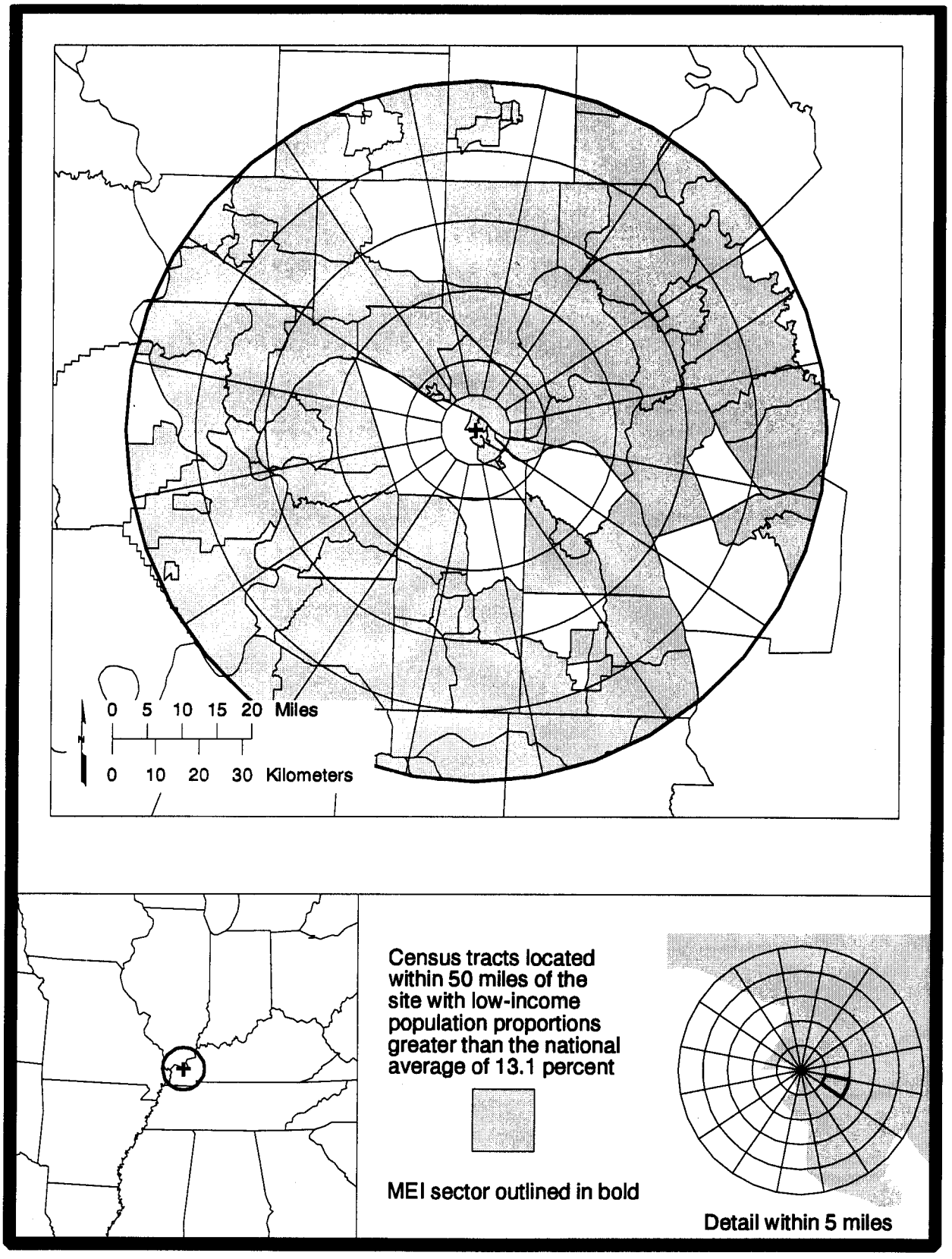

Figure C.4-33. Distribution of Low-Income Populations at the Paducah Gaseous Diffusion Plant.

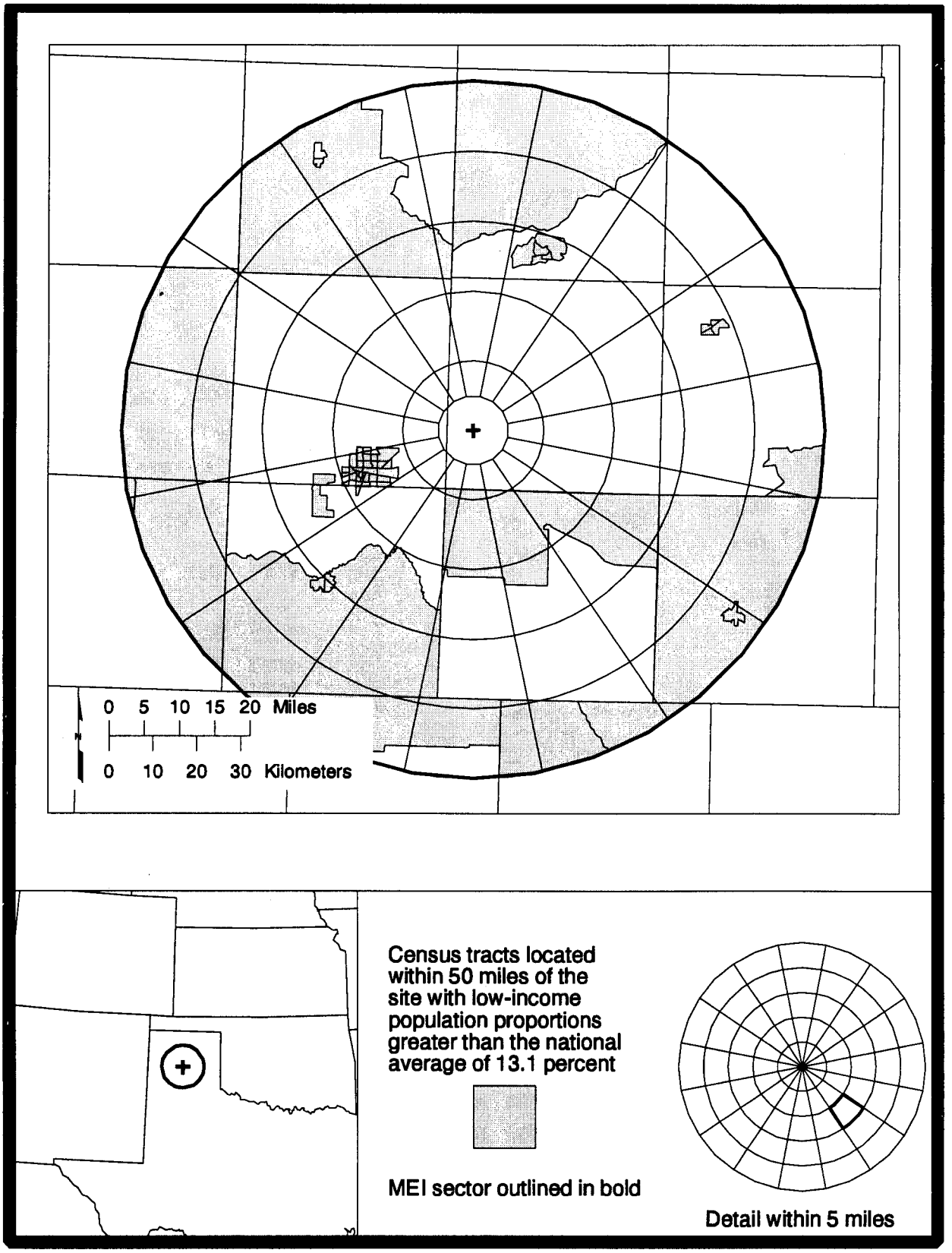

Figure C.4–34. Distribution of Low-Income Populations at the Pantex Plant.

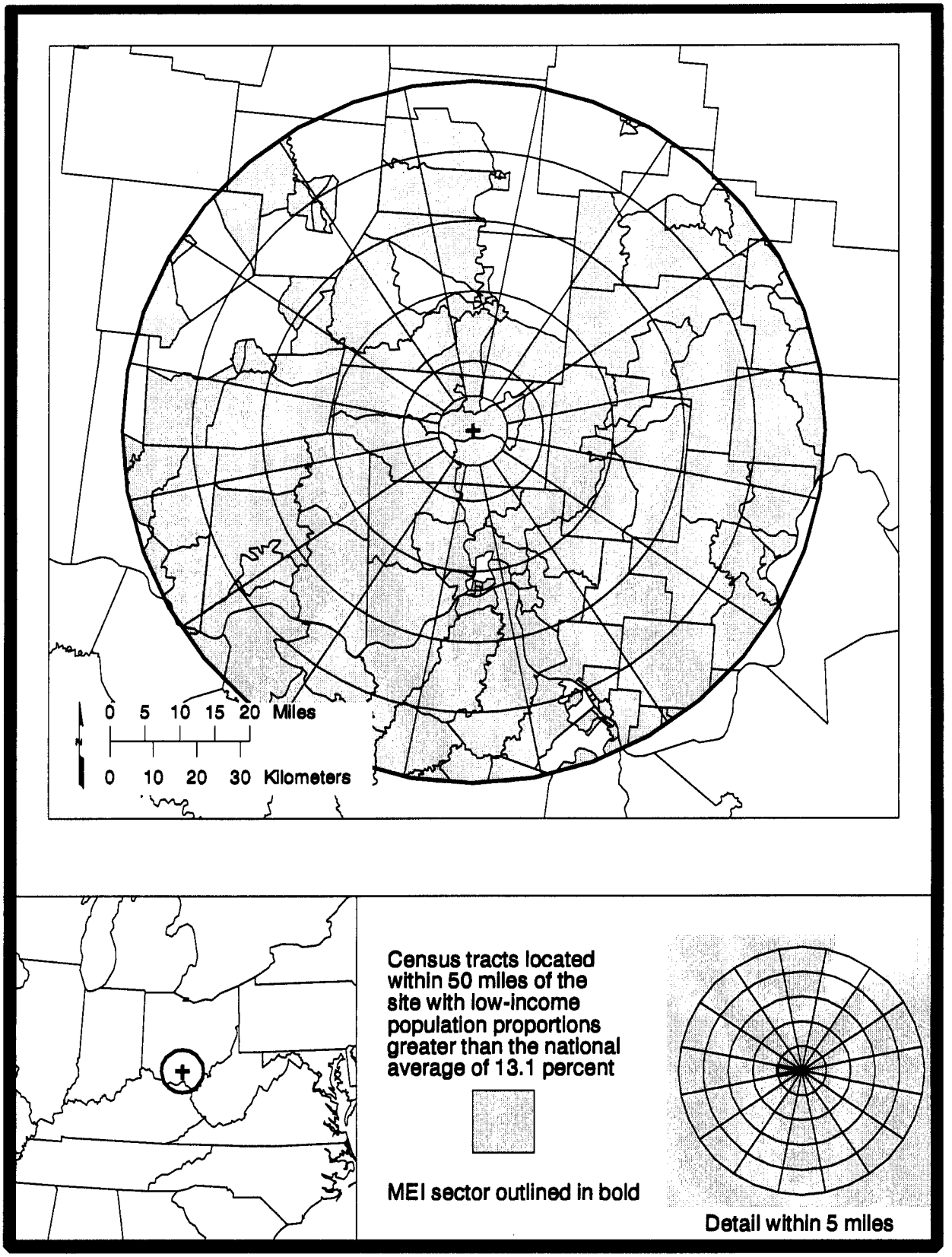

Figure C.4-35. Distribution of Low-Income Populations at the Portsmouth Gaseous Diffusion Plant.

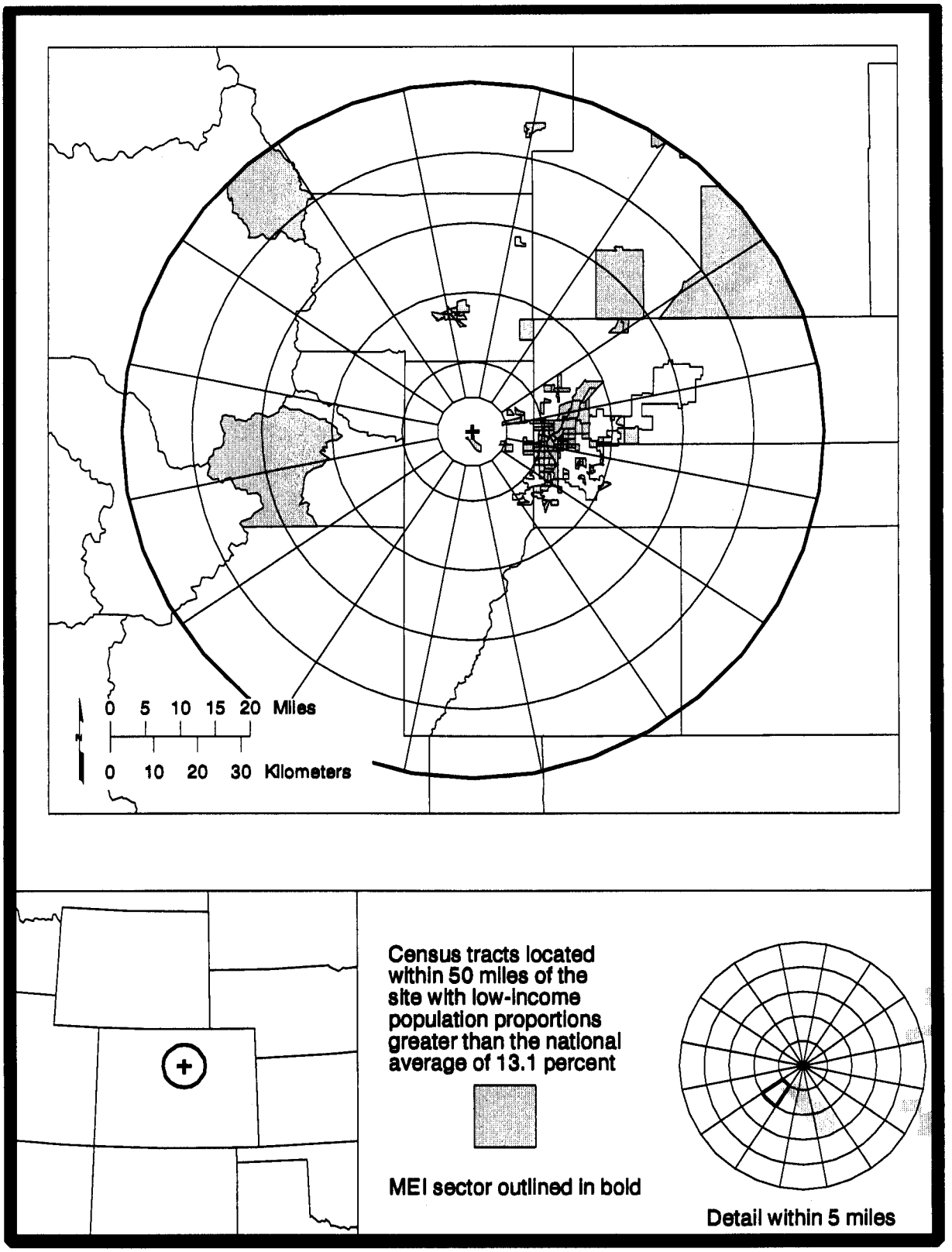

Figure C.4-36. Distribution of Low-Income Populations at Rocky Flats Environmental Technology Site.

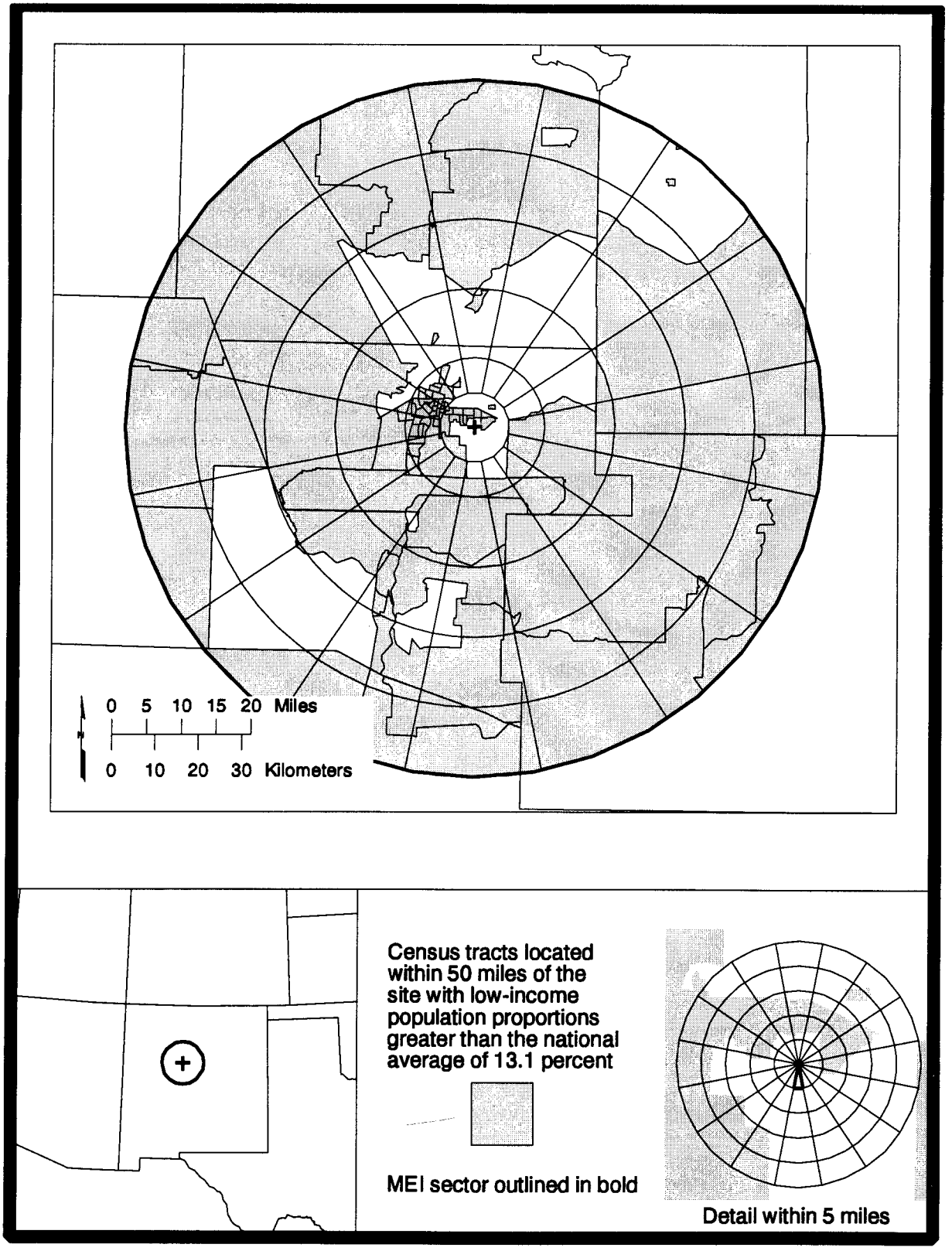

Figure C.4–37. Distribution of Low-Income Populations at Sandia National Laboratories-New Mexico.

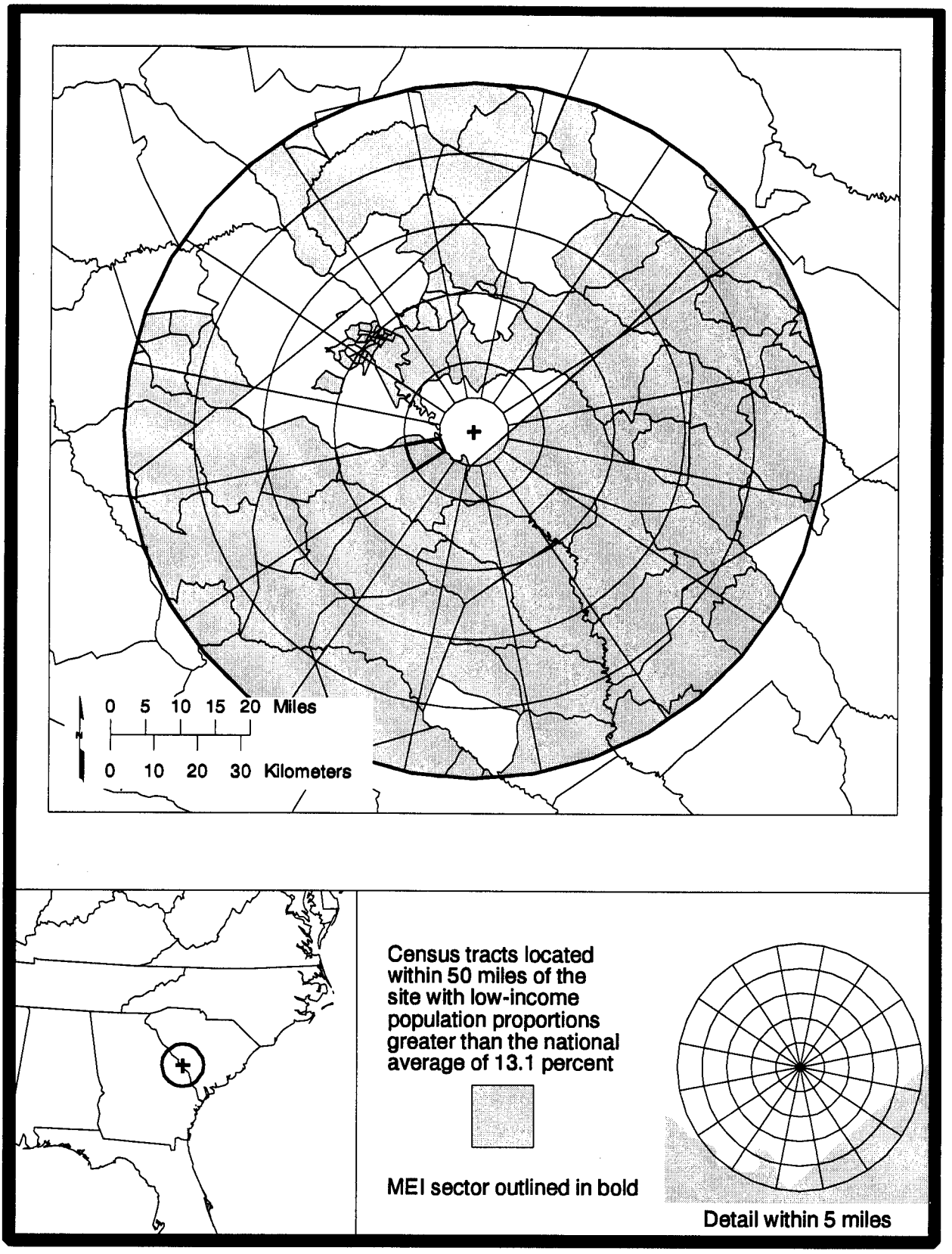

Figure C.4-38. Distribution of Low-Income Populations at the Savannah River Site.

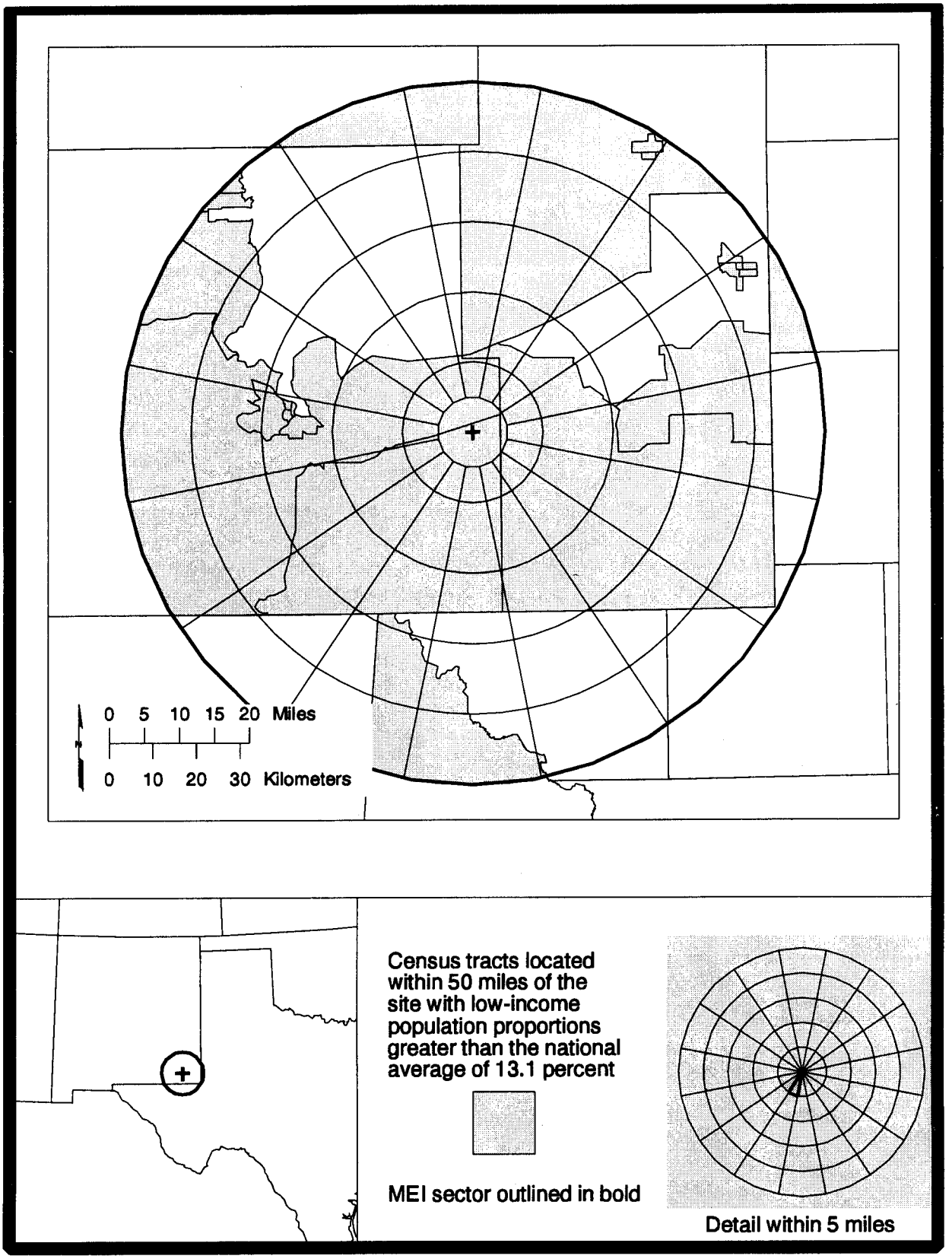

Figure C.4–39. Distribution of Low-Income Populations at the Waste Isolation Pilot Plant.

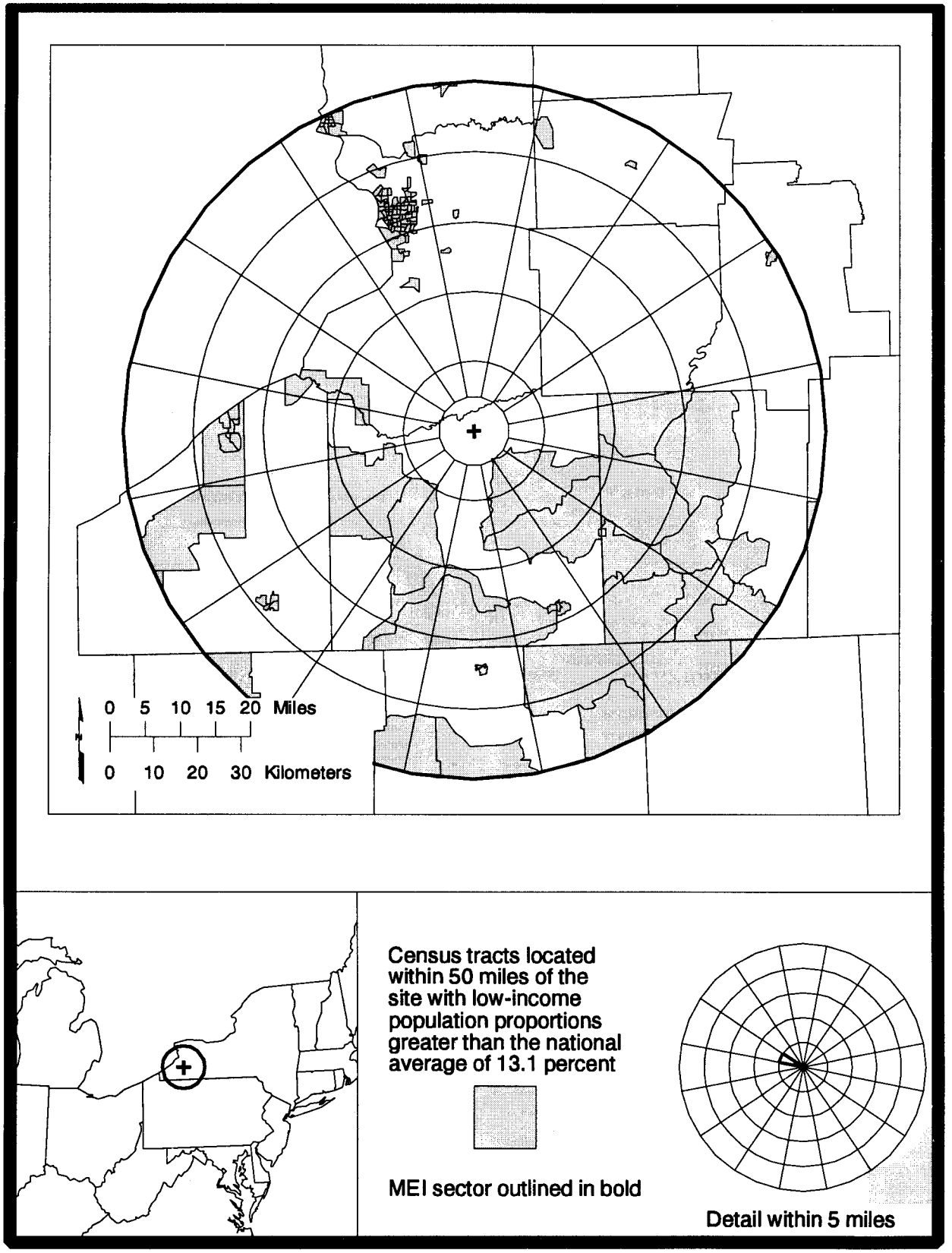

Figure C.4–40. Distribution of Low-Income Populations at the West Valley Demonstration Plant.

C.4.7.2.4 *Vulnerability of Minority and Low-Income Population due to Subsistence Food Consumption*

Section 4-4 of Executive Order 12898 directs Federal agencies, "whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence and that federal agencies communicate to the public the risks of these consumption patterns."

The potential environmental impacts of DOE activities on populations engaging in subsistence consumption could vary greatly depending on the precise location of a waste management facility at a particular site, the type of waste management facility, and the technology employed for the treatment or disposal of wastes at such a facility. In a prior NEPA review, DOE found the potential impacts associated with the consumption of fish and wildlife at INEL, Hanford, SRS, NTS, and ORR to be small or no different from the potential impacts on the general population (DOE, 1995c). DOE could not determine whether the impacts from fish consumption at WVDP were disproportionately high and adverse (DOE, 1996c). However, DOE predicted a high long-term risk of contracting cancer for a variety of groups (including Native Americans) for the No Action and long-term management alternatives for the Tank Waste Remediation System (TWRS) at Hanford (DOE, 1996d). The subsistence consumption scenario used for TWRS "has not received a complete review by the scientific community nor has it been approved by the potentially affected tribes" (DOE, 1996d).

To assemble and disseminate information on subsistence hunting and fishing, DOE began publishing *A Department of Energy Environmental Justice Newsletter: Subsistence and Environmental Health*, in the spring of 1996. The three goals of the newsletter are (1) "to provide useful information about the health implications of consuming contaminated fish, wildlife, livestock products or vegetation," (2) "to provide information about projects and programs at DOE and other federal and state agencies that address the problems associated with consuming contaminated fish, wildlife, livestock products, or vegetation," and (3) "to receive relevant information from readers." In addition to the newsletter, DOE has a new project underway

Internet Access is Available for DOE's Environmental Justice Information

Subsistence and Environmental Health Newsletter On-line:
http://www.em.doe.gov/health/

Environmental Justice Strategy for the Department of Energy:
http://www.em.doe.gov/stake/envjus.html

Table C.4-25. Factors Contributing to the Possibility of Subsistence Consumption of Fish and Wildlife

Site	Federally Recognized Native American Groups[a]	Distance to Major Surface Water Bodies	Population in the 50-Mile Region of Influence (in millions)	Percentage Minority (within a 50-mile radius)	Percentage of Low Income Populations
Sites with Higher Possibility of Subsistence Consumption					
Hanford	Yes	On site	0.35	25.8	18.8
INEL	Yes	NA[b]	0.11	10.2	12.5
LANL	Yes	At site boundary	0.27	48.1	13
RFETS	Yes	On site	1.98	19.7	9.8
SNL	Yes	6 miles	0.61	45.1	14.8
SRS	Yes	At site boundary	0.59	37.8	18
WIPP	Yes	NA	0.10	36.9	21.6
WVDP	Yes	On site	1.54	11.6	12.2
Sites with Intermediate Possibility of Subsistence Consumption					
NTS	Yes	NA	0.01	12.8	12.6
ORR	None	At site boundary	0.88	6.1	16.2
PGDP	None	<2 miles	0.50	9.1	19.1
PORTS	None	<1 mile	0.61	3.2	20.8
Sites with Lower Possibility of Subsistence Consumption					
ANL-E	None	<1 mile	8.03	33.5	11.4
BNL	None	On site	5.26	21.4	5.4
FEMP	None	<1 mile	2.64	13.2	11.8
LLNL	None	NA	6.31	40.9	9.5
Pantex	None	NA	0.27	19.8	15.2

[a] The presence of a federally recognized Native American group was assumed to be the most important indicator of potential subsistence fishing and hunting. The remaining factors are listed in descending importance from left to right.
[b] NA = not applicable; no major surface water bodies within the region of influence.

to identify what information is being collected on subsistence consumption by other Federal agencies and to serve as a clearinghouse for such information.

In a recent article reviewing the literature on subsistence consumption, ANL found that (1) "the majority of the studies that have been conducted to date are focused on site- or region-specific exposure concerns. . . . At present, it is unclear whether the findings of these studies are representative of consumption and exposure levels among minority populations at a national level;" (2) "a large number of risk assessment studies focusing on fish and wildlife consumption examined whole populations without distinguishing between consumption and exposure patterns of specific ethnic (or other) subpopulations;" (3) "the vast majority of studies have focused on fish consumption as an exposure pathway. Few examined wildlife consumption and contamination, and even in such cases the studies were not motivated by minority exposure concerns;" and (4) "the majority of the studies identified found rates of fish and shellfish consumption among minority populations to be significantly higher than for the population as a whole" (Elliot, 1994).

With regard to the impacts analyzed in this PEIS, and in the absence of subsistence consumption data by population subgroups, DOE prepared Table C.4–25 using the following criteria and assumptions weighted in order of importance, to identify groups of sites that may be near minority and low income populations potentially engaging in subsistence consumption.

- Proximity of Tribal Lands to DOE sites (the presence of Native Americans near DOE sites is assumed to create a greater possibility for subsistence consumption)
- Distance of the DOE site to major surface water bodies (populations nearer water are assumed to have a greater possibility of subsistence consumption of fish)
- Population density in the 50-mile region of influence around the site (rural residents are assumed to have a greater possibility of engaging in subsistence hunting and fishing)
- Proximity and concentration of minority and low-income populations to DOE sites (higher concentrations of minority and low-income populations are assumed to have a greater potential for subsistence consumption)

The 17 major DOE sites appear in the table in three groups: those with the higher possibility for subsistence consumption, those with intermediate possibilities for subsistence consumption, and those with the lower possibilities for subsistence consumption. As Table C.4–25 shows, more rural sites with recognized Native American groups are assumed more likely to engage in subsistence hunting and fishing. These sites include

Hanford, INEL, LANL, RFETS, SNL, SRS, WIPP, and WVDP. Sites of intermediate concern include NTS, ORR, PGDP, and PORTS, because of the respective sites' rural surroundings, the presence of Native American populations, the presence of minority or low-income populations, or the presence of surface water on site. While sites like ANL-E and LLNL have a large percentage of minorities, both sites are in urban areas with populations of 8 and 6.3 million respectively. Because of these factors, ANL-E and LLNL are listed along with BNL, FEMP, and Pantex as having a lower possibility of populations who principally rely on fish and/or wildlife for subsistence.

C.4.8 LAND USE IMPACTS

The land use impacts analysis evaluated the potential for the management alternatives for the five waste types to adversely affect land use at the sites by comparing the amount of land required for proposed waste treatment, storage, or disposal facilities with the amount of land designated for future waste management operations in the site development plans for the 17 major sites. For those of the 17 sites not having a portion of the site designated for waste operations, the land required for waste management activities was compared with an estimated amount of land suitable for development. This estimate was made by subtracting from the total installation acreage the known or estimated acreage of land in existing structures, sensitive habitats including wetlands, topographic and surface water features, and other features such as wildlife management areas and cultural resources. At sites where the land requirement constitutes 1% or more of designated or suitable land, a potential for impacts is noted in the waste type impacts discussion and the percent required is listed in a summary table for the site/alternative. The text then discusses the severity of impacts depending on how great a portion of the available land is required and includes an indication of the likelihood of conflicts with land uses adjacent to the site. Where the land requirements for waste management activities exceeds the amount of land designated or suitable, the analysis indicates that significant land use impacts are likely. Apart from the analysis of the percent of suitable site land used, the analysis also indicates whether the description of future uses at the sites given in the site development plans appears to indicate a potential conflict between those planned uses and the uses proposed under the waste type alternatives.

C.4.9 INFRASTRUCTURE IMPACTS METHODOLOGY

Construction and operation of waste management facilities at the sites will increase the sites' use of water supply, wastewater treatment facilities, and electrical power systems and will increase traffic on site roads.

The impacts of the waste management alternatives on site water, wastewater, and power systems were evaluated using estimates of the percentage of existing system capacity the new requirements represented. Where the new requirements were substantial, they were added to current use rates and the sum compared to the existing supply capacities of those systems. Site transportation infrastructure impacts were assessed indirectly using increased site employment as an indicator of increased stress on the system. Impacts to community infrastructure systems were assessed using estimated waste management project-induced population increases as an indicator of increased demand on those systems. The impacts assessment evaluated the separate effects of the construction and operations phases for each alternative for each waste type.

C.4.9.1 Site Infrastructure Impacts

The site infrastructure impacts analysis focused on the effects of the WM alternatives on the 17 major sites' water supply, wastewater treatment, and electrical power infrastructure systems. Data on new infrastructure requirements under each alternative are described in Section C.3.2 of this appendix. Current use rate and existing capacity data are described in PEIS Chapter 4 on the Affected Environment and in the Affected Environment Technical Report.

New project requirements of less than 5% of existing capacity were considered likely to have negligible or minor impacts on an infrastructure system and were not further evaluated. Moderate or major impacts were considered possible where increases in system requirements were 5% or greater. These cases were further evaluated on a site by site basis. Major impacts were considered possible where new requirements caused system capacity to be approached or exceeded. Therefore, any increase of 5% or greater that caused the total site use rate to exceed 90% of available capacity, was considered to have the potential to cause a major infrastructure impact. In such cases, site infrastructure may require substantial expansion or construction of new systems to meet the added demand. Such projects would have associated costs and environmental impacts beyond the direct impacts of the waste management facilities.

Where site infrastructure capacity information was not available, the new requirements were evaluated as a percentage of current use. In these cases, new requirements of less than 5% of current use were considered likely to have negligible or minor impacts. Increases in requirements from 5% to less than 15%

were considered to have the potential to cause moderate impacts, and increases of 15% or greater were considered to have the potential to cause major impacts.

Site transportation infrastructure impacts were evaluated indirectly by comparing new site employment to existing site employment as an indicator of increased stress on site transportation systems. New site employment of less than 5% of current employment was considered likely to have negligible or minor impacts. Site employment increases from 5% to less than 15% were considered to have the potential to cause moderate impacts, and increases of 15% or greater were considered to have the potential to cause major impacts.

C.4.9.2 Community Infrastructure Impacts

Community infrastructure would be affected indirectly by any substantial increase in population caused by the influx of labor to implement the WM alternatives. Community infrastructure impacts were evaluated by comparing estimated population increases with current population levels as an indicator of increased use rates of community infrastructure systems. This analysis was based on the in-migration estimates and 1990 regional population data described in the social impacts analysis (see Section C.4.6). Population increases of less than 5% of current (1990 census) population levels were considered to have the potential to cause negligible or minor impacts. Increases of 5% or greater were considered to have the potential to cause moderate impacts, and increases of 15% or greater were considered to have the potential for major infrastructure impacts.

C.4.9.3 Site and Community Infrastructure Baseline

Baseline water, wastewater, and power information can be found in the Affected Environment chapter and appendix. The information is summarized below. Proposed resource requirements under the alternatives are compared to the current capacity to determine whether increased use will impact the infrastructure systems. Site employment information is provided in the socioeconomic impacts discussion and is summarized in Table C.4–26. Proposed increases in site employment under the various alternatives is compared to current site employment to determine possible impacts to transportation infrastructure.

Table C.4-26. Baseline Infrastructure Data for the 17 Major DOE Sites

Site	Water (gpd)		Wastewater (gpd)		Power (MW)		Site Employment
	Current Use	Capacity	Current Use	Capacity	Current Use	Capacity	
ANL-E	625,000	1,800,000	434,000	2,600,000	23	NA	4,455
BNL	3,500,000	6,000,000	1,000,000	2,300,000	35	47	3,557
FEMP	400,000	1,600,000	2,180,000	2,270,000	33	NA	1,939
Hanford	9,510,000	79,060,000	158,000	200,000	550	NA	14,394
INEL	5,242,000	30,630,000	254,000	unlimited	42	NA	11,813
LANL	4,100,000	10,000,000	NA	1,000,000	68	120	6,199
LLNL	717,000	2,520,000	400,000	1,680,000	61	100	8,173
NTS	1,360,000	2,780,000	140,000	338,000	30	45	7,086
ORR	18,300,000	40,200,000	2,000,000	4,100,000	116	660	21,544
PGDP	15,000,000	30,000,000	400,000	1,750,000	1,564	3,040	1,740
Pantex	500,000	1,500,000	275,000	545,000	13	1,523	2,891
PORTS	14,000,000	37,000,000	350,000	1,200,000	1,537	1,929	2,386
RFETS	272,000	1,000,000	150,000	500,000	18	35	7,365
SNL	1,000,000	4,030,000	548,000	NA	35	50	8,596
SRS	1,600,000	5,000,000	500,000	750,000	80	175	17,319
WIPP	14,000	540,000	12,000	185,000	NA	NA	932
WVDP	70,000	110,000	70,000	70,000	3	7	1,100

Notes: gpd = gallons per day; NA = not available. Data for baseline infrastructure represent onsite use only. Wastewater use and capacity are based on sanitary waste. No process wastes are included.

C.4.10 Cultural Resources Impacts

The potential for cultural resources to be affected by waste management activities was considered by using the estimated acreage of site disturbance to construct waste management facilities under each waste-type alternative as an estimate of the area of potential cultural resource effects and as a comparative indicator of the extent of the cultural resource survey requirements at each site. Cultural resources impacts were not directly evaluated in the PEIS because the analysis would require identification of specific locations of proposed waste management facilities.

C.4.10.1 Cultural Resources Considered

The cultural resources considered in this analysis include prehistoric and historic resources, and Native American resources. Paleontological resources, though not cultural in origin, are also included because of their recognized value and similar need for protection.

C.4.10.1.1 *Prehistoric and Historic Properties*

A "historic property" is an archeological site, standing structure, or traditional cultural property that is listed or is potentially eligible for listing on the National Register of Historic Places (36 CFR 60). Requirements for the assessment of historic properties for the PEIS are met through compliance with Section 106 of the National Historic Preservation Act of 1966 (16 USC 470), as amended, with implementing regulations contained in 36 CFR 800. In general, Federal agencies are required to determine the effects of proposed actions on significant historic properties within a defined area of potential effects.

C.4.10.1.2 *Native American Resources*

Resources that may be of concern to Native Americans may be structures, regional locations, natural features, native plants, objects and other materials that are considered to be of value to contemporary Native American groups for traditional, religious, or ceremonial purposes. Examples of these resources can include burial grounds, sacred sites, and areas, materials for the production of sacred objects and traditional implements, and botanical, biological, and geological resources of ritual importance. Impacts to these areas include both direct physical impacts (destruction, loss of access) and indirect social and economic effects. Several laws and Executive Orders are specifically applicable to the protection of Native American resources including American Indian Religious Freedom Act of 1978 (42 USC 1996), the Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001 *et seq.*), and Executive Order 13007 regarding sacred sites. Determination of potential impact to these sites is similar to that for other historic properties.

C.4.10.1.3 *Paleontological Resources*

Paleontological materials and features are the physical remains of life forms (fossils) from a former geologic age. These include the remains of animals, plants, or trace fossils such as impressions, burrows or tracks. Although paleontological resources are not treated with the same level of specificity as archeological or historic properties, they are included in several Federal statutes such as the Archeological Resources Protection Act of 1979 (16 USC 470aa-470ll) and the Federal Land Management Policy Act of 1976 (43 USC 1701 *et seq.*).

C.4.10.2 Cultural Resources Protection Procedures

Federal agencies protect cultural resources through compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, which is implemented through regulations contained in 36 CFR 800. These regulations require Federal agencies to consider the existing information, undertake identification activities if the existing information is insufficient, determine whether any cultural resources contained within the agency-defined area of potential effects meet the criteria for eligibility for inclusion in the National Register of Historic Places, determine the effect of the proposed action on significant historic properties, consult with the State Historic Preservation Office (SHPO), and afford the Advisory Council on Historic Preservation (ACHP) the opportunity to comment.

To comply with 36 CFR 800, the lead federal agency defines an "area of potential effects," or project area, for the proposed action. The project area usually comprises the physical limits of disturbance or alteration that will result from the proposed actions, such as construction, demolition, staging, or operation of a facility.

The next step in the process is to identify the presence of absence of historic properties within the area of potential effects (36 CFR 800.4). An "historic property" is an archeological site, standing structure, or traditional cultural property that is listed or is potentially eligible for listing on the National Register of Historic Places (NRHP) (36 CFR 60). Identificational studies can comprise a variety of site-specific archaeological, architectural, or cultural surveys of the undertaking's project area. Other studies may be conducted in order to evaluate an identified resource's eligibility for inclusion on NRHP.

If no cultural resources eligible or potentially eligible for the NRHP are identified during these studies, then, given the concurrence of the SHPO, the project will have no effect on historic properties and the undertaking may proceed. If historic properties are identified within the project area, then the agency in consultation with the SHPO must apply the "criteria or effect and adverse effect" as defined in 36 CFR 800.5 and 800.9.

An undertaking is considered to have an adverse effect when the effect on a historic property may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects on historic properties include, but are not limited to:

- Physical destruction, damage, or alteration to all or part of the property
- Isolation of the property from or alteration to the character of the property's setting when that character contributes to the property's qualification for the National Register
- Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting
- Neglect of a property resulting in its deterioration or destruction
- Transfer, lease, or sale of the property (36 CFR 800.9.b.1-5)

C.4.10.3 Consideration of Cultural Resources Impacts in the WM PEIS

Given the various levels of cultural resource information (the number of recorded resources and the size of surveyed areas) associated with DOE facilities across the country and the cultural resource diversity known or presumed to be located at these sites, the specific analysis of impacts must be left to site-specific or project-level NEPA documents. In addition, the locations of the different waste management activities at individual sites have not been identified. Thus, at the programmatic level, both the specific area of potential effects and the presence or absence of National Register eligible historic properties are at present unknown. Therefore, evaluation of potential impacts in this PEIS was limited to providing relevant information on existing cultural resources identified at the sites (see Chapter 4, Affected Environment) and an estimate of the extent to which potential new site surveys would be required (see the Cultural Impacts sections in the waste-type Chapters 6–10).

Appendix C
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Appendix D

Waste Management Facility Human Health Risk Estimates

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Acronyms and Abbreviations

The following is a list of acronyms and abbreviations (including units of measure) used in this appendix.

Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
AEDE	annual effective dose equivalent
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
ANSI	American National Standards Institute
BNL	Brookhaven National Laboratory
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	cancer fatality
CFR	*Code of Federal Regulations* (indicating citation from)
CH	contact-handled
CI	cancer incidence
C&OF	construction and operational fatalities
D&D	decontamination and decommissioning
DITTY	the Dose-in-Ten-Thousand-Years computational model
DOE	U.S. Department of Energy
DUST	Disposal Unit Source Term computational model
EDE	effective dose equivalent
EI	exposure index
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ETEC	Energy Technology Engineering Center
FEMP	Fernald Environmental Management Project
Fermi	Fermi National Accelerator Laboratory
FTE	full-time equivalent
GENII	Generation II of the Hanford Environmental Radiation Dosimetry Software System
GENII-S	Sensitivity and Uncertainty Analysis portion of the GENII computational model
GTCC-LLW	greater-than-Class-C low-level waste
Hanford	Hanford Site
HEAST	Health Effects Assessment Summary Tables

HI	hazard index
HLW	high-level waste
HW	hazardous waste
ICRP	International Commission on Radiological Protection
IDLH	immediately dangerous to life and health
INEL	Idaho National Engineering Laboratory
INEXPLC	computational model for simulating close-in atmospheric dispersion, explosive releases, and particle deposition
IRIS	Integrated Risk Information System
ISC2	Industrial Source Complex Dispersion Models, Version 2
ITRI	Inhalation Toxicology Research Institute
K-25	Oak Ridge K-25 Site
KAPL-K	Knolls Atomic Power Laboratory–Kesselring
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LDRs	land disposal restrictions
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
MEI	maximally exposed individual
MEL	maximally exposed lifetime of the hypothetical farm family
MEPAS	Multimedia Environmental Pollutant Assessment System
NAS	National Academy of Sciences
NAS/NRC	National Academy of Sciences/National Research Council
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commision
NRF	Naval Reactor Facility
NTS	Nevada Test Site
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
Pantex	Pantex Plant
PCB	polychlorinated biphenyl
PEIS	DOE *Draft Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*
PGDP	Paducah Gaseous Diffusion Plant
Pinellas	Pinellas Plant
PNNL	Battelle Pacific Northwest National Laboratory
PORTS	Portsmouth Gaseous Diffusion Plant
PRESTO	series of computational models for assessing the potential human health impacts from the disposal of low-level waste

RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RH	remote-handled
SNL-CA	Sandia National Laboratory (California)
SNL-NM	Sandia National Laboratories (New Mexico)
SRS	Savannah River Site
TLV	threshold limit value
TRUPACT II	Transuranic Package Transporter–II
TRUW	transuranic waste
TWA–TLV	time-weighted average threshold limit value
UofMO	University of Missouri (Columbia)
WIPP	Waste Isolation Pilot Plant
WIPP–WAC	Waste Isolation Pilot Plant Waste Acceptance Criteria
WM	of or pertaining to the DOE Waste Management Program
WVDP	West Valley Demonstration Project
Y-12	Oak Ridge Y-12 Plant

Abbreviations

Am	americium
C	carbon
Ci	curie(s)
Cm	curium
cm^2	square centimeter(s)
cm^3	cubic centimeter(s)
Co	cobalt
Cs	cesium
d	day(s)
E	east
ENE	east-northeast
ESE	east-southeast
Fed. Reg.	*Federal Register* (indicating citation from)
ft^3	cubic foot (feet)
g	gram(s)
gal	gallon(s)
h	hour(s)
H-3	tritium

I	iodine
in.	inch
K_d	sorption distribution coefficient (for contaminants in soil)
kg	kilogram(s)
km	kilometer(s)
L	liter(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
mi	mile(s)
min	minute(s)
mph	mile(s) per hour
mrem	milliroentgen equivalent man
N	north
nCi	nanocurie(s)
NE	northeast
NNE	north-northeast
NNW	north-northwest
Np	neptunium
NW	northwest
P	phosphorus
pCi	picocurie(s)
Pu	plutonium
qt	quart(s)
rem	roentgen equivalent man
RfC	reference concentration
RfD	reference dose
Ru	ruthenium
S	south
S	sulfur
SE	southeast
Sr	strontium
SSE	south-southeast
SSW	south-southwest
SW	southwest
t	ton(s)
Tc	technetium
Th	thorium
U	uranium

W	west
WNW	west-northwest
WSW	west-southwest
Y	yttrium
yr	year(s)
yd	yard(s)

APPENDIX D
Waste Management Facility Human Health Risk Estimates

D.1 Introduction

This appendix summarizes the human health impacts posed by stationary sources of waste at U.S. Department of Energy (DOE) waste management facilities. The term "stationary source" refers to facilities that process, store, or dispose of various types of waste throughout the DOE complex, in contrast to waste transport. Waste transportation risks are discussed in Appendix E. Supplemental details of this human health risk assessment are available in a separate technical report (ORNL, 1996).

This appendix is organized as follows:

- Section D.1 defines the purpose and scope of the Waste Management (WM) Program human health risk evaluation including an overview of the five DOE WM Program waste types and waste consolidation alternatives.
- Section D.2 presents general information on the risk assessment process, including a discussion of the potentially exposed populations and health effects evaluated, assumptions used to calculate the risks to the affected populations and individuals, explanations of certain risk calculations, and directions on how to read and interpret the risk results that are presented in Section D.3.
- Section D.3 contains the human health risk evaluations for the five DOE WM Program waste types. It provides definitions of the wastes; identifies the waste consolidation alternatives evaluated; discusses the assumptions used in estimating the human health risks for routine waste management activities and potential accidents by waste type; presents a summary of the human health risk results for routine waste management activities and (where applicable) accidents by waste type; and identifies the waste consolidation options and contaminants that potentially pose the greatest and least risks to human health.
- Section D.4 describes the uncertainties associated with the waste management human health risk evaluation.
- Section D.5 presents a discussion of the mathematical models used to develop the human health risk estimates for this study.

A summary narrative explaining the health risk analysis methodologies for the reader interested in less technical information is presented in the Summary and in Chapter 5 of Volume I. Summarized results of

the risk analyses for each of the five waste types are presented in the Summary and in Chapters 6–10 of Volume I.

D.1.1 Purpose of the Waste Management Human Health Risk Evaluation

The purpose of this human health risk evaluation is to provide projections of the health risks posed by the waste consolidation options being considered for DOE waste management facilities in this draft programmatic environmental impact statement (hereinafter called the PEIS). This information, in conjunction with other PEIS impacts (e.g., transportation risks, ecological risks, air, water, and socioeconomic impacts) and costs, is intended to aid in determining the advantages and disadvantages of the various waste consolidation options.

The risk estimates presented here are based on various assumptions, best available data, and data generated by fate and transport and exposure modeling (instead of data gathered by monitoring). This was necessary because monitored data were not consistently available for all sites and/or processes have not been demonstrated fully. To maintain consistency with current regulatory approaches to risk assessment, the methodologies used to estimate the various elements of risk for the PEIS were partially adapted from existing accepted risk assessment methods (NAS, 1983; EPA, 1989a, 1991a,b; ICRP, 1977, 1979, 1990) or developed specifically for the PEIS (ORNL, 1995a-c). While it is important to recognize the purpose and limitations of this assessment, the same assumptions and methodologies were applied uniformly to all sites. Therefore, when used on a *comparative* basis at the program level, these results should provide a relatively accurate overview of the risks posed by WM Program treatment, storage, and disposal activities. More detailed risk estimates for a particular DOE site should be performed when necessary in site-specific documents (e.g., environmental impact statements, environmental assessments, risk assessments).

D.1.2 Waste Types Evaluated

Both existing and future waste management facilities were evaluated for the following waste types:

- High-level waste (HLW) (Section D.3.1)
- Low-level waste (LLW) (Section D.3.2)
- Hazardous waste (HW) (Section D.3.3)

- Transuranic waste (TRUW) (Section D.3.4)
- Low-level mixed waste (LLMW) (Section D.3.5)

The risk analysis for each waste type and site was performed based on data including (1) estimated rates of contaminant release to the air and/or the water in the water table (called "groundwater"), and (2) estimated waste processing rates (which determine a worker's hourly exposure). These two types of release rates are called "source terms." The source terms for the human health risk analysis were developed by Argonne National Laboratory (ANL) based on waste inventory information and characterization data, waste management module characterization information, and the definitions of the various PEIS alternatives. This process, as well as the source terms used in the analysis, are included in Appendix C and supporting technical reports by ANL (ANL, 1995a-e).

Health effects were not evaluated for spent nuclear fuel (from which HLW is derived) because its programmatic issues are assessed in a separate environmental impact statement (see further discussion of this in Chapter 1 of the PEIS). It is assumed that privatizing DOE treatment and disposal would produce essentially the same health effects, if the facilities are near or are in similar locations to those analyzed in this document.

D.1.3 Waste Consolidation Alternatives

For each of the waste types listed in Section D.1.2, the Oak Ridge National Laboratory (ORNL) estimated the potential health effects posed by up to four general alternatives for consolidating, processing, storing, and disposing of wastes:

- No Action: Wastes are processed and/or disposed at each site using existing or approved facilities (an approved facility is one for which National Environmental Policy Act [NEPA] review has been completed, appropriate permits received, and the decision made to proceed with the facility).
- Decentralized: Wastes are processed and/or disposed at the site where they were generated.
- Regionalized: Wastes are consolidated for processing and/or disposal at regional sites.
- Centralized: Wastes are consolidated for processing and/or disposal at one or two sites.

Within each type of alternative, there were often several potentially feasible waste management options. For example, a spectrum of Regionalized Alternatives was considered for contact-handled TRUW in which

wastes are treated and stored at as many as 10 or as few as 3 sites. The rationale for selecting these alternatives is discussed in Chapter 3.

The waste processing and disposal period for the No Action Alternatives was assumed to be 20 years. For the remaining alternatives except for HLW, it was assumed that 10 years would be needed for the construction of required waste management facilities and 10 years would be required for waste processing and disposal. The risk analysis for HLW differed in that only interim storage pending final disposal was assessed because a treatment method has already been selected and is being performed at some sites.

Many DOE sites do not currently have facilities for waste management. In the alternatives evaluation, it was necessary to assume that these sites would construct the waste management facilities required under the alternative being evaluated, and that waste processing would begin after construction was completed.

The waste disposal evaluation assessed disposal only for the sites currently storing waste. It did not include federal facilities planned for waste disposal such as Yucca Mountain because these sites will be addressed in site-specific NEPA reviews (for more information on this subject, see Chapter 2).

D.2 Evaluating the Risks Associated With Waste Management Activities

This section presents a brief introduction to the concepts and methods used to perform the human health risk analysis for the PEIS including information on the potentially exposed human populations, the means by which people could be exposed to WM Program wastes, the health effects that could result from exposure to the various wastes, and an overview of the process of estimating human health risks. In addition, this section contains a discussion of how to read and interpret the risk analysis results presented in Section D.3.

Risk analysis entails several steps including characterizing the environmental setting of the site being studied; identifying potential receptors, environmental transport pathways, and exposure routes; identifying potential human health effects to be evaluated; quantifying contaminant intakes, doses, and exposures; and calculating risks. For more detailed information on the risk analysis process used in this study, see the ORNL risk methodologies (ORNL, 1995a-c).

D.2.1 CHARACTERIZING THE ENVIRONMENTAL SETTING

The first step in estimating risk is to collect information about the site's environmental setting including agricultural data (e.g., prevalent livestock and crops, crop yields), geographical location, climatological information (e.g., annual rainfall, storm frequency, temperature range, joint frequency distribution for wind), and land use on and around the site. The environmental setting information used in the PEIS can be found in the ORNL site description report (ORNL, 1995d).

D.2.2 IDENTIFYING POTENTIALLY EXPOSED POPULATIONS

The next step is to identify the categories of people (called "receptors" in the analysis) who might be exposed to or affected by waste management processes. The receptor categories below were selected (1) to represent the populations that would most likely be exposed to contaminants during waste management activities or (2) as receptors potentially receiving the greatest exposure for the risk analysis. Health risks were not evaluated for persons who may drink water supplied from contaminated surface water or who derive a portion of their food supply from plants and animals that obtain water from contaminated surface water bodies.

- Offsite (general public) population: The offsite population within an 80-km (50-mi) radius of each site.
- Noninvolved workers: Onsite employees not directly involved in a site's waste handling activities.
- Maximally exposed individual (MEI) of the offsite population.
- MEI of the noninvolved worker population.
- Waste management workers: Onsite employees working in a site's waste management facilities, including both the workers directly involved in the waste management process and the construction workers who build the waste management facilities.
- Hypothetical farm family: An imaginary family of two adults and two children assumed to live 300 m (approximately 330 yd) downgradient of the center of a waste disposal facility in a period when institutional controls (fences, warning signs, etc.) no longer exist. The farm family engages in farming activities such as growing and consuming their own crops and livestock, and uses groundwater for drinking and for watering the crops and animals.
- Hypothetical intruder: An imaginary adult who drills a well directly through a waste disposal facility down to the water table (groundwater), brings the contaminated soil from within the disposal facility to the surface during drilling, and mixes the contaminated soil into the top 15 cm (5.9 in.) of surface soil of a 2,500-m^2 (0.6-acre) plot of land. The intruder then farms this plot and feeds him- or herself

with the crops. The intrusion scenario takes place in a period when institutional controls no longer exist.

Estimates of the offsite population and distribution within an 80-km radius of each site were obtained from the 1990 U.S. census. The population and distribution of noninvolved workers at each site were estimated based on site records, site maps, and best judgment. Because of lack of information, it was necessary at some sites to simply assume an even distribution of workers in all directions around a facility. The offsite and noninvolved worker population size and distribution for each site and the location of each site's MEIs can be found in the ORNL site description report (ORNL, 1995d).

Risks to the offsite and noninvolved worker populations were assumed to result from exposure to airborne contaminants, and were estimated only for the first 70 years after an alternative is implemented (i.e., for the lifetime of a person living during the period when treatment and storage activities take place).

The greatest risk estimates to an individual member of the offsite and noninvolved worker populations was assessed by considering the MEI in each population. In these scenarios, the MEI receives the highest total chemical intake and/or radiation dose for all exposure routes (e.g., inhalation, ingestion, direct exposure) over the person's lifetime. In considering the results of the TRUW and LLMW alternatives, note that for each *site* the MEI is one individual; however, for each *alternative* (in which the impacts from all relevant sites are considered together), the MEI is a composite of the greatest exposure to radionuclides and carcinogenic and noncarcinogenic chemicals.

The hypothetical farm family and hypothetical intruder represent two most-conservative exposure situations that occur at a time when institutional controls (fences, warning signs, land records, etc.) no longer exist, and are analyzed to determine upper-bound exposures only. The farm family is assumed to set up residence 300 m downgradient from the center of the disposal facility. The 300-m distance was chosen to ensure that the farm family's groundwater well was beyond the boundary of the disposal site (no matter what type of disposal facility is assumed for a particular site).

Risks to the hypothetical onsite farm family are evaluated for 143 consecutive 70-year lifetimes (i.e., 10,000 years) in order to determine the upper bound of long-term risks from exposure to groundwater that has been contaminated by the failure of a waste disposal facility. The maximum exposure would presumably occur in the future when the peak concentration of contaminant(s) passes the farm family's well, and might

be significant over a series of lifetimes. The 10,000-year time period was selected for the analysis in order to maintain consistency with current performance assessments and the *Guidelines for Radiological Performance Assessment of DOE Low-Level Radioactive Waste Disposal Sites* (Case and Otis, 1988). To provide some perspective on the timing of health risks predicted to result from disposal, the risk analysis identifies the 70-year lifetime (out of the 143 lifetimes evaluated) during which the highest exposures, hence, risks, are estimated to occur for the hypothetical farm family. This peak-risk lifetime is referred to in the results as the maximally exposed lifetime (MEL) of the farm family.

The intruder scenario involves chronic exposure of an individual to contaminated material brought up to the ground surface by drilling a well directly through a waste disposal facility (following guidance on intruder scenarios presented in *Intruder Scenarios for Site-Specific Low-Level Radioactive Waste Classification* [Kennedy and Peloquin, 1988]). The intruder scenario is intended to show the most conservative risk from the disposal technology itself; therefore, only the health effects from direct exposure to contaminated drilling wastes (as opposed to additional exposure to other contaminated media such as groundwater) are evaluated for this scenario. Exposure to an intruder is evaluated for one lifetime for two instances of intrusion: one at 100 years after closure of the disposal facility and one at 300 years after closure.

Worker risks are estimated both for short-term construction activities and for longer term facility operation activities. Worker activities are expected to occur over 10 to 20 years, depending on waste type and alternative, so worker risk is estimated to be a factor only during the first lifetime, or 70 years, after implementation of an alternative. The number of waste management workers involved in the various alternatives was determined as described in Section D.2.7.2.

D.2.2.1 Populations Not Specifically Evaluated

The human health risk analysis did not explicitly include risks to sensitive subpopulations (as defined by the U.S. Environmental Protection Agency [EPA] [EPA, 1989a]) such as children, the elderly, or pregnant or nursing women; however, sensitive subpopulations were considered in the development of the toxicity and exposure values that were used in the analysis, hence, are indirectly included.

For radiological exposures, the nominal risk probability coefficients (referred to as "risk factors") used to estimate the risk of cancer and adverse genetic effects from radionuclide exposures are taken from Volume 60 of the proceedings of the International Commission on Radiological Protection (ICRP), which is referred to as *ICRP 60* (ICRP, 1990). *ICRP 60* states that "[a]lthough there are differences between the sexes and between populations of different age-specific mortality rates, these differences are not so large as to necessitate the use of different nominal probability coefficients." A small difference exists, however, between the risk factors used for workers and those used for the population as a whole. This difference arises principally because the more sensitive younger age groups and pregnant women are included in the whole population (as opposed to the worker population). With regard to the elderly, the radiological risks presented in the PEIS were calculated as the estimated risks a person would sustain over a 70-year lifespan assuming 50 years of radionuclide uptake and commitment (the concept of radionuclide commitment is explained in Section D.2.6). A person who is already elderly when a PEIS alternative is implemented would not likely be exposed for the entire 50 years. Therefore, the use of a 50-year uptake and commitment period should lead to an overestimate of the risks to the elderly. This overestimate would be more pronounced in populations containing a disproportionate number of elderly people.

The EPA slope factors and reference doses (RfDs) or reference concentrations (RfCs) used to evaluate risks from exposures to chemicals are similarly conservative. Slope factors and RfDs or RfCs are generally extrapolated from animal data and include what is termed an "uncertainty factor." This uncertainty factor is an attempt to arithmetically express how well or poorly the pharmacokinetic differences between animals and humans are understood for a particular chemical; it also accounts for the effects of the chemical on various human subpopulations. As such, these slope factors and RfDs or RfCs are considered valid for a wide range of human subpopulations. For more information on this subject, readers may wish to refer to the EPA sources for toxicity factors, the Health Effects Assessment Summary Tables (referred to as HEAST) and the on-line Integrated Risk Information System (called IRIS).

Executive Order 12898 on environmental justice mandates adding the dimension of minority and low-income populations to research, data collection, and analysis to the extent practicable and appropriate. Certain Native American and minority or low-income populations might consume larger quantities of locally grown produce or fish from local water sources than the population as a whole; this situation might result in higher risks to these particular people.

DOE has not evaluated the human health risk to subpopulations that may derive a substantial portion of their food supply from native plants and animals that live near the DOE sites. The results of such a complex analysis would likely vary widely both within and among sites, depending on the assumptions used for parameters such as locations of waste management facilities on the sites, routes of exposure, and dietary habits. Thus, the results would not help to clarify programmatic decisions. The risk to human health from ingesting native plants and animals cannot be fully analyzed with confidence until the locations of facilities on the sites are known, the routes of exposure are explicitly defined, and the dietary habits of affected subpopulations are quantified. Therefore, analysis of health effects from subsistence consumption of fish, wildlife, and native plant species is not included in the WM PEIS but may be considered in subsequent sitewide or project-specific NEPA documents if the appropriate information is available.

D.2.3 IDENTIFYING ENVIRONMENTAL TRANSPORT PATHWAYS

The next step in the risk analysis process is to identify the pathways between the sources of contamination and the individuals or populations at risk. These pathways are the actual physical routes along which the contaminants would travel from the source to the exposed individual or population.

Waste management workers working at waste management facilities can come into direct contact with wastes and/or waste containers and with intrafacility airborne contamination during routine treatment, storage, and disposal operations, and during accidents. The remaining receptors become exposed only if contaminants are released from the waste management facility to environmental media such as air or groundwater. For the purposes of the PEIS, it is assumed that contaminants are released (1) to the air during waste treatment operations and accidents, (2) to the groundwater at some point after wastes have been disposed of in engineered disposal facilities, and (3) to the surrounding soil upon intrusion into disposal facilities following institutional control. During treatment operations and accidents, area winds carry released contaminants from the treatment facility toward the offsite and noninvolved worker populations. These airborne contaminants can be inhaled as well as deposited on plants and soil. Wind also transports the contaminated soil that the intruder brings to the surface during drilling and mixes into his/her farm plot. In the waste disposal scenarios, it is assumed that contaminants leach from the facility to the groundwater and are transported downgradient toward the hypothetical farm family's drinking water well.

D.2.3.1 Transport Pathways Not Evaluated

DOE has not evaluated the human health risk to persons who may drink water supplied from contaminated surface water or who derive a portion of their food supply from plants and animals that obtain water from surface water bodies. This is a complex analysis that cannot be performed with confidence until the locations of the facilities on the sites are known and the routes of exposure explicitly defined. Therefore, analysis of health effects from the surface water pathway is not included in the WM PEIS but may be considered in subsequent sitewide or project-specific NEPA documents. A limited analysis was performed to show the potential health effects from the deposition of airborne contaminants on surface water bodies.

Deposition of Radionuclides Onto Surface Water with Subsequent Ingestion. The deposition of contaminants by an airborne plume on an exposed body of water was eliminated as a pathway from detailed quantitative analysis. Preliminary tests were performed to determine the order-of-magnitude impacts of this secondary exposure pathway. These tests, which involved varying rates of flow of surface water, widths of surface water bodies, and distances from the atmospheric source to the receptor, demonstrated that the contribution of this secondary pathway to the final dose was at least 3 orders of magnitude smaller than the dose resulting from inhalation of the plume. Tests were performed for a hypothetical unit release and atmospheric deposition of several representative radionuclides using parameters associated with the Columbia River near Hanford (Washington) and the Clinch River near ORNL (Tennessee). The Columbia has an average width of 457.2 m, an average depth of 6.1 m, and an average flow speed of 1.2 m/s. The Clinch River has an average width of 124.3 m, an average depth of 9.1 m, and an average flow speed of 0.1 m/s. For the test, the atmospheric source was located at three different distances from both rivers: 10 m, 300 m, and 16.1 km. The receptor was located at the river and drank 1 L (0.9 qt) of contaminated water per day. The cancer incidence risk from inhalation of the plume is compared with the cancer incidence risk from ingestion of the contaminated water. Table D.2–1 summarizes the results for uranium–238.

Deposition of Chemicals Onto Surface Water With Subsequent Ingestion. Tests were performed for exposure to unit releases of chemicals for some of the same scenarios outlined above. Benzene and 1,1,1-trichloroethane were chosen because both are in the PEIS source terms (Table D.2–2). Benzene is a carcinogen for inhalation and ingestion, and 1,1,1-trichloroethane is a noncarcinogen for inhalation and ingestion. Chemicals that exhibit carcinogenicity for ingestion but not for inhalation (or vice versa) were not examined because an accurate comparison could not be made.

Table D.2-1. Preliminary Surface Water Analysis Results for Radionuclides

Contaminant: Uranium-238				
River	**Distance (m)**	**Ingestion Cancer Incidence Risk**	**Inhalation Cancer Incidence Risk**	**Approximate Difference[a]**
Columbia	10	2.4E-11	4.9E-01	10 orders of magnitude
	300	5.3E-13	3.6E-04	9 orders of magnitude
	16,100	7.7E-15	9.5E-08	7 orders of magnitude
Clinch	10	3.4E-12	3.6E-04	8 orders of magnitude
	300	7.7E-11	2.4E-01	10 orders of magnitude
	16,100	1.0E-13	1.9E-07	6 orders of magnitude

[a] Difference (in orders of magnitude) between cancer incidence risks for ingestion versus inhalation.

Table D.2-2. Preliminary Surface Water Analysis Results for Chemicals

Columbia River at 300 m					
Contaminant	**Ingestion Hazard Quotient**	**Inhalation Hazard Quotient**	**Ingestion Cancer Incidence Risk**	**Inhalation Cancer Incidence Risk**	**Approximate Difference[a]**
Benzene	--	--	7.5E-19	8.7E-10	9 orders of magnitude
1,1,1-Trichloroethane	1.4E-14	7.8E-06	--	--	8 orders of magnitude

[a] Difference (in orders of magnitude) between hazard indices and cancer incidence risks for ingestion versus inhalation.

D.2.4 IDENTIFYING LIKELY EXPOSURE ROUTES FOR POPULATIONS AND INDIVIDUALS

The following sections describe the exposure routes by which the various receptors may come into contact with radiological and chemical contaminants. These exposure routes are illustrated in Figures D.2-1 through D.2-4.

D.2.4.1 Offsite and Noninvolved Worker Population Exposure Routes

It was assumed that the offsite population could be exposed to radionuclides, carcinogenic chemicals, and noncarcinogenic toxic chemicals by coming into contact with contaminated air. Airborne contaminants can be inhaled, taken up by agricultural animals and plants and subsequently ingested, or can cause direct (external) exposure via immersion in a plume of contaminated air or exposure to contaminated soil. Noninvolved workers were assumed to be exposed only to atmospheric releases, because institutional controls should ensure that this population is not exposed to contaminated groundwater or surface water through drinking or showering.

The offsite and noninvolved worker populations were evaluated for dermal exposure to tritium derived from tritiated water in the atmosphere. Both absorption through the skin and the lungs were taken into account; this combined rate of absorption was assumed to be 150% of the inhalation intake rate alone (Napier et al., 1988).

D.2.4.2 Hypothetical Farm Family Exposure Routes

The risks to the hypothetical farm family were analyzed only for the waste types that will be disposed of in DOE facilities (e.g., LLW and LLMW). It was assumed that the farm family could be exposed directly and indirectly to groundwater contaminated by a release from the disposal facility. Shallow land disposal facilities were assumed to allow immediate releases; tumulus and below-ground vault disposal facilities were assumed to fail and allow release in 300 and 750 years, respectively. The exposure routes evaluated for the farm family include ingestion of contaminated groundwater and ingestion of crops and animals contaminated by exposure to groundwater.

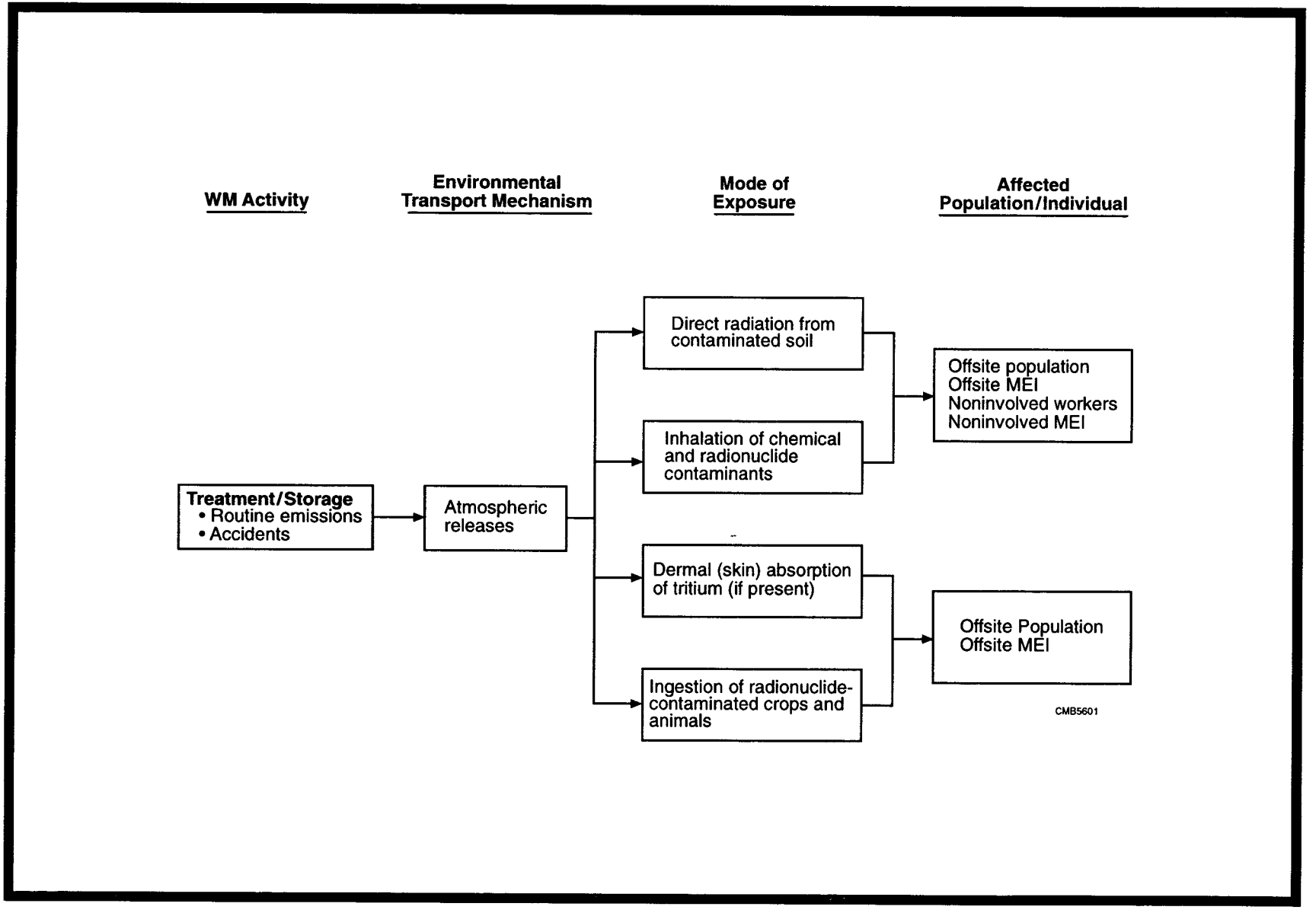

Figure D.2–1. Exposure Routes for the Offsite and Noninvolved Worker Populations for Treatment and Storage Activities

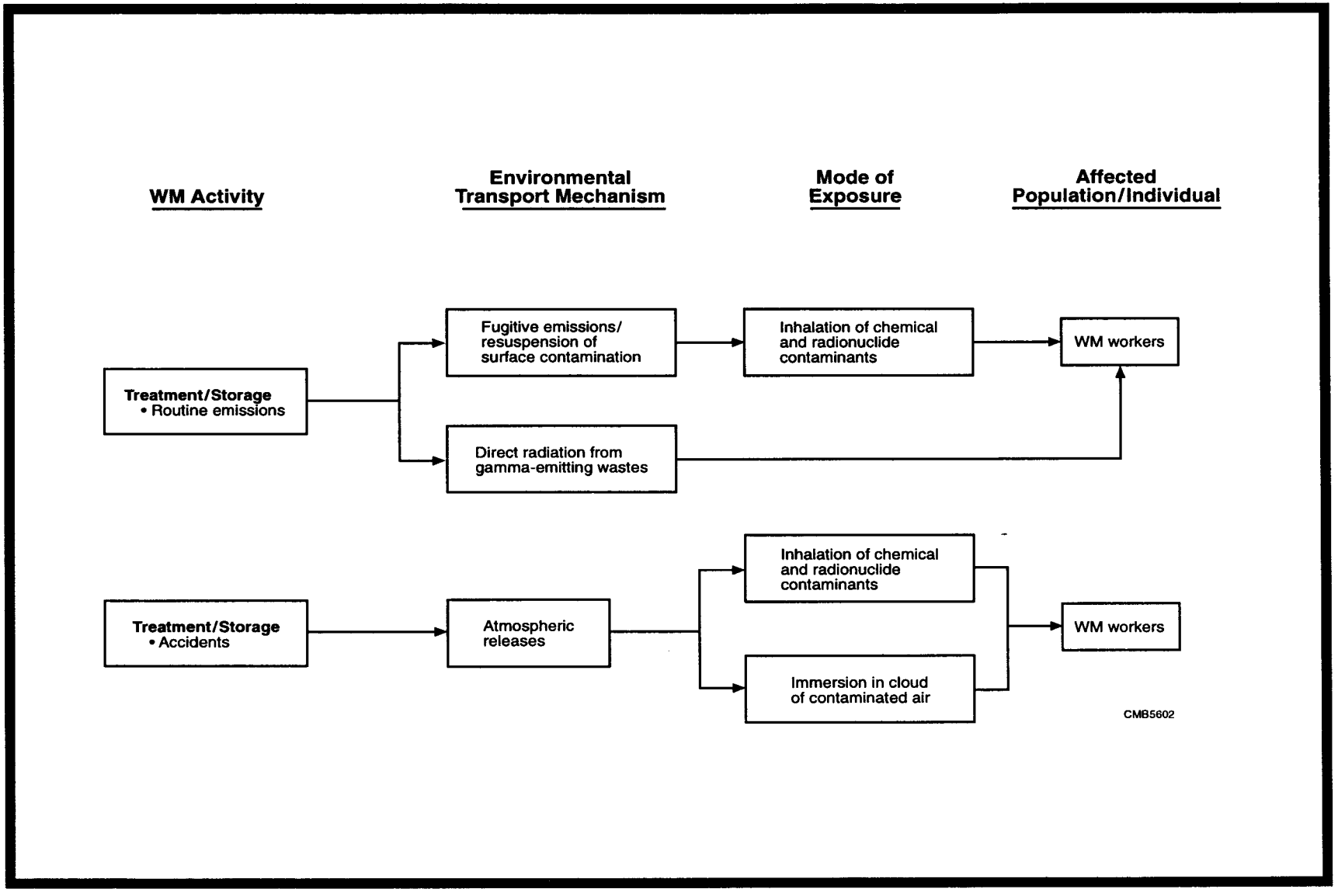

Figure D.2–2. Exposure Routes for Waste Management Workers for Routine Operations and Accidents During Waste Treatment and Storage

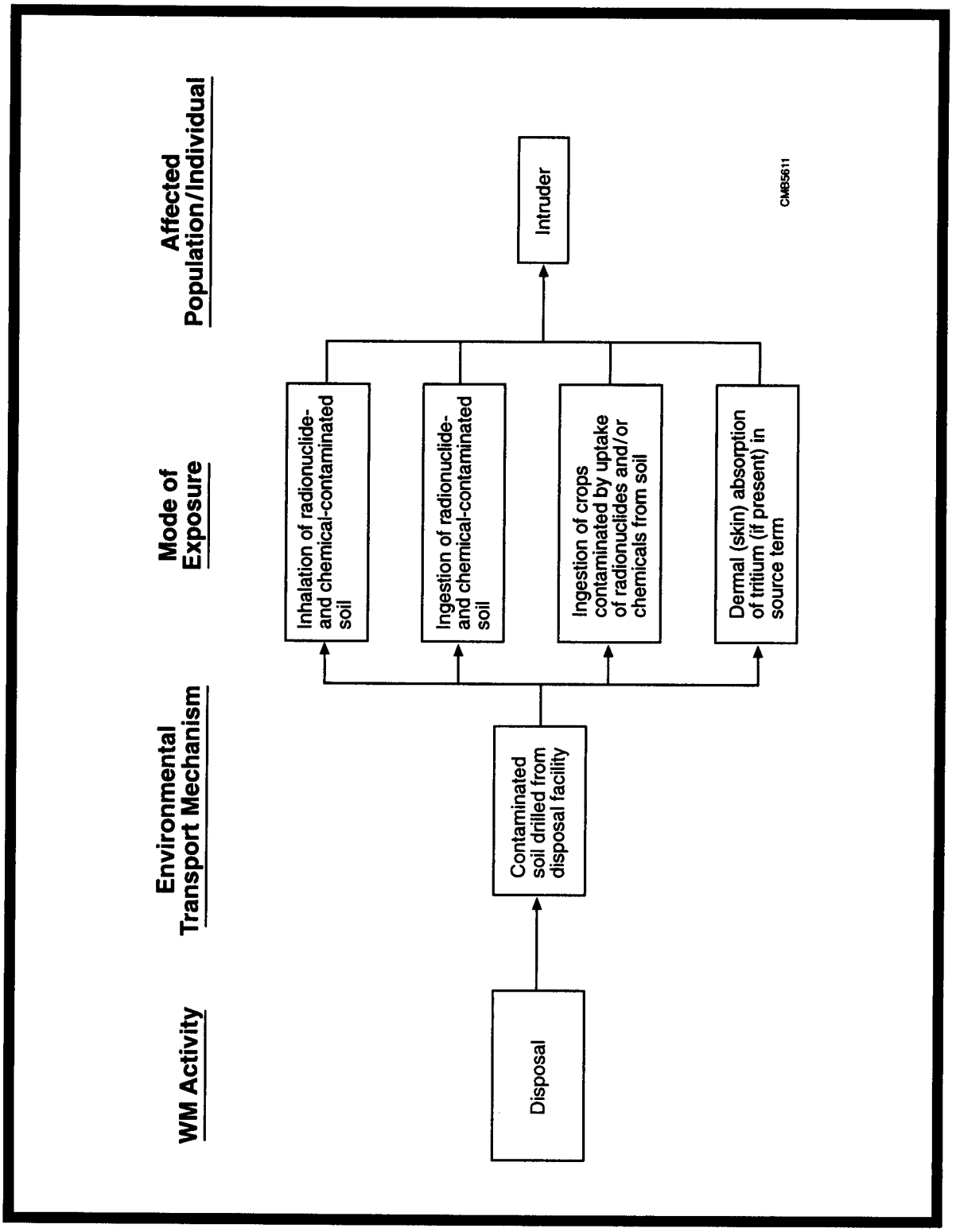

Figure D.2-3. Exposure Routes for the Intruder for Disposal Activities

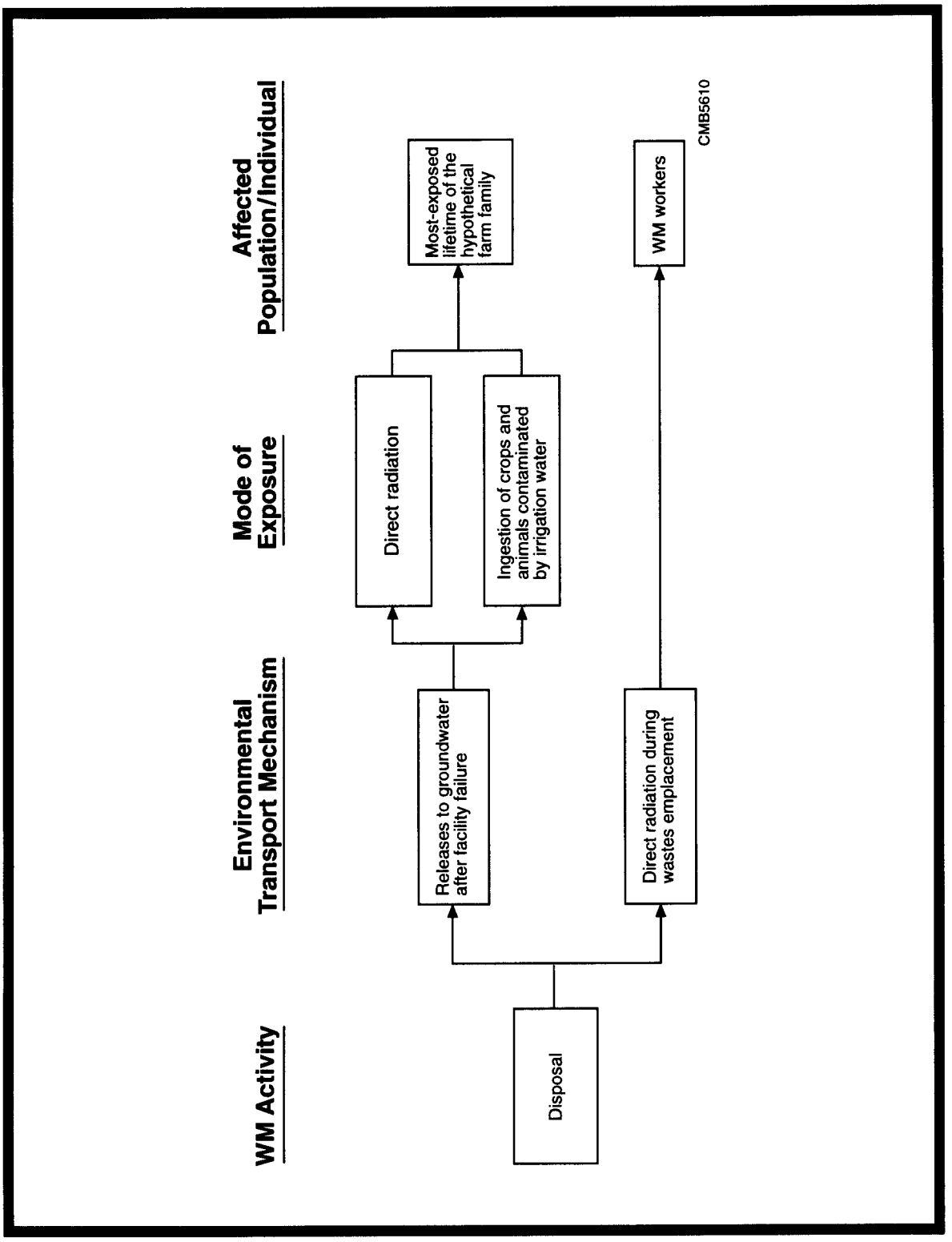

Figure D.2–4. Exposure Routes for the Farm Family and Waste Management Workers for Disposal Activities

D.2.4.3 Hypothetical Intruder Exposure Routes

Exposure of the intruder was assessed only for LLW and LLMW, the waste types that will be disposed of in DOE facilities. The exposure routes evaluated for the intruder involve exposure to soil contaminated with radionuclides for LLW and with radionuclides and hazardous chemicals for LLMW. These exposure routes are direct radiation from the soil, ingestion of plants, inadvertent ingestion of soil, and inhalation of resuspended soil (for radionuclides); and ingestion of plants, inadvertent ingestion of soil, and inhalation of resuspended soil (for chemicals).

D.2.4.4 Worker Exposure Routes

To provide an overview of the program-level health impacts from waste treatment, storage, and disposal activities, the risks to waste management workers include the risks to workers building waste management facilities. Workers directly involved in treatment, storage, and disposal were assumed to be exposed to contaminated air in work areas resulting from fugitive treatment emissions and resuspended surface contamination on waste containers, to receive external exposure from radioactive wastes, and to be at risk of death or injury from industrial-type physical hazards. The worker exposures associated with placing wastes into disposal facilities were assessed separately from treatment risks. Construction workers were assumed to be exposed only to construction-related physical hazards, not to radiological and chemical wastes. The construction and operational risk factors used in this risk analysis are based on current statistics from the U.S. Bureau of Labor Statistics and the National Safety Council, as discussed in the PEIS unit risk methodology (ORNL, 1995c). At sites where no construction was assumed, these risks were not estimated.

D.2.5 Identifying the Human Health Effects to Be Evaluated

The PEIS focuses on certain human health impacts as one of the bases for comparing the various waste management alternatives. In this risk evaluation, it was assumed that health effects, which might range from mild clinical symptoms of chemical exposure to bodily injury, illness, or death, could result from exposure to radionuclides, carcinogenic chemicals, and noncarcinogenic toxic chemicals as a result of both routine waste management operations and potential accidents. In addition to exposure-related health problems, waste management workers were assumed to be at risk of on-the-job injuries or deaths from physical trauma

(falls, crushing, electrocution, etc.). The following health effects, called "endpoints" in the analysis, were evaluated:

- Cancer incidence from radionuclide and chemical exposures
- Cancer fatalities from radionuclide exposures only
- Adverse genetic effects caused by exposure to radionuclides
- Hazard index for nonworkers (an indicator of the likelihood of noncancer toxicity caused by continuous exposure to nonradioactive waste components)
- Exposure index for workers (an indicator of the likelihood of noncancer toxicity caused by work-day exposure to nonradioactive waste components)
- Waste management worker fatalities and injuries associated with the construction and operation of waste management facilities

In addition, in the accident scenarios, an "immediately-dangerous-to-life-and-health (IDLH) index" was calculated for workers as an indicator of the likelihood that contaminant levels might impair escape or be immediately dangerous to life and health.

For the purposes of this evaluation, the concepts of cancer incidence and cancer fatality refer to what are termed "excess cancers," i.e., cancers that would not otherwise have occurred. These terms encompass all types of cancer and any occurrence(s) of cancer over the 70-year lifetime of an individual.

Radiation-Related Health Effects. It was assumed that exposures to radiation can result in cancer incidence, cancer fatality, and adverse genetic effects. Adverse genetic effects include gene mutations (alterations in the elementary units of heredity, the genes) and gross chromosomal aberrations (changes in the structure or number of chromosomes). Because exposure to contaminants in and from DOE sites might occur over many generations, concern exists that the cumulative genetic damage carried benignly across generations might, at some point, produce disease that is not accounted for in the basic cancer risk calculations.

The frequency with which these three health effects occur was assumed to be directly proportional to the amount of radiation absorbed by the receptor (see the discussions on "effective dose equivalent" and dose "commitment" in Section D.2.6). Moreover, these impacts were assumed to occur in a fixed ratio to one another. For example, for all receptors except waste management workers, the ratio of cancer incidence

to cancer fatality to genetic effects was taken to be 17:5:1 (see Section D.2.8.1 for a more detailed discussion of these assumptions).

Chemical-Related Health Effects. It was assumed that exposure to hazardous (nonradioactive) chemicals can cause cancer and/or a spectrum of toxic effects ranging from mild headaches or nasal irritation to more serious impacts such as organ (e.g., liver, kidney) toxicity, neurotoxicity, immunotoxicity, developmental toxicity, reproductive toxicity, and genetic toxicity.

The risk of cancer fatality was calculated for radionuclides but not for chemical carcinogens; this is discussed in more detail in Section D.2.6.3.

D.2.5.1 Factors Excluded From the Analysis

The risks from enhanced or diminished toxicity from interactions among components of a contaminant mixture (termed "synergy" and "antagonism," respectively), or the effects of multiple chemical forms of the same atom ("speciation") or combination of atoms ("complexing") were not evaluated because not enough information exists on these effects. If synergism or antagonism is occurring at a particular site, the risks there will be accordingly under- or overestimated. Similarly, since complexing and speciation can affect a contaminant's physicochemical and health-related properties including its toxicity, carcinogenicity, reactivity, and water solubility (hence, transportability), the lack of toxicity information on waste complexing and speciation may introduce some additional uncertainty to the risk analysis.

D.2.6 Quantifying Contaminant Intakes, Doses, and Exposures

This section presents a brief overview of how chemical and radiological exposures are measured. For more information, refer to the EPA risk assessment guidelines (EPA, 1989a) and the ORNL risk methodologies (ORNL, 1995a,b).

D.2.6.1 Quantifying Chemical Intake and Exposure

Chemical hazards are generally quantified by an individual's intake of a chemical. Intake is expressed in milligrams of contaminant ingested, inhaled, or absorbed per kilogram of body weight per day. When evaluating health effects from chemical exposure, intake values for noncarcinogenic chemicals are compared to EPA RfDs or RfCs as published in HEAST (EPA, 1992b) and IRIS (EPA, 1991c) (for all receptors except waste management workers), and intake values for chemical carcinogens are multiplied by EPA cancer slope factors (EPA, 1991c, 1992b) (for all receptors). For workers, American Conference of Government Industrial Hygienists' (ACGIH) time-weighted average threshold limit values (TWA–TLVs, or more simply, TLVs) are used rather than RfDs or RfCs, since TLVs are based on workday exposure concentrations (ACGIH, 1992).

There are many uncertainties inherent in the process of formulating RfDs and cancer slope factors. For example, a margin of safety is incorporated into these values (i.e., these values tend to overestimate the risk of the toxicant to some degree to help ensure that human health is protected). In addition, uncertainties are introduced when the findings of dose-response research performed on animals are applied to humans; findings of studies performed at high exposure levels are extrapolated to low exposure levels; results concerning acute exposures are extended to chronic exposures; and findings from occupational conditions are used to characterize toxicity in nonoccupational or environmental conditions.

The magnitude of these uncertainties is not well known; estimates from different studies vary depending upon factors such as the number of studies performed for a particular substance and the receptors and scenarios for which the substance was investigated.

D.2.6.2 Quantifying Radiological Dose and Exposure

A variety of units are used to indicate the amount, intensity, and potential health effects of radiation. The "curie" (abbreviated Ci) is a measure of the amount of radioactive decay occurring in a sample of radioactive material, and is defined as 37 billion disintegrations (individual radioactive decay events) per second. The rate of decay of 1 g of radium is the basis for this unit of measure. Amounts of radionuclides are commonly measured in curies or fractions of curies such as the picocurie (pCi), which is a trillionth of a curie. Emission rates are typically measured in picocuries per year (pCi/yr), and concentrations in units such as picocuries per cubic meter (pCi/m^3) or picocuries per gram (pCi/g).

The same dose (absorbed by the human body) of different types of radiation (e.g., alpha, beta, gamma) can produce different health risk outcomes and different effects on living cells. To standardize for these effects, a unit of radiation measure called a "rem" is used as a way of measuring the biological effects of a given dose of any type of radiation. The rem has built-in factors that weight the dose according to each type of radiation's capacity for causing biological damage (this capacity is called the "biological effectiveness" of the radiation). Hence, 1 rem of one type of radiation (for example, gamma radiation) is presumed to have the same biological effects on a given type of tissue as 1 rem of any other type of radiation (say, beta radiation). This unit of measure allows comparison of the biological effects (on a given type tissue) of radionuclides that emit different types of radiation. A millirem (mrem) is one-thousandth of a rem. See the ORNL worker risk methodology (ORNL, 1995b) for a more detailed description of the different types of radiation.

The various organs of the body have different susceptibilities to harm from radiation; for example, the gonads tend to be more sensitive to radiation damage than the cornea of the eye. The unit of measure that takes these different susceptibilities into account to provide a broad indicator of the total effective radiation dose is called an "effective dose equivalent" (or "EDE"). It is obtained by multiplying the dose (or "dose equivalent") in rems in each major organ or tissue by a weighting factor associated with the risk susceptibility of the tissue or organ, then summing the totals. This unit of measure allows comparison of the general adverse consequences to people who are exposed to radiation, regardless of the different susceptibilities of individual types of tissue in different organs to such exposure. For a more detailed discussion of organic and tissue weighting factors, see the ORNL worker risk methodology (ORNL, 1995b).

Three types of radiation doses are calculated in the PEIS: an external dose, an internal dose, and a combined external and internal dose (or total dose). External doses are from sources located outside the body such as a sealed radioactive container or contaminated air, water, or soil. Internal doses arise from sources that have entered the body, usually from eating or drinking contaminated substances or breathing contaminated air.

D.2.6.3 Comparing Radionuclide Exposures to Chemical Exposures

Radionuclide and chemical exposures are, for the most part, very different from one another. A chemical contaminant may be released to groundwater or dispersed into the air, whereupon it is deposited on the ground, vegetables or other crops, or other surfaces. A person becomes exposed by inhaling the contaminant, drinking contaminated water, eating contaminated vegetables, etc. A number of chemicals, such as mercury, lead, and PCBs, bind to or "bioaccumulate" in various body tissues such as bone and fat and may continue to cause toxic effects long after initial exposure. However, quite often, a chemical that has entered the body exerts its toxic or carcinogenic effect over a relatively short period of time and is excreted or otherwise eliminated from the exposed person's body. (The time required for a living organism to eliminate half the amount of an absorbed or ingested chemical substance by natural processes is termed the "biological half-life" of that substance.)

There seems to be an exposure *threshold* for noncancer effects caused by chemicals that do not bioaccumulate. Above this threshold exposure level, these chemicals begin to exert adverse effects; below the threshold, their effects seem to be negligible. A person can be exposed many times to less than the exposure threshold of chemicals that do not bioaccumulate and show no cumulative adverse noncancer effects.

Based on the characteristics of the contaminants of concern in the WM Program waste types, it was assumed in this risk analysis that chemical contaminants of concern do not significantly bioaccumulate. Accordingly, the exposure time for toxic chemicals was assumed to equal the release time. The release time was assumed to be equal to the total processing period for the waste type in question (e.g., 10 or 20 years). While this assumption may be somewhat conservative, it is applied across all sites; hence, the *relative* ranking of sites by risk will likely remain the same.

People are exposed to radionuclides by the same mechanisms as they are to chemicals. However, radionuclides may be present in forms such as simple salts that, when ingested, can be incorporated into body tissues (such as bone) more readily than many hazardous chemicals. Radionuclides may also adhere to particles that, once inhaled, are too small for the lungs to expel. In these circumstances, a radionuclide will stay in the body and continue to deliver a radiation dose long after the exposed person has stopped ingesting or inhaling the radionuclide. (The persistence time of a radionuclide in a living organism is measured in terms of the radionuclide's "effective half-life." This is the period of time required for the

amount of radionuclide in an organism to diminish 50% from the combined action of radioactive decay and biological elimination.)

Based on the radionuclides found in the WM waste types and ICRP guidance (ICRP, 1977; 1990), it was assumed that most ingested or inhaled radionuclides remain in the body and continue to expose the person for the rest of his or her life (i.e., the internal dose continues to accumulate). In risk analysis, this continuing, cumulative internal exposure period is referred to as the "commitment period." A commitment period of 50 years was chosen for this study (ICRP, 1990). This time period reflects the average person's working lifetime beginning at age 18, and is a standard time period used in risk assessments. Accordingly, in this study, the risks from radionuclide exposure are calculated not just for the waste treatment time span (10 or 20 years, according to waste type) but as though the internal exposure period persists for a total of 50 years (this does not apply to external exposure to radiation). Therefore, the total EDE deposited in the body over the 50 years after intake of a radionuclide, called the "committed EDE," is used in the PEIS risk calculations.

Because we do not have a clear understanding of the biological processes by which chemicals and radiation cause cancer, a conservative approach (and the one adopted in the PEIS) is to assume that there is *no minimum or threshold value for exposures to carcinogens*. This means that any exposure to a carcinogen increases the lifetime risk of cancer. Consequently, it is assumed that the risk of cancer accumulates with repeated exposures to carcinogens and that the risk of cancer from multiple exposures to multiple sources is additive.

The risk of cancer fatality was calculated for radionuclides but not for chemical carcinogens. This is because research and epidemiological studies have provided enough information to develop risk factors for both cancer incidence and fatality caused by radionuclides; however, there is not yet enough information to develop risk factors for cancer deaths resulting from chemical exposures. These differences between the amounts of information available about cancers associated with chemical and radionuclide exposures have another implication: The risk of cancer incidence from exposure to hazardous chemicals is not, strictly speaking, directly comparable to the risk of cancer incidence from exposure to radionuclides (this becomes an issue only in the risk analyses for TRUW and LLMW, which contain both radionuclides and hazardous constituents). Readers should bear this in mind when assessing the risk analysis results.

D.2.7 Calculating Exposures for the PEIS Receptors

This section presents a brief introduction to the methods used to model the fate and transport of chemical and radiological contaminants between their initial release and the point at which the various receptors are exposed, and to calculate the unit chemical intakes and radiological doses the receptors receive.

For every potential contaminant in these studies, it was assumed that one unit amount of contaminant is released to various environmental media (e.g., air, soil, or groundwater); or, for worker exposures to radionuclides, is available to cause direct exposure. This unit is 1 Ci for radionuclides and 1 g for chemicals. Appropriate fate and transport models and dose assessment models were then used to estimate the exposures the various receptors sustain from this unit of contaminant. These models use information about the physical and chemical properties of the contaminants and the specific environmental setting in which the contaminants were released to calculate the direction in which the contaminants move; the rate at which they move into different environmental media (for example, air, soil, water); their dilution, dispersion, and degradation or decay; and their movement via the food chain. The models described below are discussed further in Section D.5 and in supporting ORNL technical reports (ORNL, 1995a-c).

D.2.7.1 Calculating Exposures to the Offsite and Noninvolved Populations, Hypothetical Farm Family, and Hypothetical Intruder

Regulatory Considerations for Public Receptors. While there are regulatory standards governing the maximum permissible radionuclide and chemical exposures to members of the public (i.e., to all receptors other than waste management workers), the doses to these receptors were not limited in this analysis for two reasons. First, a waste management facility is a relatively controlled environment so worker exposures are somewhat more easily monitored than exposures to the public. Second, leaving the predicted exposures to the offsite and noninvolved worker populations unmodified enables the reader to make a better assessment of the maximum risks among the various PEIS alternatives. (Applicable environmental requirements would be taken into account in the implementation of a selected alternative).

Estimating Doses From Contaminated Groundwater. For the groundwater pathway, the computer models DUST (Disposal Unit Source Term) (Sullivan, 1992), MEPAS (Multimedia Environmental Pollutant Assessment System) (Droppo et al., 1989), and DITTY (Dose in Ten Thousand Years) (derived from the GENII model) are used to simulate environmental transport of contaminants from the source (waste disposal

location) to groundwater to potential receptors. Contaminant-specific unit rate of transfer (flux) rates out of the engineered disposal facility are generated by DUST and are used by MEPAS to simulate the transport of contaminants through the vadose zone (the area above the permanent groundwater level) and into the groundwater. The MEPAS model then predicts the environmental concentration of contaminants at various receptor locations as a function of time. For radionuclides, the 70-year average concentrations from MEPAS are used by DITTY to predict the dose to receptors for each radionuclide. For hazardous chemicals, the 70-year average concentrations are multiplied by standard intake values for water and food to arrive at a contaminant-specific intake, which is multiplied by the size of the drinking water population to give the total contaminant dose for each 70-year period.

Radioactive decay and ingrowth of daughter products are taken into account at several points during the estimation of dose from the groundwater pathway. Radioactive decay that occurs prior to the disposal facility breach is calculated, and the contaminant inventory is modified accordingly. Decay that occurs after the facility breach and during transport to the vadose zone is accounted for prior to the transfer of flux rates to MEPAS. The MEPAS model then accounts for radioactive decay and ingrowth involved in transport through the vadose and saturated zones. All doses from daughter products are attributed to the parent radionuclide in the analysis results.

Estimating Radionuclide Doses From the Atmosphere. For atmospheric transport of radionuclides, doses are estimated by a program called GENII (Generation II of the Hanford Environmental Radiation Dosimetry Software System) (Napier et al., 1988). GENII contains algorithms, data, and methods for calculating radiological doses to various organs and tissues and for calculating EDEs based on ICRP guidance (ICRP, 1977, 1979). To create unit doses for the atmospheric release of radionuclides, GENII is run using an emission rate of 1 Ci per year for each radionuclide in the GENII library. The GENII program then uses the modeled atmospheric concentrations to predict the unit dose to potential receptors. A separate unit dose is generated for both an acute (i.e., 24-h) release period and a one-year release period. The unit dose calculated for acute releases is used to evaluate the accidental release scenarios. The one-year unit dose is used to project cumulative doses associated with chronic release scenarios. This is accomplished using radionuclide-specific cumulative dose conversion equations, which calculate the cumulative EDE based on the number of years of release. As previously noted, when calculating the cumulative EDE, radioactivity is assumed to be continually deposited in the body for 50 years after exposure occurs. GENII also accounts for radioactive decay and ingrowth of daughter products; all doses from daughter products are attributed to the parent in the analysis results.

Estimating Chemical Intakes From the Atmosphere. For chemicals, ISC2 dispersion models (Industrial Source Complex Dispersion Models, Version 2) (EPA, 1992a) are used to estimate exposures to contaminants. To create site-specific unit intakes for the atmospheric release of chemicals, ISC2 is run using an emission rate of 1 g/s with site-specific information for wind distribution. The ISC2 model predicts atmospheric concentrations based on this emission rate for each block in a circular grid comprising 16 directional sectors (e.g., north, north-northeast, northeast, east-northeast, etc.) at 10 radial distances out to 80 km (50 mi) from the point of release, yielding a distribution of unit atmospheric concentrations. The highest concentration in a block with actual population is used to generate the MEI's intake, while the population-weighted average concentration is used to generate the population intake. Recall that, unlike radionuclides, there is no commitment period for chemical exposures. To generate the unit intakes for chemicals, the unit air concentration predicted by ISC2 is converted to a unit intake using standard exposure parameters developed by the EPA, such as how much air an average-sized adult breathes per day (EPA, 1991a).

Estimating Doses and Intakes From Contaminated Soil for the Intruder Scenario. This estimate is based on the inventory of contaminants in the disposal facility. Contaminant concentrations in soil are derived for the intruder by (1) calculating the volume of the cylinder of soil removed from the waste facility during drilling; (2) multiplying the inventory in the disposal facility by the ratio of the well volume to the facility volume to derive the amount of contaminant removed by drilling; and (3) calculating the final concentration of contaminant in the 2,500-m^2 farm plot after the contaminated well-drilling soil is mixed into the top 15 cm of plot soil.

The exposure pathways evaluated for radionuclides are direct radiation from the soil, ingestion of plants, inadvertent ingestion of soil, and inhalation of resuspended soil. The exposure pathways for chemicals are ingestion of plants, inadvertent ingestion of soil, and inhalation of resuspended soil. The GENII computer model is used to calculate the 50-year cumulative EDE for radionuclide exposures. This dose is multiplied by the appropriate risk factors to calculate the resulting potential cancer fatalities, cancer incidence, and genetic effects. Radioactive decay and ingrowth of daughter products are accounted for in both intruder scenarios. An enhanced version of the PRESTO computer model (Fields et al., 1986; Fields and Mellescue, in preparation) is used to calculate the cancer incidence for carcinogenic chemicals and the hazard index for noncarcinogenic chemicals.

D.2.7.2 Calculating Exposures to Waste Management Workers

Characterizing Waste Management Facilities and Treatment Processes. Estimating worker exposures calls for characterizing the various waste management facilities and treatment processes used in each alternative. To make comparative analysis possible, these characterizations are based on the conceptual designs of "generic" waste management facilities developed by EG&G Idaho, Inc., for estimating the costs associated with the various PEIS alternatives, and on consistent assumptions about worker activities and worker protection (EG&G, 1992). Each individual process or step of treating, storing, and disposing of a waste (such as retrieving waste from current storage, receiving and inspection, shredding and compaction, incineration, solidification, interim storage, packaging, shallow land burial, and below-ground vault disposal) is identified and analyzed separately for risk as a "module." Each module serves conceptually as a self-contained "box" within which worker exposures may occur; each can contain several submodules or worker activities (see ORNL, 1995b).

Modules can be arranged to form "treatment trains" that contain all the processes required to treat, store, and dispose of a specific type of waste. A treatment train for solid LLW, for instance, might consist of size reduction (shredding), compaction, packaging, and shallow land burial. These generic modules are interchangeable and can be used as needed to formulate the treatment trains for all the different waste types in the analysis (for example, the incineration module is used in several of the treatment trains for HW, LLW, LLMW, and TRUW; and the compaction module is used in many of the treatment trains for LLW, LLMW, and TRUW).

Estimating Staffing Requirements. Once the various types of waste management facilities have been characterized, staffing requirements are then estimated. To make it possible to compare estimated worker exposures to regulatory criteria, staffing was expressed as the number of "full-time equivalents" (FTEs). An FTE was assumed to be commensurate to one individual working full-time in a waste management facility. In reality, one FTE could represent several individuals who are not exposed full-time to waste management activities, but whose *cumulative* work time totals one FTE. Because the risk of exposure could be shared by more than one worker working less than full-time in a waste management facility, risks to actual individual workers might be overestimated. When interpreting the risk analysis results, readers may find it useful to think of an FTE as a hypothetical worker or "worker equivalent." Note that radiation doses to workers are expressed in FTE-rem instead of person-rem.

The staffing requirements for facilities of various sizes were estimated using equations developed through linear regression analysis. These equations, which predict the number of FTEs needed according to facility capacity, were based on data points provided by EG&G Idaho, Inc. It was assumed that the facilities operate at 70% availability (i.e., they are not operating the other 30% of the time). Workers are assumed to be exposed by treatment or handling processes 5.6 hours/day, 240 days/year, totaling 1,344 hours/year (EG&G, 1992).

Regulatory Considerations for Waste Management Workers. Regulatory requirements have been established to limit exposures of workers to radionuclides and hazardous chemicals. These requirements are generally considered to be conservative to ensure safe conditions for workers. Code of Federal Regulations, Title 10, Chapter 835 (abbreviated "10 CFR 835") and DOE Order 5480.11 specify that the maximum allowable worker exposure to radionuclides is 5 rem/year. However, DOE installations institute their own additional radioactive waste operations procedures and administrative exposure limits for workers. DOE facilities adhere to the principle that radiological exposures should be kept "as low as reasonably achievable" (the "ALARA" principle). Guidance documents such as the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, Standard Operating Safety Guides, and Field Standard Operating Procedures provide information oriented toward reducing exposures at hazardous waste sites. One of the primary assumptions of the worker risk analysis is that waste management worker exposures do not routinely exceed occupational exposure limits. This assumption is based on historical occupational exposure data showing that workers involved in routine operations are generally exposed to levels less than these limits. According to the DOE Radiological Control Manual (DOE, 1994), the DOE Administrative Control Level per person is 2,000 mrem. However, the Manual also states that "an annual facility Administrative Control Level of 500 mrem or less should be challenging and achievable. An annual facility Administrative Control Level above 1,500 mrem is in most cases not sufficiently challenging to meet the goals of this Manual." Therefore, for the worker risk analysis, the radiation exposure guideline of 1,000 mrem/year (1 rem/year) is assumed to be the upper bound of worker exposure to radiation.

Estimated air concentrations are also compared to occupational exposure criteria such as TLVs for chemicals and EPA derived air concentrations for radionuclides to evaluate worker exposure conditions. The methodology used to estimate worker risks assumes the use of good work practices under normal conditions. If a TLV is not available for a particular chemical, estimated air concentrations of that chemical may be compared instead to 10% of the IDLH concentration, as established by the National Institute for Occupational Safety and Health (1992). The IDLH level is defined as the maximum air concentration to

which an individual without a respirator can be exposed for 30 min without suffering escape-impairing or irreversible health effects; 10% of that level is considered the boundary between negligible and reversible health effects for a 30-min exposure (ORNL, 1995b).

Estimating Doses From Indoor Air. For indoor scenarios in which individuals work inside treatment, storage, and disposal facilities, air concentrations are estimated using a room model (Jayjock, 1988). Contaminant releases are assumed to be distributed evenly throughout the entire volume of the room where treatment takes place. Intakes or doses from inhalation are estimated for each module, contaminant, and worker classification. For the worker risk evaluation, 10% of the stack emissions are assumed to escape from the module into the room (EPA, 1989b). Stack emission rates from treatment, storage, and disposal facilities are provided by ANL. Dose conversion factors used to calculate committed EDEs for inhalation of radionuclides are obtained from the EPA (EPA, 1988).

Estimating Doses From External Radiation. Doses received by treatment, storage, and disposal workers from exposure to radiation from sources external to the body (not inhaled or ingested) are calculated by taking into account the capacity of each module, worker types and numbers, exposure durations, and available shielding. With the aid of the MicroShield computer model (Grove Engineering, 1992), a "unit" EDE is calculated for workers within each module. MicroShield modeling is performed assuming that a unit concentration (1 Ci/m^3) of each radionuclide is present. Since treatment periods are assumed for a maximum of 10 years, radioactive decay and ingrowth of daughter products are considered for a five-year time period (average of the treatment period) in order to include external doses from photon-emitting daughter products.

D.2.8 Calculating Risks

This section describes how the unit doses and intakes estimated by modeling (as described in the previous section) are scaled up according to each site's source term and how the PEIS human health risk estimates are calculated for the various alternatives.

D.2.8.1 Scaling Unit Doses and Intakes According to Installation Source Term

For each site, a database is created of unit doses and intakes for all known contaminants. The database comprises numerous tables that contain waste-, site-, and exposure pathway-specific information. For radionuclides, the database contains tables of unit doses by site, receptor, contaminant, and pathway. For chemicals, the database contains tables of unit intakes by site, receptor, contaminant, and pathway.

Once unit doses and intakes have been estimated for the contaminants at a particular site for a particular alternative, they are scaled up based on the waste inventory at that site. To estimate exposures to the offsite and noninvolved populations, intruder, and farm family posed by a particular contaminant at the site, the inventory for that contaminant is first multiplied by the fraction of contaminant released during treatment, storage, and disposal activities. This product, the source term, is the estimated amount of contaminant released to the environment that could result in exposure via ingestion or inhalation. To estimate worker exposures, the unit exposure values are scaled by the inventory of contaminant present in each module for a particular site.

D.2.8.2 Calculating Risks From Unit Doses and Intakes

Calculating Risks for Noncarcinogens. The health risk value for each noncarcinogenic hazardous chemical is estimated by dividing the intake by the appropriate chemical-specific toxicity value (e.g., the EPA RfD) for all receptors but waste management workers. For workers, the estimated air concentration is divided by the ACGIH TLV. The resulting quotients (called the "hazard quotient" and "exposure ratio," respectively) express how closely the exposure to this toxicant, under the conditions in the exposure scenario, approaches the EPA or ACGIH exposure standard (this concept is explained in greater detail in Sections D.2.9, D.2.10, and D.2.11).

Calculating Risks for Carcinogens. Risks for carcinogens are estimated by multiplying the unit dose or intake by the appropriate cancer risk values from the EPA and the ICRP. For chemical carcinogens, EPA chemical-specific cancer potency factors are used (EPA, 1991b). The risk factors used for radionuclides are published in *ICRP 60* (ICRP, 1990). The radiological risk factors for the public (all receptors except waste management workers) and waste management workers are shown in Table D.2-3.

Table D.2-3. ICRP Radiological Risk Factors Used in the PEIS Human Health Risk Evaluation

Endpoint	Risk Factor for Public Receptors[a]	Risk Factor for Workers
Cancer incidence	0.0017/rem-lifetime	0.0014/rem-lifetime[b]
Cancer fatality	0.0005/rem-lifetime	0.0004/rem-lifetime[b]
Genetic effects	0.0001/rem-lifetime[c]	0.00006/rem-lifetime[c]

[a] Public receptors include offsite population and noninvolved workers.
[b] The nominal probability coefficient for fatal cancers is used to derive the cancer incidence nominal probability coefficient. The probability of fatal cancer, F (which for workers is 80% of F, as described in *ICRP 60*) is divided by the lethality fraction, k, for each organ. The total cancers per organ are then summed over all organs to result in total cancer incidence nominal probability coefficient of 0.0014.
[c] Includes weighting for severity of hereditary effects, but not for years of life lost should harm occur.

Source: ICRP (1990).

As stated above, these factors are multiplied by the EDE or committed EDE (for internal radiological exposures) sustained by a receptor or group of receptors to yield risk estimates associated with radiation exposure. The *ICRP 60* risk factors are consistent with the recommendations of the DOE Office of National Environmental Policy Act Oversight and are contained in the preamble to the U.S. Nuclear Regulatory Commission's Standards for Protection Against Radiation, 56 *Fed. Reg.* 23363.

In comparing the risks from radionuclide exposures with the risks from chemical carcinogen exposures, it is important to note that radionuclide and chemical carcinogen risks are determined by different methods. The dose conversion factors and risk factors used to estimate radionuclide-associated risks are based on observed potency in humans (typically studies of atomic bomb victims). The slope factors used to estimate chemical-carcinogen-associated risks are derived from animal studies and believed to be more conservative as a result of the uncertainty in extrapolating results for humans. These differences in risk estimation should be considered when comparing radionuclide and chemical carcinogen risks.

Risk Factors for Construction and Operational Hazards. Construction and operational risks are calculated based on current Bureau of Labor Statistics and National Safety Council statistics for the number of construction fatalities per 100,000 full-time workers; the rate of injuries, illnesses, or lost work days per 100 full-time workers over 200,000 work hours; and the risk of operational fatality, illness, or injury to

sanitary (sewerage and refuse) services workers (including both government and private industry employees).

Calculating Risks to the Public (All Receptors Except Waste Management Workers). The following example summarizes the steps involved in calculating risk for the offsite population:

- **Calculating Unit Dose**—Assuming that 1 Ci of plutonium-238 is released per year from one treatment module in LLW Treatment Facility No. 2 at Site X, a unit dose of 0.0001 rem/Ci/year is calculated, using the computer model GENII, for inhalation of plutonium-238 by the offsite population.

- **Calculating Exposure to Public Receptors**—The unit dose of 0.0001 person-rem/(Ci/year) is multiplied by the source term, which is the inventory of plutonium-238 (expressed in Ci) released per year. Assuming that the source term for plutonium-238 emissions from one treatment module in LLW Treatment Facility No. 2 at Site X is 20 Ci/year:

$$0.0001 \text{ person-rem/(Ci/year)} \times 20 \text{ Ci/year} = 0.002 \text{ person-rem} \qquad \text{(D.2-1)}$$

- **Calculating Annual Risk of Cancer Fatalities**—The annual risk for cancer fatalities resulting from the release of plutonium-238 from one treatment module in LLW Treatment Facility No. 2 at Site X is calculated by multiplying the dose calculated in equation (1) above by the risk factor for cancer fatalities for the offsite population (Table D.2-3) to obtain the annual risk for release of plutonium-238 from one treatment module in LLW Treatment Facility No. 2 at Site X:

$$0.002 \text{ person-rem} \times 0.0005/\text{person-rem} = 0.000001 \text{ (or one in one million)} \qquad \text{(D.2-2)}$$

- **Calculating Cumulative Risk for Entire Release Period**—To calculate the cumulative cancer fatality risk release of plutonium-238 from one treatment module in LLW Treatment Facility No. 2 at Site X for the entire 20-year release period, the annual risk calculated in equation (2) above is multiplied by 20:

$$0.000001/\text{year} \times 20 \text{ years} = 0.00002 \text{ (or 2 in 100,000) over 20 years} \qquad \text{(D.2-3)}$$

The risks for all of the contaminants in the site's source term are calculated as described in the four steps above, then summed to yield the total risk for each exposure pathway. The risks for each pathway

associated with a treatment module are summed to give a risk for each module. The risks for all modules are summed to give a risk for each waste type. The risks for treatment of each waste type at a site can then be summed to give the site's total risk. Population risk estimates represent the estimated number of occurrences of a health effect such as cancer incidence, cancer fatality, or genetic effects within the total population. A risk estimate for an individual (i.e., for the MEIs) is the estimated probability that the individual will develop a particular health effect.

Calculating Risks to Waste Management Workers. Risks to waste management workers from exposure to a unit amount of contaminant are estimated using unit doses similar to the those described above. Worker risks are calculated by the following steps:

- Waste management modules, treatment trains, worker types, and staffing estimates are characterized as described in Section D.2.7.2.
- Unit doses and intakes for each technology or module are then calculated.
- Worker exposures are estimated based on unit intakes and doses, site/module-specific contaminant inventories and waste throughputs, and module-specific person-hours required to perform the selected technologies or activities.
- The risks of injury and death from physical trauma (crushing, burning, electrocution, etc.) during construction and operation of waste management facilities are calculated based on worker person-hours and current Bureau of Labor Statistics and National Safety Council data, as described in Section D.2.8.1 and the ORNL worker risk methodology (ORNL, 1995b).

For example, assume that a rate of 0.00005 deaths per person-hour from physical trauma is expected for workers involved in heavy construction. If an estimated 20,000 person-hours are required to build a treatment facility, then:

$$20{,}000 \text{ person-hours} \times 0.00005 \text{ deaths/person-hour} = 1 \qquad \text{(D.2-4)}$$

Therefore, one death is estimated to occur during facility construction.

D.2.9 CALCULATING AND INTERPRETING THE HAZARD INDEX

The hazard index is an indicator of the total *additive*, noncancer toxicity from exposure to mixtures of hazardous chemicals (EPA, 1991a). It is calculated for the offsite and noninvolved worker MEIs at each site, by alternative, for both routine waste management operations and potential accidents. The highest offsite and noninvolved worker hazard indices for a particular alternative represent the estimated highest noncarcinogenic chemical exposure that an offsite individual and individual noninvolved worker, respectively, would receive at any site under that scenario.

The first step in calculating the hazard index is to estimate the receptor's predicted exposure to a hazardous chemical in the waste mixture, and divide the predicted exposure level by that chemical's maximum acceptable level (the level to which a person can be exposed 24 hours/day over a 70-year lifetime without developing adverse effects). These maximum acceptable levels are determined based on EPA RfDs and RfCs.

The resulting number from this calculation is the "hazard quotient." Hazard quotients are calculated for all of the hazardous components in the mixture and the results are summed to yield the hazard index.

Hazard index estimates should be interpreted according to EPA risk assessment guidelines (EPA, 1991a). According to this guidance, if the hazard index is less than or equal to 1.0, the exposure is unlikely to produce adverse toxic affects. However, the closer the hazard index is to 1.0, the more concern about the potential hazard of the chemical mixture increases. If the index exceeds 1.0, the concern is the same as if an individual chemical exposure had exceeded its acceptable level by the same proportion. While the hazard index does not provide a statistical probability that a particular mixture at a particular exposure level will cause a particular adverse effect (recall that below-threshold exposures for single components of a mixture may not contribute to adverse effects), it can serve as an indicator of the *relative potential for causing harm.* For a more detailed explanation of this concept, refer to supporting technical reports by ORNL (1995b,c).

If a contaminant has no RfD, it is excluded from the public risk analysis and the effect of excluding it is discussed in the results.

D.2.10 Calculating and Interpreting the Exposure Index

For routine waste management operations, the exposure index is calculated for the maximally exposed FTE ("worker equivalent") instead of the hazard index. Like the hazard index, the exposure index is an estimate of the greatest total noncancer toxicity from exposure to hazardous chemicals (EPA, 1991a). However, it is based on occupational exposure (which is episodic) rather than continuous, residential-type exposure.

The first step in determining the exposure index is to divide the concentration of each hazardous chemical in the workroom air by its TLV to yield an "exposure ratio" for each chemical. TLVs are typically time-weighted average exposure concentrations considered safe for a normal 8-hour (or 10-hour) work day and a 40-hour work week. The TLVs for an 8-hour work day were used for this analysis when available (ACGIH, 1992).

The exposure ratios for all of the chemicals in the workroom air are summed to determine the exposure index. Results greater than 1.0 indicate exposure at levels higher than recommended and an increased likelihood of adverse health effects. Similar to the hazard index, the exposure index in the results shows the highest chemical exposure to the maximally exposed FTE at any site under a particular alternative.

If no TLV or IDLH concentration has been determined for a particular contaminant, it is not included in the worker risk estimates. If an excluded contaminant comprises a significant percentage of the waste, the results discussion for that waste addresses the effect of excluding it.

D.2.11 Calculating and Interpreting the IDLH Index for Accidents

For *accidents* involving hazardous, noncarcinogenic wastes, the IDLH index (NIOSH, 1992), instead of the exposure index, is determined for FTEs. The IDLH index is similar in concept to the exposure index and is calculated similarly for the maximally exposed FTE at any site under a particular alternative. However, it is based on comparison to contaminant air concentrations that impair escape or are immediately dangerous to life and health if exposure lasts more than 30 min. An IDLH index greater than 1.0 indicates an increased likelihood of immediate danger to life and health (whereas an exposure index greater than 1.0 indicates exposure at a level higher than recommended for a safe work environment). The IDLH index is used for accidents based on the assumption that if exposure to a contaminant does not impair escape or

threaten health or life for at least 30 min, this exposure does not impair escape or threaten health or life in the few seconds or minutes postulated for the accident scenarios analyzed in this part of the PEIS.

D.2.12 Assessing the Risks From Potential Accidents

This section provides a brief overview of the methodology for calculating accident risks; additional details can be found in (ORNL, 1995b).

There are two general types of accidents likely to affect waste management operations: operational accidents involving waste management workers in the course of routine waste management activities; and external events, which are accidents caused by forces or events outside of waste management operations. Operational accidents include handling mishaps, explosions, uncontrolled reactions, fires, and leaks or spills. External events include those caused by humans (such as airplane crashes) and natural phenomena (such as earthquakes, extreme winds or tornadoes, and volcanoes). One or more of these types of accidents were postulated and evaluated for all WM Program waste types as part of the PEIS human health risk analysis. The rationale for the design and selection of the PEIS accident scenarios can be found in Appendix F. In general, accidents for which the attendant risks are potentially highest (such as an earthquake followed by fire and explosion) and accidents that are likely to occur during waste management operations (such as drum-handling accidents) have been selected to represent the spectrum of potential accidents.

In all accident scenarios, one shift of workers is assumed to be present in the facility when the accident occurs. The workers are assumed not to be using personal protective equipment because adequate engineering and administrative controls are assumed to be in place to protect them during routine operations. It is assumed that workers are not blocked or injured by falling or burning debris, and are not so overcome by heat or smoke that they cannot escape from the accident scene. The injuries or fatalities considered in the risk analysis result solely from the radiological and/or chemical exposure the workers receive in the accident.

It is assumed that when an accident occurs, the released contaminants mix uniformly into a specified volume of air. The size and shape of this volume vary according to waste type and accident scenario. The concentration of contaminants in this volume of air is the concentration to which workers are exposed. Exposure durations vary depending on the type of accident and whether it occurs indoors or outdoors. Any

contamination that escapes during the accident is assumed to disperse to the offsite and noninvolved worker populations via the atmosphere. Both populations are at risk from inhaling contaminated air. In addition, the offsite population may be directly exposed by contaminated soils, and by ingesting contaminated water, soil, meat, and agricultural products (ORNL, 1995a). The resulting health effects and their duration depend on the type of contaminant(s) released and the exposure pathway(s) and route(s) (ORNL, 1995a). Because the exposure pathways and routes may be different for the offsite and noninvolved worker populations than for workers, the contaminant of greatest concern to these nonworker populations may be different from the contaminant causing the most risk to workers.

The population distributions and meteorological monitoring data used in the accident analyses can be found in the technical report, "PEIS Installation Descriptions" (ORNL, 1995d). Any additional assumptions used in evaluating accident risks are noted in the text where appropriate.

D.2.12.1 Predicted Annual Frequency of Accidents

Each accident type in the PEIS risk evaluation is assigned an estimated annual frequency of occurrence as follows (see Appendix F):

- Anticipated (greater than 1 chance in 100 years)
- Unlikely (between 1 chance in 100 and 1 chance in 10,000 years)
- Very unlikely (between 1 chance in 10,000 and 1 chance in 1,000,000 years)
- Extremely unlikely (less than 1 in 1,000,000 years)

For example, incinerator ash explosions during the processing of LLW are considered to be anticipated, while a large aircraft impact with resulting fire and explosion is considered extremely unlikely.

The accident risk estimates presented in the results section reflect only the *consequence* of each accident as though it occurs; the estimated annual frequency is not factored into these results. However, when considering the results, readers should bear both of these parameters in mind. There may be cases in which an accident scenario has extremely serious projected consequences but the probability that it will occur is extremely remote. Conversely, an accident with relatively small consequences may be of substantial concern because it is predicted to occur relatively often.

D.2.13 CONTENTS OF THE RISK ANALYSIS TABLES

The risk analysis results tables in the subsequent sections of this appendix present a breakdown of the total human health risks associated with managing and disposing of that waste under its waste consolidation alternatives. For each of the waste types, the tables show:

- The estimated risk to each total offsite and noninvolved worker population, their respective MEIs, and waste management workers of developing cancer, dying of cancer, or suffering adverse genetic effects from exposure to chemicals and/or radionuclides, by alternative and site
- The risks to waste management workers of death or injury from physical trauma during waste management activities and the construction of waste management facilities, by alternative and site (it is assumed that no contaminants are released during these events so physical hazards can be assessed separately from chemical and radiological hazards)
- A hazard index calculation for the offsite and noninvolved worker MEIs, indicating the greatest likelihood of noncancer toxicity from continuous exposure to chemical contaminants, by alternative
- An exposure index calculation for the maximally exposed FTE (hypothetical worker or "worker equivalent"), indicating the greatest likelihood of noncancer toxicity effects from work-day (episodic) exposure to chemical contaminants, by alternative
- The risks to waste management workers, the maximally exposed generation of the hypothetical farm family, and all generations of the farm family from disposal of LLW and LLMW, by alternative and site
- The risks to the hypothetical intruder for intrusion at 100 years and 300 years, by alternative
- The risks to all populations and MEIs from potential accidents, by alternative

D.2.14 READING AND INTERPRETING THE RISK AND PROBABILITY NUMBERS

The numbers in the results tables are displayed in the standard "scientific" (exponential) notation used in risk assessment and are read as follows. Assume that a table contains the entry 5.0E–01 to represent the total estimated operations fatalities to waste management workers incinerating a particular waste under a Regionalized Alternative. The notation "E–01" indicates the power of 10 by which the leftmost, two-digit number (in this case, 5.0) is to be multiplied. Therefore, 5.0 is multiplied by 10^{-1} (0.1) to yield 0.5. This result means it is predicted that nationwide operations for that waste type under this Regionalized Alternative will result in an estimated 0.5 fatality during routine incineration operations over the total processing period for that waste (e.g., 10 or 20 years). Note that the estimate in this example is a fraction

of 1, that is, a number less than 1. This means that over the period studied (under the assumptions used in the risk analysis), no waste management workers are estimated to die as a result of routine incinerator operations. (However, note that there is some degree of error in any risk estimate due to uncertainties in the assumptions, data, models, etc., used to perform the analysis; see Sections D.2.15 and D.4).

Probability is expressed as a number between zero and one. If there is no chance that a particular event will occur, it is assigned a probability of zero; if that event is certain to occur, its probability is one. The probability that the offsite and noninvolved worker MEIs will develop or die of cancer, or manifest noncancer toxicity, etc., is expressed in the same notation as risk. Assume that a table contains the entry 3.0E–06 to represent the probability that the noninvolved worker MEI for a particular waste type scenario will develop cancer from exposure to a radioactive waste. The notation 3.0E–06 indicates that 3.0 is multiplied by 10^{-6} (0.000001). Therefore, this probability is 0.000003, which means that there are 3 chances in 1,000,000 that, over the total waste processing period, the noninvolved worker MEI will develop cancer from exposure to that radioactive waste. (Again, note that this estimate will be affected by any uncertainties associated with the risk calculations.)

As discussed in preceding sections, the maximum exposure to workers allowed under 10 CFR 835 and DOE Order 5480.11 is 5 rem/year. In contrast, DOE Order 5400.5 states that the maximum annual allowable radiation dose to the members of the public from DOE-operated nuclear facilities is 100 mrem/year. For perspective, it is estimated that the average individual in the United States receives a dose of about 300 mrem (0.3 rem)/year from all sources combined, including medical sources of radiation (such as x-rays) and natural background radiation (such as radon gas). A modern chest x-ray results in a dose of approximately 8 mrem, while a diagnostic hip x-ray results in a dose of approximately 83 mrem. A person must receive an acute (short-term) dose of approximately 600,000 mrem before there is a high probability of near-term death (NAS/NRC, 1990). Another relevant benchmark is the disposal standard for spent nuclear fuel, HLW, and TRUW (40 CFR 191), which states that disposal of these materials in compliance with the containment requirements should not result in MEI doses greater than 15 mrem/yr.

Note that the estimated risks of injury to waste management workers take into account all on-the-job injuries from the most minor to the most severe. Similarly, the risks to all receptors of adverse effects from noncarcinogenic, hazardous chemicals (expressed as the hazard and exposure indices) consider all adverse manifestations with no indication of their severity.

Finally, there are two ways to examine and compare the risks between alternatives in this risk analysis: at the *program level* and at the *site level*. This is illustrated in the following example.

Consider a Decentralized Alternative (for example, Hypothetical Alternative 1) that affects the populations at 14 sites and a Centralized Alternative (Hypothetical Alternative 2) that affects the population at only 1 site. If the total risks across all sites in Hypothetical Alternative 1 are *numerically* higher than the total risks for the one site in Hypothetical Alternative 2, Hypothetical Alternative 1 is the highest-risk alternative at the *program level*. However, the reader may find it useful in some instances to look at these risks at the *site level* as well.

Suppose the overall programwide risk of cancer incidence from radionuclide exposure in Hypothetical Alternative 1 is 8.0E–01, and this total risk is distributed across 23 million people, the sum of the offsite populations at all 14 sites involved in that alternative. If this programwide risk, 8.0E–01, is divided by the total affected population, 23 million, the resulting number is:

$$8.0\text{E–}01 \text{ (total risk for alternative)} \div 23{,}000{,}000 \text{ people affected overall} = 3.5\text{E–}08 \quad \text{(D.2-5)}$$

This result, 3.5E–08, might be considered the "average" risk to an individual member of the programwide offsite population. (Note that this number is *not* the risk to the MEI, and will *in all cases* be less than the risk to the MEI. This is because, on average, individual members of the population receive less exposure, by definition, than the MEI, the maximally exposed member of the population.)

D.2.15 Overview of Uncertainties in the PEIS Risk Analysis Process

The results of any human health risk assessment are conditional estimates based on multiple assumptions about exposure, toxicity, release of contaminants into the environment, human behavior patterns, and other variables. Therefore, the uncertainties accompanying the analysis should be evaluated to place these risk estimates in proper perspective. Uncertainties can be classified into three broad categories:

- Model uncertainty
- Scenario uncertainty
- Parameter uncertainty

Model uncertainty can result from the general limitations of mathematical models. Modeling involves trying to simulate a process that is inherently complex using a fixed and relatively small number of variables. Model uncertainty is usually estimated in the verification and validation phase of model development. Model uncertainty can also result from the inappropriate application of a model to a particular scenario (for instance, in situations for which no model has been specifically designed, and existing models must be adapted for use).

Scenario uncertainty may result from a generalized or incorrect conceptualization of a contaminant release or an exposure scenario. For example, there may be errors in the generalized assumptions concerning the amount of contaminants released, the spatial distribution of potential receptors, and the intake parameters considered for the receptors.

Parameter uncertainty may result from sampling errors, natural variability of the parameter, or the use of generic data (data that are not site-specific). The fate and transport models used to estimate risks for the PEIS require large amounts of data, including meteorological measurements, hydrogeologic settings, and release parameters. Actual data are used where possible, but generic data are often substituted where site-specific data are unavailable.

Keep in mind that the goal of the PEIS risk analyses is to evaluate the *relative* differences in risks among the various waste management alternatives if implemented nationwide. The assumptions made in performing this program-level evaluation were intended to yield reasonably conservative risk estimates (i.e., estimates that tend to overestimate rather than underestimate risk) using the best available data and state-of-the-art models. Given the programmatic nature of the PEIS and the use of the unit approach to risk assessment (ORNL, 1995c), many of the uncertainties associated with the PEIS risk estimates are "systematic." That is, many modeling and scenario assumptions were applied consistently—that is, "systematically"—throughout the analysis (such as facility emission rates for particular types of waste treatment or storage, inhalation rates, etc.). Therefore, the *relative* differences in risk estimates among waste management alternatives should not be affected by errors associated with these systematically applied assumptions. For example, if consumption of contaminated agricultural food products by the offsite population was overestimated for one alternative, it was similarly overestimated for all other alternatives.

Other uncertainties in risk estimates may be specific to assumptions about a particular scenario or site (such as wind conditions, crop yields, etc.). Section D.4 presents an evaluation of some of these parameter

uncertainties associated with the PEIS health risk estimates. In addition, readers may also wish to refer to the modeling literature cited in the reference list.

D.3 Risk Analysis by Waste Stream

This section contains a summary of the risk analysis for both routine waste management operations and potential accidents associated with each of the DOE WM Program waste streams. The information for each waste stream includes a brief definition of the waste, an overview of the alternatives analyzed, the special assumptions and considerations used in the analysis, tables showing the results of the analysis, and results summaries.

D.3.1 High-Level Waste

High-level waste (HLW) is the highly radioactive material resulting from the reprocessing of spent nuclear fuel. When spent nuclear fuel is reprocessed, reactor fuel elements are divided and dissolved to separate plutonium and uranium from their fission products; the plutonium and uranium can then be reused. The byproduct, HLW, includes liquid waste produced directly in reprocessing as well as any solid waste derived from the liquid, and contains a combination of TRUW and fission products in concentrations requiring careful handling and permanent isolation (DOE, 1988). Because a variety of solvents, acids, and alkaline agents are used in spent nuclear fuel reprocessing as well as in treatment, HLW may also contain hazardous waste components (nonradioactive but hazardous substances subject to Resource Conservation and Recovery Act regulation). However, once HLW has been vitrified (vitrification involves mixing the waste with glass-forming frit; heating the mixture to fuse it into a glass, ceramic, or other noncrystalline solid; and storing the immobilized waste in sealed, decontaminated metal canisters), these are no longer present or are immobilized in the glass matrix and are no longer emitted. DOE has determined that spent nuclear fuel reprocessing will be phased out as soon as possible; therefore, liquid HLW will no longer be generated in the future.

Four sites manage DOE-owned HLW (note that the abbreviations given here are used in the tables in this appendix):

- Hanford Site (Hanford), Richland, Washington

- Idaho National Engineering Laboratory (INEL), Idaho Falls, Idaho
- Savannah River Site (SRS), Aiken, South Carolina
- West Valley Demonstration Project (WVDP), West Valley, New York

Because DOE has already selected vitrification as the method for immobilizing HLW, evaluations were performed only for the worker risks associated with interim storage of the resulting HLW canisters pending final disposal in a national geologic repository. Public risks were not evaluated for interim storage because the offsite population would be at negligible risk of exposure. However, public risks were calculated for potential accidents; the results are presented in Sections D.3.1.5 through D.3.1.7. Transportation risks are presented in Appendix E.

Chapters 3 and 9 of the PEIS and the HLW technical report (ANL, 1996a) provide more detailed information on this waste including HLW inventories at DOE sites, estimated release rates, treatment categories used in the PEIS, and the process for developing the PEIS HLW alternatives.

D.3.1.1 Summary of HLW Alternatives

The PEIS waste management alternatives (No Action, Decentralized, Regionalized, and Centralized) and the rationale for developing them are discussed rigorously in the main body of the PEIS. Five HLW alternatives (the No Action, Decentralized, Regionalized 1, Regionalized 2, and Centralized Alternatives) were analyzed. For each alternative, two cases—designated Storage Cases 1 and 2—were analyzed. In Storage Case 1, it was assumed that a geologic repository would be available in 2015 and would accept HLW canisters at a rate of 800/year. In Storage Case 2, it was assumed that there would be a delay in the availability of a geologic repository past 2015, but that when the repository began accepting HLW, it would accept canisters at a rate of 800/year. For each alternative except the Centralized Alternative, the number of canisters produced and stored at each site is identical between Storage Cases 1 and 2. In Storage Case 1 of the Centralized Alternative, Hanford stores only the portion of canisters produced by SRS until 2015; and in Storage Case 2 of the Centralized Alternative, Hanford stores all of the SRS canisters.

- In the No Action Alternative, HLW canisters are stored in existing and approved interim storage facilities at Hanford, SRS, and WVDP. No interim storage facility exists or has been approved for INEL; therefore, no risks are calculated for INEL under the No Action Alternative.

- In the Decentralized Alternative, each of the four sites continues to store its own inventory of immobilized HLW awaiting ultimate disposal in a national geologic repository.
- In the Regionalized Alternative 1, 340 vitrified canisters of HLW from WVDP are shipped to SRS to be stored there until final disposition. Hanford and INEL store their own HLW.
- In the Regionalized Alternative 2, 340 canisters of HLW from WVDP are shipped to Hanford for interim storage. SRS and INEL store their own HLW.
- In Storage Case 1 of the Centralized Alternative, 2,373 canisters from SRS and 340 from WVDP are transported to Hanford for interim storage until a geologic repository is available. The remaining canisters produced at SRS (2,199) are stored onsite until a geologic repository is in operation. In Storage Case 2, Hanford stores all SRS, INEL, and WVDP canisters (a total of 21,612) and would require additional storage capacity.

Construction hazards were analyzed for the sites where additional storage facilities would be needed until the opening of a national geologic repository in the year 2015 or later.

Table D.3.1-1 depicts the five HLW alternatives and shows which sites ship their wastes to regional or central consolidation sites for interim storage. The numbers in parentheses are the numbers of canisters stored at the site. For each alternative, Storage Cases 1 and 2 are identical to one another except in the Centralized Alternative, in which Hanford would store all of the SRS, WVDP, and INEL canisters (making a total of 21,612 HLW canisters at Hanford).

D.3.1.2 Special Assumptions and Considerations Used in the HLW Risk Analysis

Once HLW has been vitrified, sealed in stainless steel canisters, decontaminated, and moved into dedicated storage, there is expected to be very little risk of exposing the public to these materials under routine (nonaccident) conditions; therefore, only routine operational worker risks associated with interim storage of treated HLW were evaluated. These include risks associated with exposure to radiation and with operational or construction hazards. Risk estimates were based on expected worker person-hours associated with loading and storage activities. Potential exposures and health risks to the public and workers from accidental releases during HLW storage are considered in Sections D.3.1.5, D.3.1.6, and D.3.1.7.

Table D.3.1-1. PEIS Waste Consolidation Alternatives for HLW

Alternative		Hanford	INEL	SRS	WVDP
No Action (both storage cases)	Ship	--	--	--	--
	Store	Hanford (750)	--	SRS[a] (4,572)	WVDP (340)
Decentralized (both storage cases)	Ship	--	--	--	--
	Store	Hanford[a] (15,000)	INEL[a] (1,700)	SRS[a] (4,572)	WVDP (340)
Regionalized 1 (both storage cases)	Ship	--	--	--	Store temporarily for 6 years then ship 340 to SRS
	Store	Hanford[a] (15,000)	INEL[a] (1,700)	SRS[a] (4,912)	
Regionalized 2 (both storage cases)	Ship	--	--	--	Store temporarily for 16 years then ship 340 to Hanford
	Store	Hanford[a] (15,340)	INEL[a] (1,700)	SRS[a] (4,572)	
Centralized—Storage Case 1	Ship	--	--	Ship 2,373 to Hanford	Ship 340 to Hanford
	Store	Hanford[a] (17,713)	INEL[a] (1,700)	SRS (2,199)	--
Centralized—Storage Case 2	Ship	--	Ship 1,700 to Hanford	Ship 4,572 to Hanford	Ship 340 to Hanford
	Store	Hanford[a] (21,612)	--	--	--

Note: Numbers within parentheses are the numbers of canisters stored at the site.
[a] Construction of a new storage facility is required.

Interim storage is defined as long-term storage prior to disposal in a geologic repository. Temporary storage is defined as more short-term storage prior to shipment to another site for interim storage pending disposal in a geologic repository. For the purposes of this analysis, all shipments of HLW are assumed to be by truck.

It was assumed that the canisters are thoroughly decontaminated before they are transported to interim storage; this would remove any radioactive residue from the outside of a canister that could be inhaled, ingested, or transferred to the skin. Therefore, WM workers would be subject only to radiation that penetrates the HLW canister wall (this is termed "external" or "direct" radiation) and to the physical hazards associated with construction and routine facility operations. It was also assumed that HLW treatment would remove or immobilize any hazardous, nonradioactive components; therefore, there would be little or no risk of chemical carcinogenesis or toxic effects.

D.3.1.3 Results Tables for the HLW Human Health Risk Analysis

This section contains the results tables for the HLW human health risk analysis. A discussion of the results is presented in Section D.3.1.4. The fatality and cancer incidence numbers in the tables are displayed in

the standard exponential notation used in risk assessment; directions on reading this notation and a more complete description of the types of information in the tables are given in Section D.2.

- Table D.3.1-2 presents an overview, by alternative (for Storage Case 1 only), of the *total*, programwide risks of cancer fatalities, cancer incidence, and construction and operational fatalities to waste management workers. This table provides the estimated *total number* of workers involved in storage and handling activities who will develop or die of cancers caused by exposure to HLW over the next 50 years if a particular alternative is implemented nationwide. In addition, it shows the estimated total number of workers who will be killed in construction and operational activities associated with storage and handling of HLW.
- Tables D.3.1-3 through D.3.1-7 show the programwide worker risks by health effect and Storage Case 1 alternative.
- Tables D.3.1-8 through D.3.1-12 present the worker population risks for each site, by Storage Case 1 alternative.
- Tables D.3.1-13 and D.3.1-14 present the incremental annual risk for each Storage Case 2 alternative (where the repository opening is delayed past 2015). These risk numbers show the additional risk per year from storage past 2015.
- Table D.3.1-15 presents the additional risks at Hanford for the Storage Case 2 Centralized Alternative. This alternative requires Hanford to accept all canisters of HLW produced at WVDP, INEL, and SRS which will result in more loading and unloading risks and additional construction risks.

Table D.3.1-2. Summary of Programwide Risks Associated With Routine Management of HLW: Risks to Worker Population Under Storage Case 1, by Alternative

Storage Case 1 Alternative	Total Fatalities[a]	CF	CI	C&OF
No Action	3.0	2.2	7.5E+01	8.1E-01
Decentralized	4.7	3.2	1.1E+01	1.5
Regionalized 1	4.8	3.3	1.1E+01	1.5
Regionalized 2	4.8	3.3	1.2E+01	1.5
Centralized	5.0	3.4	1.2E+01	1.6

Notes: CF = cancer fatality associated with exposure to radionuclides; CI = cancer incidence; C&OF = construction and operational fatalities.
[a] Sum of fatalities from construction, operation, and cancer associated with exposure to radionuclides.

Table D.3.1-3. Programwide Risks Associated With Managing HLW Under Storage Case 1 of the No Action Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
WM workers	Dose (FTE-rem)	5.4E+03	
	Cancer fatalities	2.2	
	Cancer incidence	7.5	
	Genetic effects	3.2E-01	
	Construction fatalities		7.9E-03
	Construction injuries		3.5
	Operation fatalities		8.1E-01
	Operation injuries		6.9E+02

Table D.3.1-4. Programwide Risks Associated With Managing HLW Under Storage Case 1 of the Decentralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
WM workers	Dose (FTE-rem)	8.1E+03	
	Cancer fatalities	3.2	
	Cancer incidence	1.1E+01	
	Genetic effects	4.8E-01	
	Construction fatalities		1.4E-01
	Construction injuries		6.2E+01
	Operation fatalities		1.3
	Operation injuries		1.1E+03

Table D.3.1-5. Programwide Risks Associated With Managing HLW Under Storage Case 1 of Regionalized Alternative 1, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
WM workers	Dose (FTE-rem)	8.1E+03	
	Cancer fatalities	3.3	
	Cancer incidence	1.1E+01	
	Genetic effects	4.9E-01	
	Construction fatalities		1.4E-01
	Construction injuries		6.3E+01
	Operation fatalities		1.3
	Operation injuries		1.1E+03

Table D.3.1-6. Programwide Risks Associated With Managing HLW Under Storage Case 1 of Regionalized Alternative 2, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
WM workers	Dose (FTE-rem)	8.2E+03	
	Cancer fatalities	3.3	
	Cancer incidence	1.2E+01	
	Genetic effects	4.9E-01	
	Construction fatalities		1.5E-01
	Construction injuries		6.4E+01
	Operation fatalities		1.4
	Operation injuries		1.2E+03

Table D.3.1-7. Programwide Risks Associated With Managing HLW Under Storage Case 1 of the Centralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
WM workers	Dose (FTE-rem)	8.4E+03	
	Cancer fatalities	3.4	
	Cancer incidence	1.2E+01	
	Genetic effects	5.1E-01	
	Construction fatalities		1.7E-01
	Construction injuries		7.3E+01
	Operation fatalities		1.4
	Operation injuries		1.2E+03

Table D.3.1-8. Risks Associated With Managing HLW Under Storage Case 1 of the No Action Alternative, by Site

Site	Worker Risks	
	Total Fatalities[a]	Cancer Incidence
Hanford	1.5	3.8
INEL	0.0	0.0
SRS	1.3	3.4
WVDP	1.2E-01	2.8E-01
Total	3.0	7.5

[a] Includes fatalities associated with both radiation exposures and physical hazards.

Table D.3.1-9. Risks Associated With Managing HLW Under Storage Case 1 of the Decentralized Alternative, by Site

Site	Worker Risks	
	Total Fatalities[a]	Cancer Incidence
Hanford	2.5	6.1
INEL	8.0E-01	1.6
SRS	1.3	3.3
WVDP	1.2E-01	2.7E-01
Total	4.7	1.1E+01

[a] Includes fatalities associated with both radiation exposures and physical hazards.

Table D.3.1-10. Risks Associated With Managing HLW Under Storage Case 1 of Regionalized Alternative 1, by Site

Site	Worker Risks	
	Total Fatalities[a]	Cancer Incidence
Hanford	2.5	6.1
INEL	8.0E-01	1.6
SRS	1.4	3.5
WVDP	7.8E-02	1.7E-01
Total	4.8	1.1E+01

[a] Includes fatalities associated with both radiation exposures and physical hazards.

Table D.3.1-11. Risks Associated With Managing HLW Under Storage Case 1 of Regionalized Alternative 2, by Site

Site	Worker Risks	
	Total Fatalities[a]	Cancer Incidence
Hanford	2.6	6.4
INEL	8.1E-01	1.6
SRS	1.3	3.3
WVDP	1.0E-01	2.3E-01
Total	4.8	1.2E+01

[a] Includes fatalities associated with both radiation exposures and physical hazards.

Table D.3.1-12. Risks Associated With Managing HLW Under Storage Case 1 of the Centralized Alternative, by Site

Site	Worker Risks	
	Total Fatalities[a]	Cancer Incidence
Hanford	3.0	7.2
INEL	8.3E-01	1.6
SRS	1.1	2.7
WVDP	1.0E-01	2.3E-01
Total	5.0	1.2E+01

[a] Includes fatalities associated with both radiation exposures and physical hazards.

Table D.3.1-13. Storage Case 2: Incremental Annual Exposure Risks Associated With Storage Beyond 2015, in Risk per Year

Storage Case 2 Alternative	Hanford			INEL			SRS			WVDP		
	CF	CI	GE	CF	CI	GE	CF	CI	GE	CF	CI	GE
No Action	2.4E-03	8.4E-03	3.6E-04	0.0	0.0	0.0	7.2E-03	2.5E-02	1.1E-03	1.6E-03	5.6E-03	2.4E-04
Decentralized	3.6E-02	1.3E-01	5.4E-03	3.2E-03	1.1E-02	4.8E-04	7.2E-03	2.5E-02	1.1E-03	1.6E-03	5.6E-03	2.4E-04
Regionalized 1	3.6E-02	1.3E-01	5.4E-03	3.2E-03	1.1E-02	4.8E-04	7.2E-03	2.5E-02	1.1E-03	0.0	0.0	0.0
Regionalized 2	3.6E-02	1.3E-01	5.4E-03	3.2E-03	1.1E-02	4.8E-04	7.2E-03	2.5E-02	1.1E-03	0.0	0.0	0.0
Centralized	5.0E-02	1.8E-01	7.6E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes: CF = cancer fatalities; CI = cancer incidence; GE = genetic effects.

Table D.3.1-14. Storage Case 2: Incremental Annual Operational Risks Associated With Storage Beyond 2015, in Risk per Year

Storage Case 2 Alternative	Hanford		INEL		SRS		WVDP	
	OF	OI	OF	OI	OF	OI	OF	OI
No Action	1.1E-03	9.2E-01	0.0	0.0	3.2E-03	2.8	7.2E-04	6.1E-01
Decentralized	1.6E-02	1.4E+01	1.4E-03	1.2	3.2E-03	2.8	7.2E-04	6.1E-01
Regionalized 1	1.6E-02	1.4E+01	1.4E-03	1.2	3.2E-03	2.8	0.0	0.0
Regionalized 2	1.6E-02	1.4E+01	1.4E-03	1.2	3.2E-03	2.8	0.0	0.0
Centralized	2.3E-02	1.9E+01	0.0	0.0	0.0	0.0	0.0	0.0

Notes: OF = operational fatalities; OI = operational injuries and illnesses.

Table D.3.1-15. Storage Case 2: Additional Loading, Unloading, and Construction Risks at Hanford

Storage Case 2 Alternative	Hanford						
	CF	CI	GE	OF	OI	CnF	CnI
Centralized	4.2E-01	1.5	6.3E-02	6.3E-02	5.3E+01	6.7E-02	2.9E+01

Notes: CF =cancer fatalities; CI = cancer incidence; GE = genetic effects; OF = operational fatalities; OI = operational injuries and illnesses; CnF = construction fatalities; CnI = construction injuries and illnesses.

D.3.1.4 Results of the HLW Human Health Risk Analysis for Routine Operations

In general, there are only slight differences in estimated worker cancer and physical hazard risks among the Storage Case 1 alternatives (in which the repository is assumed to be available in 2015; see Table D.3.1-2 and Tables D.3.1-3 through D.3.1-12). Programwide fatalities from cancer and physical hazards range from 2.3 to 5.8. The risks for each health endpoint differ by about a factor of two. The factors influencing the risks among the alternatives are: (1) the duration of interim storage; (2) the construction of new interim storage facilities at SRS, Hanford, and INEL; and (3) the volumes of HLW at SRS and Hanford. In the Storage Case 2 alternatives, for every year that operation of the repository is delayed past 2015, there are additional storage risks at certain sites depending on the alternative (see Tables D.3.1-13 and D.3.1-14). Table D.3.1-15 shows the additional risks at Hanford as a result of the increased number of canisters being shipped there for storage in the Storage Case 2 Centralized Alternative.

The lowest estimated cancer fatality risks are for the No Action Alternative in Storage Case 1. This is because there are fewer canisters at Hanford and the risks are zero at INEL. The risks for the Storage Case 1 consolidation alternatives (Decentralized, Regionalized, and Centralized) are higher by a factor of about 1.5. This increased risk is due to the relatively long time that SRS, Hanford, and INEL store their canisters—40 to 45 years at all three sites. These long storage periods are based on the assumption that the national geologic repository accepts 800 canisters/year; therefore, average canister shipping rates to the repository are about 400 canisters/year at Hanford and 200 canisters/year at the other sites. Note that in each of these consolidation alternatives, the canisters are moved from one site to another but the total number of canisters at all sites, hence, the total associated risk, stays approximately the same.

The risk of fatalities from physical hazards follows the same trend as the risk of cancer fatalities; Storage Case 1 risks for the Decentralized, Regionalized, and Centralized Alternatives (1.5 to 1.6) are approximately 2 times higher than the risks for Storage Case 1 of the No Action Alternative (8.1E-01). These higher risks are due to the extended loading and storage periods at Hanford and INEL; this means that more person-hours are devoted to storage activities in these alternatives than in the No Action Alternative. Because more HLW is present at SRS and Hanford, the highest estimated risks of total fatalities are associated with these two sites (see Tables D.3.1-8 through D.3.1-12).

D.3.1.5 Special Assumptions and Considerations Used in the HLW Accident Analysis

This section presents an overview of the types of potential accidents analyzed for the interim storage of immobilized HLW. For this analysis, ANL estimated source terms for the HLW facilities at Hanford and INEL for accidents involving a canister breach due to dropping, collision, or both. These accident source terms are site-specific but do not differ by alternative (i.e., a glass canister breach at a particular site is considered to have the same consequences regardless of the alternative under which the accident occurs). The probability or frequency of HLW accidents is not addressed. Instead, consequences are presented as if each accident occurs once over the course of HLW interim storage. However, this should *not* be construed as indicating the actual probability or frequency of the postulated storage accidents.

Two accident scenarios were evaluated to determine the risks from radiological exposure to the offsite population and MEI, the noninvolved worker population and MEI, and waste management workers. In both, it was assumed that one canister of vitrified HLW is breached inside the storage facility and produces

a cloud of pulverized, radioactive material. One shift of four waste management workers is assumed to be inside the facility when the accident occurs.

When the canister is breached, the contaminants are assumed to disperse in a hemispherical mixing volume with a radius of 5 m. The four waste management workers are 1 m away from the canister when it is breached and walk away at 1 m/s; therefore, the workers are exposed for 4 sec. It is assumed that the workers do not hold their breath while walking away. While immersed in the resulting cloud of contaminated air, the workers are subject to external radiation and to internal radiation exposure by inhalation.

In the first accident, the storage facility's high-efficiency particulate air (HEPA) filtration system is assumed to be fully functional when the canister is breached and only a small amount of the cloud of contaminated air escapes from the building. This material is atmospherically dispersed and presents a risk of internal and external exposure to the offsite and noninvolved worker populations and their respective MEIs.

In the second accident, the storage facility's HEPA filtration system is assumed to be completely disabled when the canister is breached. The entire cloud of contaminated air escapes from the building, is atmospherically dispersed, and presents a risk of internal and external exposure to the offsite and noninvolved worker populations and their respective MEIs.

For the worker exposure assessment, it was assumed that workers are always exposed to unfiltered releases, thus, the same unfiltered source term was used for both accident scenarios. As a result, worker risks are the same for both accident types at a particular site. The methodology and models for estimating worker risks are different from those used to estimate the risks that noninvolved worker and offsite receptors might receive from atmospheric releases (ORNL, 1995b). Because of this, air concentrations are different for workers than for nonworkers; controlling contaminants and exposure routes may also differ.

D.3.1.6 Results Tables for the Risk Analysis of Potential HLW Accidents

Table D.3.1-16 presents a programwide summary of the risks of cancer incidence and cancer fatality to all receptors, by accident type and site. Table D.3.1-17 provides the sizes of the offsite, noninvolved worker, and worker populations for each site. Table D.3.1-18 lists the contaminant contributing the most risk to the total offsite population and the dose contributed by that contaminant.

Table D.3.1–16. Summary of Risks From Potential HLW Accidents, by Accident Type and Site

Accident	Site	Offsite Population		Offsite MEI		Noninvolved Worker Population		Noninvolved Worker MEI		Workers[a]	
		CF	CI	CF	CI	CF	CI	CF	CI	CF	CI
Filtered canister breach	Hanford	6.7E-06	2.3E-05	1.6E-10	5.3E-10	1.5E-07	5.2E-07	1.5E-09	5.1E-09	7.1E-03	2.5E-02
	INEL	1.5E-07	5.2E-07	1.8E-11	6.0E-11	5.6E-09	1.9E-08	3.3E-12	1.1E-11	4.8E-04	1.7E-03
Unfiltered canister breach	Hanford	3.3	1.1E-01	7.8E-05	2.6E-04	7.6E-02	2.6E-01	7.5E-04	2.6E-03	7.1E-03	2.5E-02
	INEL	7.7E-02	2.6E-01	8.9E-06	3.0E-05	2.8E-03	9.5E-03	1.7E-06	5.7E-06	4.8E-04	1.7E-03

Notes: MEI = maximally exposed individual; CF = risk of cancer fatality associated with radiological exposure; CI = risk of cancer incidence associated with radiological exposure.
[a] Worker exposures for a particular site are the same in both accidents.

Table D.3.1–17. Size of Offsite, Noninvolved Worker, and Worker Populations Affected by the Risks From Potential HLW Storage Accidents, by Site

Site	Offsite Population	Noninvolved Worker Population	Worker Population
Hanford	377,645	8,674	4
INEL	153,061	8,451	4

Table D.3.1–18. HLW Radionuclides Contributing the Highest Risk of Cancer Fatality to the Offsite Population, by Accident Type and Site

Accident Type	Radionuclide and Dose, by Site	
	Hanford	INEL
Filtered canister breach	Strontium-90 7.1E-03 person-rem	Cesium-137 1.9E-04 person-rem
Unfiltered canister breach	Strontium-90 3.6E+03 person-rem	Cesium-137 9.4E+01 person-rem

Note: All exposures received via internal exposure (inhalation and ingestion).

D.3.1.7 Summary of the HLW Accident Analysis Results

As expected, the risks to all offsite and noninvolved worker receptors from the accident in which HEPA filtration is lost are markedly higher than the risks from the accident in which filtration is retained. As shown in Table D.3.1–16, estimated cancer incidence and fatalities for both populations and MEIs are 5 to 6 orders of magnitude greater for the unfiltered canister breach than for the filtered accident.

In the filtered canister breach, cancer incidence and fatality risks to all offsite and noninvolved worker MEI receptors are 1 to 5 orders of magnitude below 1.0E–06. In the unfiltered canister breach, cancer incidence and fatality risks exceed 1.0E–04 for the noninvolved worker MEI at Hanford, and are in the E–06 to E–05 range for the offsite and noninvolved worker MEIs at INEL.

In both accident scenarios, strontium–90 contributes most of the offsite population risk at Hanford and cesium-137 is the major contributor at INEL (see Table D.3.1–18). In both circumstances, the predominant exposure route is inhalation.

Worker exposure is the same in both accident scenarios (see Table D.3.1–16). Worker risks do not differ appreciably between the sites, and are highest at Hanford by less than 0.5 order of magnitude. The controlling radionuclides for worker exposure are strontium-90 at INEL and americium-241 at Hanford; inhalation is the principal exposure route.

D.3.2 Low-Level Waste

This section contains the human health risk analysis results for low-level waste (LLW). LLW includes all radionuclide-containing wastes not classified as high-level waste, transuranic waste with an activity greater than 100 nanocuries (billionths of a curie) per gram, spent nuclear fuel, or byproduct material as defined in Section 11e(2) of the Atomic Energy Act of 1954 (such as tailings containing uranium or thorium). Waste designated as LLW contains source, special nuclear, or byproduct material that is acceptable for disposal in a land disposal facility and does not contain hazardous components regulated under the Resource Conservation and Recovery Act (RCRA). LLW that contains hazardous components is classified as low-level mixed waste, which is addressed in Section D.3.5.

DOE generates LLW primarily in research and development, defense activities, uranium enrichment operations, and the naval nuclear propulsion program. About 30 sites within the DOE complex generate LLW, including those listed below:

- Argonne National Laboratory-East (ANL-E), Argonne, Illinois
- Argonne National Laboratory-West (ANL-W), Idaho Falls, Idaho
- Brookhaven National Laboratory (BNL), Brookhaven, New York
- Fernald Environmental Management Project (FEMP), Fernald, Ohio
- Hanford Site (Hanford), Richland, Washington
- Idaho National Engineering Laboratory (INEL), Idaho Falls, Idaho
- Kansas City Plant (KCP), Kansas City, Missouri
- Knolls Atomic Power Laboratory-Kesselring (KAPL-K), Schenectady, New York
- Lawrence Berkeley Laboratory (LBL), Berkeley, California
- Lawrence Livermore National Laboratory (LLNL), Livermore, California
- Los Alamos National Laboratory (LANL), Los Alamos, New Mexico
- Mound Plant (Mound), Miamisburg, Ohio
- Naval Reactors Facility (NRF), Idaho Falls, Idaho
- Nevada Test Site (NTS), Las Vegas, Nevada
- Oak Ridge Institute for Science and Education (ORISE), Oak Ridge, Tennessee
- Oak Ridge Reservation (ORR), Oak Ridge, Tennessee (comprises the Oak Ridge K-25 Site [K-25], the Oak Ridge National Laboratory [ORNL], and the Oak Ridge Y-12 Plant [Y-12])
- Paducah Gaseous Diffusion Plant (PGDP), Paducah, Kentucky
- Pantex Plant (Pantex), Amarillo, Texas
- Pinellas Plant (Pinellas), Largo, Florida
- Portsmouth Gaseous Diffusion Plant (PORTS), Piketon, Ohio
- Rocky Flats Environmental Technology Site (RFETS), Golden, Colorado
- Sandia National Laboratories–New Mexico (SNL-NM), Albuquerque, New Mexico
- Sandia National Laboratory–California (SNL-CA), Livermore, California
- Savannah River Site (SRS), Aiken, South Carolina
- West Valley Demonstration Project (WVDP), West Valley, New York

This list includes the 16 major sites considered for LLW management described in Section 1.6.1 and Chapter 7 of Volume I and presented in Table D.3.2–1.

Table D.3.2-1. PEIS Alternatives for LLW

Alternative	Treat	Dispose	ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
No Action	10[a]	6				TD	TD	D	T	D	TD	T			T		TD	
Dec.		15	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Reg. 1		11			D	D	D	D	D	D	D	D	D	D	D		D	
Reg. 2	11	11			TD	TD	TD	TD	TD	D	TD	TD	TD	TD	TD		TD	
Reg. 3		6				D	D	D		D	D						D	
Reg. 4	7	6				TD	TD	TD		D	TD			T	T		TD	
Reg. 5	4	6				TD	TD	D		D	TD						TD	
Reg. 6		2				D											D	
Reg. 7		2								D							D	
Cen. 1		1				D												
Cen. 2		1								D								
Cen. 3	7	1				TD	T	T			T			T	T		T	
Cen. 4	7	1				T	T	T		D	T			T	T		T	
Cen. 5	1	1				TD												

Notes: T = treatment site. In this context, treatment entails volume reduction using thermal organic destruction, size reduction (shredding, etc.), and compaction followed by solidification. All sites perform minimum treatment in all alternatives; this consists of solidifying liquids and powdered material, packaging, and shipment. D = disposal site. Each of the 6-site disposal alternatives uses the same sites, and each of the 12-site disposal alternatives uses the same 12 sites. Dec. = Decentralized; Reg. = Regionalized; and Cen. = Centralized.

[a] Ten sites use existing facilities for volume reduction. Three sites not listed as major sites above (LBL, RMI, and Mound) include volume reduction facilities.

Note that treatment risks were estimated separately in this section of the WM PEIS for the three sites comprising ORR (e.g., ORNL, Y-12, and K-25) based on the assumption that Y-12 and K-25 perform only the packaging and certification/shipment modules, while ORNL undertakes these plus additional modules such as aqueous treatment, solidification, tumulus disposal, and incineration (where applicable). Disposal risks were calculated for the combined three sites based on the assumption that disposal of LLW from all three sites takes place at one central ORR facility.

Treatment sites were also estimated separately later in this section in Tables D.3.2–20 through D.3.2–32 for several other sites in addition to the 16 major LLW management sites. These sites include KAPL-K, LBL, KCP, Mound, and Pinellas. In Chapter 7 of Volume I, treatment risks for ORNL, ORISE, K-25, and Y-12 have been combined and presented under ORR; ANL-W and NRF have been combined with INEL; and SNL-CA has been combined with LLNL. Treatment risks at the remaining smaller sites are contained in the programwide risk tables presented in this section (Tables D.3.2–7 through D.3.2–19) and in the alternative summary risk tables presented in Section 7.4 of Volume I.

LLW may contain a wide range of radionuclides at activities ranging from trace amounts to thousands of curies. Depending on its chemical and physical properties, LLW can be grouped into waste stream categories according to the type of treatment needed, such as dilute and aqueous wastes; organic wastes; combustible wastes; noncombustible, compactible or noncompactible wastes; surface-contaminated bulk metal or equipment; activated bulk metal or equipment; sludges and resins; and remote-handled LLW (RH–LLW), a high-activity waste requiring special handling.

Currently, Hanford, INEL, LANL, NTS, ORR, and SRS are authorized to dispose of DOE-generated LLW. Low-activity wastes can be disposed of by shallow, engineered land disposal; higher-activity wastes require disposal technologies offering greater confinement.

Chapters 3 and 7 of the PEIS and the LLW technical report (ANL, 1996c) provide more detailed information on this waste, including LLW inventories at DOE sites, estimated release rates, treatment categories used in the PEIS, the process for developing PEIS LLW alternatives, and the various waste consolidation alternatives.

D.3.2.1 Summary of LLW Alternatives

The PEIS waste management alternatives (No Action, Decentralized, Regionalized 1 and 2, and Centralized) and the rationale for developing them are discussed rigorously in the main body of the PEIS. A broad range of alternatives are analyzed for this waste type:

- The No Action Alternative: All sites transport LLW to six sites (Hanford, INEL, LANL, NTS, ORR, and SRS) for disposal under current arrangements. All sites use existing treatment facilities.
- The Decentralized Alternative: Twelve sites dispose of all LLW projected to be generated over the next 20 years. Minimum treatment at each site is assumed.
- The Regionalized Alternatives (seven alternatives): Two, six, or ten sites dispose of all LLW projected to be generated over the next 20 years. In three of these alternatives, treatment to reduce waste volume (by shredding, compaction, and incineration) is performed.
- The Centralized Alternatives (five alternatives): One site (Hanford or NTS) disposes of all LLW projected to be generated over the next 20 years. In three of these alternatives, treatment to reduce volume is performed.

This series of alternatives makes it possible to compare the risks of minimum treatment versus minimum treatment plus volume reduction, the risks of using volume reduction at varying numbers of sites, and the risks associated with various disposal configurations. Table D.3.2–1 depicts the overall treatment and storage schemes for the LLW Alternatives.

D.3.2.2 Special Assumptions and Considerations Used in the LLW Risk Analysis

For all disposal scenarios, it is assumed that shallow land burial will be used at sites west of the Mississippi River and tumulus (above-ground vault) disposal will be used at eastern sites. The exceptions are RFETS, which disposes in tumulus vaults, and SRS, which disposes in below-ground vaults.

Some LLW waste streams will already be disposed of onsite and are not considered in the consolidation alternatives. In particular, grout waste at Hanford and saltstone waste at SRS are not included in the LLW disposal inventories at their respective sites. Disposal of these waste forms is assumed to cause no risk to workers because the waste is piped directly into underground disposal facilities; therefore, worker risks have not been assessed for these situations.

It is assumed that, except in the No Action Alternative, LLW disposal capacity at each site will be expanded as required to meet disposal demands.

In estimating worker radiological risks, it is assumed that management and disposal of the "activated metals" and "remote-handled" categories of LLW require greater shielding for workers than the other categories because these two waste streams emit higher levels of external radiation; a remote shielding scenario was used to estimate worker radiation exposure, as described in ORNL unit risk methodology (ORNL, 1995c).

D.3.2.3 Results Tables for the LLW Human Health Risk Analysis

This section contains tables that summarize the results for the LLW human health risk analysis. A discussion of the results and the remainder of the results tables are presented in Section D.3.2.4. The fatality and cancer incidence numbers in the tables are displayed in the standard exponential notation used in risk assessment; directions on reading this notation and a more complete description of the types of information in the tables are given in Section D.2.

- Table D.3.2–2 presents an overview, by alternative, of the *total*, programwide risks associated with treatment of LLW. Included are the risks of cancer fatalities and cancer incidence for the offsite and noninvolved worker populations; and the risks of cancer fatalities, cancer incidence, and construction and operational fatalities for waste management workers associated with waste treatment. This table provides the estimated *total number* of people in the three populations who will develop or die of cancer caused by exposure to LLW if a particular alternative is implemented nationwide. In addition, it shows the estimated total number of workers who will be killed in construction and operational activities. The results in this table are drawn from Tables D.3.2–7 through D.3.2–19 on the following pages.
- Table D.3.2–3 presents an overview, by alternative, of the programwide risks associated with disposal of LLW. This table summarizes the risks of cancer fatalities and cancer incidence for the maximally exposed lifetime (MEL) of the hypothetical farm family; the total risks to members of all 143 lifetimes of the farm family; and the risks of cancer fatalities, cancer incidence, and construction and operational fatalities for waste management workers associated with waste disposal. The results in this table are drawn from Tables D.3.2–33 through D.3.2–46.
- Table D.3.2–4 shows the sizes of the total affected populations for each alternative.

- Table D.3.2–5 summarizes the risks to the noninvolved worker and offsite MEIs for each LLW alternative. The numbers in this table are the estimated *probabilities* that the offsite and noninvolved worker MEIs will die of cancer or develop cancer from radionuclide exposure. These results are drawn from Tables D.3.2–7 through D.3.2–19 and Tables D.3.2–33 through D.3.2–46.
- Table D.3.2–6 lists the radionuclides that contribute most of the risk of cancer fatality to the offsite population, by site and alternative.
- Tables D.3.2–46 through D.3.2–60 present programwide risks associated with disposal of LLW under each alternative, by site.

Table D.3.2-2. Summary of Programwide Risks Associated With Treatment of LLW: Risks to Total Populations, by Alternative

Alternative	Offsite Population		Noninvolved Worker Population		WM Workers		
	CF	CI	CF	CI	CF	CI	C&OF
No Action	2.0E-03	7.0E-03	6.0E-05	2.0E-04	1.2	4.2	2.5
Minimum Treatment Alternatives							
Decentralized	2.9E-02	9.8E-02	1.9E-04	6.4E-04	8.3E-01	2.9	1.9
Regionalized 1	2.9E-02	9.8E-02	1.9E-04	6.4E-04	8.1E-01	2.8	1.9
Regionalized 3	2.9E-02	9.8E-02	1.9E-04	6.4E-04	8.1E-01	2.8	2.0
Regionalized 6	2.9E-02	9.8E-02	1.9E-04	6.4E-04	8.6E-01	3.0	2.2
Regionalized 7	2.9E-02	9.8E-02	1.9E-04	6.4E-04	8.6E-01	3.0	2.2
Centralized 1	2.9E-02	9.8E-02	1.9E-04	6.4E-04	8.6E-01	3.0	2.2
Centralized 2	2.9E-02	9.8E-02	1.9E-04	6.4E-04	8.6E-01	3.0	2.2
Volume Reduction Alternatives							
Regionalized 2	6.4E-01	2.2	6.6E-03	2.2E-02	1.3	4.5	3.9
Regionalized 4	9.7E-02	3.3E-01	1.9E-03	6.5E-03	1.5	5.0	3.9
Centralized 3	1.0E-01	3.4E-01	2.0E-03	7.0E-03	1.4	5.0	3.9
Centralized 4	1.0E-01	3.4E-01	2.0E-03	7.0E-03	1.4	5.0	3.9
Regionalized 5	3.7E-01	1.3	5.1E-03	1.7E-03	1.7	5.8	3.4
Centralized 5	9.8E-02	3.33E-01	1.1E-03	3.7E-03	2.3	7.7	4.1

Notes: CF = cancer fatality associated with radionuclide exposure; CI = cancer incidence associated with exposure to radionuclides; C&OF = fatalities due to the physical hazards of constructing and operating waste management facilities.

Table D.3.2–3. Summary of Programwide Risks Associated With Disposal of LLW: Risks to Hypothetical Farm Family and Waste Management Workers, by Alternative

Alternative	MEL of Farm Family		All (143) Lifetimes of Farm Family		WM Workers		
	CF	CI	CF	CI	CF	CI	C&OF
No Action	5.7E-03	2.0E-02	7.6E-02	2.6E-01	3.2	11	3.4
Decentralized Disposal							
Decentralized	6.7E-02	2.3E-01	1.3	4.5	2.6	9	5.5
Regionalized Disposal							
Regionalized 1	1.5E-03	5.1E-03	2.2E-02	7.4E-02	2.5	8.6	5.4
Regionalized 2	5.2E-03	1.8E-02	7.2E-02	2.5E-01	2.0	6.9	4.1
Regionalized 3	1.1E-03	3.9E-03	1.6E-02	5.3E-02	2.8	9.6	4.9
Regionalized 4	1.4E-02	4.7E-02	1.9E-01	6.2E-01	2.1	7.4	3.8
Regionalized 5	1.4E-02	4.7E-02	1.9E-01	6.2E-01	2.1	7.4	3.8
Regionalized 6	1.6E-02	5.6E-02	2.2E-01	7.3E-01	1.8	6.2	6.4
Regionalized 7	1.7E-04	5.9E-04	1.8E-04	6.3E-03	1.4	4.9	6.0
Centralized Disposal							
Centralized 1	4.8E-03	1.6E-02	6.4E-02	2.2E-01	2.8	9.7	1.4
Centralized 2	0.00	0.00	0.00	0.00	2.2	7.7	6.1E-01
Centralized 3	9.2E-03	3.1E-02	1.2E-01	4.2E-01	1.8	6.2	8.8E-01
Centralized 4	0.00	0.00	0.00	0.00	1.6	5.5	3.9E-01
Centralized 5	9.2E-03	3.1E-02	1.2E-01	4.2E-01	1.8	6.2	8.8E-01

Notes: CF = risk of cancer fatality associated with exposure to radionuclides; CI = risk of cancer incidence associated with exposure to radionuclides; C&OF = estimated construction and operational fatalities from physical hazards.

Table D.3.2-4. Size of Total Offsite, Noninvolved Worker, and Worker Populations Affected by Risks From Routine Management of LLW, by Alternative

Alternative	Offsite Population	Noninvolved Worker Population	WM Workers
No Action	44,304,014	123,959	17,433
Decentralized	44,304,014	123,959	10,191
Regionalized 1	44,304,014	123,959	10,389
Regionalized 3	44,304,014	123,959	10,737
Regionalized 6	44,304,014	123,959	11,833
Regionalized 7	44,304,014	123,959	12,055
Centralized 1	44,304,014	123,959	11,855
Centralized 2	44,304,014	123,959	12,077
Regionalized 2	47,068,603	126,415	21,443
Regionalized 4	44,304,014	123,959	21,823
Centralized 3	44,304,014	123,959	21,972
Centralized 4	44,304,014	123,959	21,972
Regionalized 5	44,304,014	123,959	19,989
Centralized 5	44,304,014	123,959	20,762

Table D.3.2-5. Summary of Programwide Risks Associated With Treatment of LLW: Risks to the Offsite and Noninvolved Worker Maximally Exposed Individuals, by Alternative

	Offsite MEI		Noninvolved Worker MEI	
Alternative	CF	CI	CF	CI
No Action	2.0E-08	6.9E-08	2.9E-08	9.7E-08
Decentralized	2.9E-07	9.7E-07	4.7E-08	1.6E-07
Regionalized 1	2.9E-07	9.7E-07	4.7E-08	1.6E-07
Regionalized 3	2.9E-07	9.7E-07	4.7E-08	1.6E-07
Regionalized 6	2.9E-07	9.7E-07	4.7E-08	1.6E-07
Regionalized 7	2.9E-07	9.7E-07	4.7E-08	1.6E-07
Centralized 1	2.9E-07	9.7E-07	4.7E-08	1.6E-07
Centralized 2	2.9E-07	9.7E-07	4.7E-08	1.6E-07
Regionalized 2	6.3E-06	2.1E-05	1.8E-06	6.2E-06
Regionalized 4	2.3E-06	7.9E-06	8.5E-07	2.9E-06
Centralized 3	2.3E-06	7.9E-06	6.3E-07	2.0E-06
Centralized 4	2.3E-06	7.9E-06	6.3E-07	2.0E-06
Regionalized 5	9.3E-06	3.2E-05	4.1E-06	1.4E-05
Centralized 5	1.5E-06	5.2E-06	1.7E-06	5.8E-06

Notes: MEI = maximally exposed individual; CF = risk of cancer fatality associated with exposure to radionuclides; CI = risk of cancer incidence associated with exposure to radionuclides.

Table D.3.2-6. Radionuclide Contributing the Highest Risk of Cancer Fatality to the Offsite Population for LLW Treatment, by Alternative and Site

Alt.	Site											
	ANL-E	BNL	FEMP	Hanford	INEL	KCP	KAPL-K	LBL	LLNL	LANL	Mound	
No Action	Pu-238[a] 7.0E-07[b]	Pu-238 6.5E-07		Pu-238 2.3E-07	Co-60 1.3E-06	U-238 5.5E-10	Co-60 5.3E-04	H-3 7.6E-04	U-238 2.4E-07	Pu-238 1.1E-04	Pu-238 4.3E-08	
Dec.	Pu-238 7.6E-07	Pu-238 8.5E-09		Pu-238 1.5E-06	Co-60 7.6E-07	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02	H-3 1.0E-01	Pu-238 1.2E-04	Pu-238 4.7E-08	
Reg. 1	Pu-238 7.6E-07	Pu-238 7.0E-07		Pu-238 1.5E-06	Co-60 7.6E-07	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02	H-3 1.0E-01	Pu-238 1.2E-04	Pu-238 4.7E-08	
Reg. 3	Pu-238 7.6E-07	Pu-238 7.0E-07		Pu-238 1.5E-06	Co-60 7.6E-07	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02	H-3 1.0E-01	Pu-238 1.2E-04	Pu-238 4.7E-08	
Reg. 6	Pu-238 7.6E-07	Pu-238 7.0E-07		Pu-238 1.5E-06	Co-60 1.2E-06	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02	H-3 1.0E-01	Pu-238 1.2E-04	Pu-238 4.7E-08	
Reg. 7	Pu-238 7.6E-07	Pu-238 7.0E-07		Pu-238 2.2E-06	Co-60 1.2E-06	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02	H-3 1.0E-01	Pu-238 1.2E-04	Pu-238 4.7E-08	
Cen. 1	Pu-238 7.6E-07	Pu-238 7.0E-07		Pu-238 1.5E-06	Co-60 1.2E-06	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02	H-3 1.0E-01	Pu-238 1.2E-04	Pu-238 4.7E-08	
Cen. 2	Pu-238 7.6E-07	Pu-238 7.0E-07		Pu-238 2.2E-06	Co-60 1.2E-06	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02	H-3 1.0E-01	Pu-238 1.2E-04	Pu-238 4.7E-08	
Reg. 2	Pu-238 7.6E-07	Pu-238 7.0E-07	H-3 2.0E-01	Pu-238 1.9E-06	Co-60 1.3E-06	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02	H-3 3.8E-01	U-238 1.0E-01	Pu-238 4.7E-08	
Reg. 4	Pu-238 7.6E-07	Pu-238 7.0E-07		H-3 5.0E-02	Co-60 1.3E-06	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02		U-238 1.0E-01	Pu-238 4.7E-08	
Cen. 3 Cen. 4	Pu-238 7.6E-07	Pu-238 7.0E-07		H-3 5.0E-02	Co-60 1.3E-06	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02		U-238 1.0E-01	Pu-238 4.7E-08	
Reg. 5	Pu-238 7.6E-07	Pu-238 7.0E-07		H-3 5.0E-02	U-238 3.4E-04	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02		Pu-238 1.2E-04	Pu-238 4.7E-08	
Cen. 5	Pu-238 7.6E-07	Pu-238 7.0E-07		H-3 7.0E-02	Co-60 7.6E-07	U-238 5.7E-10	Co-60 5.2E-04	H-3 2.0E-02		Pu-238 1.2E-04	Pu-238 4.7E-08	
	NTS	K-25	ORNL	Y-12	PGDP	Pantex	Pinellas	PORTS	RFETS	SNL/NM	SRS	WVDP
No Action	Pu-238 2.4E-12	U-238 5.5E-08	Pu-238 2.7E-06	U-238 1.2E-08	U-238 1.8E-08	H-3 9.0E-07	H-3 1.8E-08	U-238 1.6E-09	Pu-238 4.9E-08	U-238 8.8E-07	H-3 4.1E-04	Pu-238 2.1E-06
Dec.	Pu-238 2.6E-12	U-238 1.3E-07	Pu-238 2.9E-06	U-238 2.5E-08	U-238 2.8E-07	H-3 4.4E-07	H-3 1.8E-08	U-238 2.8E-10	Pu-238 1.4E-07	U-238 8.9E-07	H-3 6.2E-06	Pu-238 7.0E-07
Reg. 1	Pu-238 2.6E-12	U-238 1.3E-07	Pu-238 2.9E-06	U-238 2.5E-08	U-238 2.8E-07	H-3 4.4E-07	H-3 1.8E-08	U-238 2.8E-10	Pu-238 1.4E-07	U-238 9.1E-07	H-3 6.2E-06	Pu-238 1.2E-06
Reg. 3	Pu-238 2.6E-12	U-238 1.3E-07	Pu-238 2.9E-06	U-238 2.5E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	U-238 1.6E-09	Pu-238 1.6E-07	U-238 9.1E-07	H-3 6.2E-06	Pu-238 1.2E-06
Reg. 6	Pu-238 3.0E-12	U-238 3.0E-07	U-238 3.5E-06	U-238 3.7E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	U-238 1.6E-09	Pu-238 1.6E-07	U-238 9.1E-07	H-3 6.2E-06	Pu-238 1.2E-06
Reg. 7	Pu-238 2.6E-12	U-238 3.0E-07	U-238 3.5E-06	U-238 3.7E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	U-238 1.6E-09	Pu-238 1.6E-07	U-238 9.1E-07	H-3 6.2E-06	Pu-238 1.2E-06
Cen. 1	Pu-238 3.0E-12	U-238 3.0E-07	U-238 3.5E-06	U-238 3.7E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	U-238 1.6E-09	Pu-238 1.6E-07	U-238 9.1E-07	H-3 6.2E-06	Pu-238 1.2E-06
Cen. 2	Pu-238 2.6E-12	U-238 3.0E-07	U-238 3.5E-06	U-238 3.7E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	U-238 1.6E-09	Pu-238 1.6E-07	U-238 9.1E-07	H-3 6.2E-06	Pu-238 1.2E-06
Reg. 2	Pu-238 3.0E-12	U-238 5.5E-08	U-238 6.5E-05	U-238 1.3E-08	U-238 1.6E-06	H-3 4.4E-07	H-3 1.8E-08	Co-60 5.8E-05	Pu-238 7.4E-05	U-238 9.1E-07	H-3 4.1E-04	Pu-238 1.2E-06
Reg. 4	Pu-238 3.0E-12	U-238 5.5E-08	U-238 6.5E-05	U-238 1.3E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	H-3 2.0E-01	Pu-238 7.4E-05	U-238 9.1E-07	H-3 4.1E-04	Pu-238 1.2E-06
Cen. 3 Cen. 4	Pu-238 3.0E-12	U-238 7.5E-08	U-238 6.5E-05	U-238 1.6E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	H-3 2.0E-01	Pu-238 7.4E-05	U-238 9.1E-07	H-3 4.1E-04	Pu-238 1.2E-06
Reg. 5	Pu-238 3.0E-12	U-238 5.5E-08	H-3 3.0E-01	U-238 1.3E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	U-238 1.6E-09	Pu-238 1.6E-07	U-238 9.1E-07	H-3 4.1E-04	Pu-238 1.2E-06
Cen. 5	Pu-238 3.0E-12	U-238 3.0E-07	U-238 3.5E-06	U-238 3.7E-08	U-238 1.8E-08	H-3 4.4E-07	H-3 1.8E-08	U-238 1.6E-09	Pu-238 1.6E-07	U-238 9.1E-07	Co-60 5.0E-6	Pu-238 1.2E-06

Notes: Alt. = Alternative; Dec. = Decentralized; Reg. = Regionalized; and Cen. = Centralized.
[a] Radionuclide contributing most risk.
[b] Associated risk of cancer fatality to the offsite population within 80 km (50 mi) of this site.

Table D.3.2-7. Programwide Risks Associated With Treatment of LLW Under the No Action Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	1.0E-01	
	Cancer Fatalities	6.0E-05	
	Cancer incidence	2.0E-04	
	Genetic effects	1.0E-05	
Noninvolved worker MEI	Dose (rem)	5.7E-05	
	Cancer Fatalities	2.9E-08	
	Cancer incidence	9.7E-08	
	Genetic effects	5.7E-09	
	Hazard index		
Offsite population	Dose (person-rem)	5.0E+00	
	Cancer Fatalities	2.0E-03	
	Cancer incidence	7.0E-03	
	Genetic effects	5.0E-04	
Offsite MEI	Dose (rem)	4.1E-05	
	Cancer Fatalities	2.0E-08	
	Cancer incidence	6.9E-08	
	Genetic effects	4.1E-09	
	Hazard index		
WM workers	Dose (FTE-rem)	2.9E+03	
	Cancer Fatalities	1.2E+00	
	Cancer incidence	4.2	
	Genetic effects	1.8E-01	
	Exposure index		
	Construction fatalities		8.2E-01
	Construction injuries		3.3E+02
	Operation fatalities		1.7
	Operation injuries		1.3E+03

Table D.3.2–8. Programwide Risks Associated With Treatment of LLW Under the Decentralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	3.7E–01	
	Cancer fatalities	1.9E–04	
	Cancer incidence	6.4E–04	
	Genetic effects	3.7E–05	
Noninvolved worker MEI	Dose (rem)	9.5E–05	
	Cancer fatalities	4.7E–08	
	Cancer incidence	1.6E–07	
	Genetic effects	9.5E–09	
	Hazard index		
Offsite population	Dose (person-rem)	5.8E+01	
	Cancer fatalities	2.9E–02	
	Cancer incidence	9.8E–02	
	Genetic effects	5.8E–03	
Offsite MEI	Dose (rem)	5.7E–04	
	Cancer fatalities	2.9E–07	
	Cancer incidence	9.7E–07	
	Genetic effects	5.7E–08	
	Hazard index		
WM workers	Dose (FTE-rem)	2.1E+03	
	Cancer fatalities	8.3E–01	
	Cancer incidence	2.9	
	Genetic effects	1.2E–01	
	Exposure index		
	Construction fatalities		9.2E–01
	Construction injuries		3.7E+02
	Operation fatalities		9.9E–01
	Operation injuries		7.6E+02

Table D.3.2-9. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 1, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	3.7E-01	
	Cancer fatalities	1.9E-04	
	Cancer incidence	6.4E-04	
	Genetic effects	3.7E-05	
Noninvolved worker MEI	Dose (rem)	9.4E-05	
	Cancer fatalities	4.7E-08	
	Cancer incidence	1.6E-07	
	Genetic effects	9.4E-09	
	Hazard index		
Offsite population	Dose (person-rem)	5.8E+01	
	Cancer fatalities	2.9E-02	
	Cancer incidence	9.8E-02	
	Genetic effects	5.8E-03	
Offsite MEI	Dose (rem)	5.7E-04	
	Cancer fatalities	2.9E-07	
	Cancer incidence	9.7E-07	
	Genetic effects	5.7E-08	
	Hazard index		
WM workers	Dose (FTE-rem)	2.0E+03	
	Cancer fatalities	8.1E-01	
	Cancer incidence	2.8	
	Genetic effects	1.2E-01	
	Exposure index		
	Construction fatalities		9.3E-01
	Construction injuries		3.8E+02
	Operation fatalities		1.0
	Operation injuries		7.6E+02

Table D.3.2-10. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 3, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	3.7E-01	
	Cancer fatalities	1.9E-04	
	Cancer incidence	6.4E-04	
	Genetic effects	3.7E-05	
Noninvolved worker MEI	Dose (rem)	9.4E-05	
	Cancer fatalities	4.7E-08	
	Cancer incidence	1.6E-07	
	Genetic effects	9.4E-09	
	Hazard index		
Offsite population	Dose (person-rem)	5.8E+01	
	Cancer fatalities	2.9E-02	
	Cancer incidence	9.8E-02	
	Genetic effects	5.8E-03	
Offsite MEI	Dose (rem)	5.7E-04	
	Cancer fatalities	2.9E-07	
	Cancer incidence	9.7E-07	
	Genetic effects	5.7E-08	
	Hazard index		
WM workers	Dose (FTE-rem)	2.0E+03	
	Cancer fatalities	8.1E-01	
	Cancer incidence	2.8	
	Genetic effects	1.2E-01	
	Exposure index		
	Construction fatalities		9.4E-01
	Construction injuries		3.9E+02
	Operation fatalities		1.1
	Operation injuries		8.4E+02

Table D.3.2–11. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 6, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	3.7E–01	
	Cancer fatalities	1.9E–04	
	Cancer incidence	6.4E–04	
	Genetic effects	3.7E–05	
Noninvolved worker MEI	Dose (rem)	9.5E–05	
	Cancer fatalities	4.7E–08	
	Cancer incidence	1.6E–07	
	Genetic effects	9.5E–09	
	Hazard index		
Offsite population	Dose (person-rem)	5.8E+01	
	Cancer fatalities	2.9E–02	
	Cancer incidence	9.8E–02	
	Genetic effects	5.8E–03	
Offsite MEI	Dose (rem)	5.7E–04	
	Cancer fatalities	2.9E–07	
	Cancer incidence	9.7E–07	
	Genetic effects	5.7E–08	
	Hazard index		
WM workers	Dose (FTE-rem)	2.1E+03	
	Cancer fatalities	8.6E–01	
	Cancer incidence	3.0	
	Genetic effects	1.3E–01	
	Exposure index		
	Construction fatalities		1.1
	Construction injuries		4.3E+02
	Operation fatalities		1.1
	Operation injuries		8.8E+02

Table D.3.2-12. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 7, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	3.7E-01	
	Cancer fatalities	1.9E-04	
	Cancer incidence	6.4E-04	
	Genetic effects	3.7E-05	
Noninvolved worker MEI	Dose (rem)	9.5E-05	
	Cancer fatalities	4.7E-08	
	Cancer incidence	1.6E-07	
	Genetic effects	9.5E-09	
	Hazard index		
Offsite population	Dose (person-rem)	5.8E+01	
	Cancer fatalities	2.9E-02	
	Cancer incidence	9.8E-02	
	Genetic effects	5.8E-03	
Offsite MEI	Dose (rem)	5.7E-04	
	Cancer fatalities	2.9E-07	
	Cancer incidence	9.7E-07	
	Genetic effects	5.7E-08	
	Hazard index		
WM workers	Dose (FTE-rem)	2.1E+03	
	Cancer fatalities	8.6E-01	
	Cancer incidence	3.0	
	Genetic effects	1.3E-01	
	Exposure index		
	Construction fatalities		1.1
	Construction injuries		4.5E+02
	Operation fatalities		1.1
	Operation injuries		8.8E+02

Table D.3.2-13. Programwide Risks Associated With Treatment of LLW Under the Centralized Alternative 1, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	3.7E-01	
	Cancer fatalities	1.9E-04	
	Cancer incidence	6.4E-04	
	Genetic effects	3.7E-05	
Noninvolved worker MEI	Dose (rem)	9.5E-05	
	Cancer fatalities	4.7E-08	
	Cancer incidence	1.6E-07	
	Genetic effects	9.5E-09	
	Hazard index		
Offsite population	Dose (person-rem)	5.8E+01	
	Cancer fatalities	2.9E-02	
	Cancer incidence	9.8E-02	
	Genetic effects	5.8E-03	
Offsite MEI	Dose (rem)	5.7E-04	
	Cancer fatalities	2.9E-07	
	Cancer incidence	9.7E-07	
	Genetic effects	5.7E-08	
	Hazard index		
WM workers	Dose (FTE-rem)	2.1E+03	
	Cancer fatalities	8.6E-01	
	Cancer incidence	3	
	Genetic effects	1.3E-01	
	Exposure index		
	Construction fatalities		1.1
	Construction injuries		4.3E+02
	Operation fatalities		1.1
	Operation injuries		8.8E+02

Table D.3.2-14. Programwide Risks Associated With Treatment of LLW Under Centralized Alternative 2, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	3.7E-01	
	Cancer fatalities	1.9E-04	
	Cancer incidence	6.4E-04	
	Genetic effects	3.7E-05	
Noninvolved worker MEI	Dose (rem)	9.5-05	
	Cancer fatalities	4.7E-08	
	Cancer incidence	1.6E-07	
	Genetic effects	9.5E-09	
	Hazard index		
Offsite population	Dose (person-rem)	5.8E+01	
	Cancer fatalities	2.9E-02	
	Cancer incidence	9.8E-02	
	Genetic effects	5.8E-03	
Offsite MEI	Dose (rem)	5.7E-04	
	Cancer fatalities	2.9E-07	
	Cancer incidence	9.7E-07	
	Genetic effects	5.7E-08	
	Hazard index		
WM workers	Dose (FTE-rem)	2.1E+03	
	Cancer fatalities	8.6E-01	
	Cancer incidence	3.0	
	Genetic effects	1.3E-01	
	Exposure index		
	Construction fatalities		1.1
	Construction injuries		4.5E+02
	Operation fatalities		1.1
	Operation injuries		8.8E+02

Table D.3.2-15. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 2, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	1.3E+01	
	Cancer fatalities	6.6E-03	
	Cancer incidence	2.2E-02	
	Genetic effects	1.3E-03	
Noninvolved worker MEI	Dose (rem)	3.6E-03	
	Cancer fatalities	1.8E-06	
	Cancer incidence	6.2E-06	
	Genetic effects	3.6E-07	
	Hazard index		
Offsite population	Dose (person-rem)	1.3E+03	
	Cancer fatalities	6.4E-01	
	Cancer incidence	2.2	
	Genetic effects	1.3E-01	
Offsite MEI	Dose (rem)	1.3E-02	
	Cancer fatalities	6.3E-06	
	Cancer incidence	2.1E-05	
	Genetic effects	1.3E-06	
	Hazard index		
WM workers	Dose (FTE-rem)	3.2E+03	
	Cancer fatalities	1.3	
	Cancer incidence	4.5	
	Genetic effects	2.0E-01	
	Exposure index		
	Construction fatalities		1.8
	Construction injuries		7.3E+02
	Operation fatalities		2.1
	Operation injuries		1.6E+03

Table D.3.2-16. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 4, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	3.8	
	Cancer fatalities	1.9E-03	
	Cancer incidence	6.5E-03	
	Genetic effects	3.8E-04	
Noninvolved worker MEI	Dose (rem)	1.7E-03	
	Cancer fatalities	8.5E-07	
	Cancer incidence	2.9E-06	
	Genetic effects	1.7E-07	
	Hazard index		
Offsite population	Dose (person-rem)	2.0E+02	
	Cancer fatalities	9.7E-02	
	Cancer incidence	3.3E-01	
	Genetic effects	2.0E-02	
Offsite MEI	Dose (rem)	4.6E-03	
	Cancer fatalities	2.3E-06	
	Cancer incidence	7.9E-06	
	Genetic effects	4.6E-07	
	Hazard index		
WM workers	Dose (FTE-rem)	3.6E+03	
	Cancer fatalities	1.5	
	Cancer incidence	5.0	
	Genetic effects	2.1E-01	
	Exposure index		
	Construction fatalities		1.8
	Construction injuries		7.5E+02
	Operation fatalities		2.1
	Operation injuries		1.6E+03

Table D.3.2–17. Programwide Risks Associated With Treatment of LLW Under Centralized Alternatives 3 and 4, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	4.1	
	Cancer fatalities	2.0E–03	
	Cancer incidence	7.0E–03	
	Genetic effects	4.1E–04	
Noninvolved worker MEI	Dose (rem)	1.2E–03	
	Cancer fatalities	6.3E–07	
	Cancer incidence	2.0E–06	
	Genetic effects	1.2E–07	
	Hazard index		
Offsite population	Dose (person-rem)	2.0E+02	
	Cancer fatalities	1.0E–01	
	Cancer incidence	3.4E–01	
	Genetic effects	2.0E–02	
Offsite MEI	Dose (rem)	4.6E–03	
	Cancer fatalities	2.3E–06	
	Cancer incidence	7.9E–06	
	Genetic effects	4.6E–07	
	Hazard index		
WM workers	Dose (FTE-rem)	3.6E+03	
	Cancer fatalities	1.4	
	Cancer incidence	5.0	
	Genetic effects	2.2E–01	
	Exposure index		
	Construction fatalities		1.8
	Construction injuries		7.5E+02
	Operation fatalities		2.1
	Operation injuries		1.6E+03

Table D.3.2-18. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 5, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	1.0E+01	
	Cancer fatalities	5.1E-03	
	Cancer incidence	1.7E-02	
	Genetic effects	1.0E-03	
Noninvolved worker MEI	Dose (rem)	8.3E-03	
	Cancer fatalities	4.1E-06	
	Cancer incidence	1.4E-05	
	Genetic effects	8.3E-07	
	Hazard index		
Offsite population	Dose (person-rem)	7.5E+02	
	Cancer fatalities	3.7E-01	
	Cancer incidence	1.3	
	Genetic effects	7.5E-02	
Offsite MEI	Dose (rem)	1.9E-02	
	Cancer fatalities	9.3E-06	
	Cancer incidence	3.2E-05	
	Genetic effects	1.9E-06	
	Hazard index		
WM workers	Dose (FTE-rem)	4.2E+03	
	Cancer fatalities	1.7	
	Cancer incidence	5.8	
	Genetic effects	2.5E-01	
	Exposure index		
	Construction fatalities		1.6
	Construction injuries		6.3E+02
	Operation fatalities		1.8
	Operation injuries		1.3E+03

Table D.3.2-19. Programwide Risks Associated With Treatment of LLW Under Centralized Alternative 5, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Noninvolved worker population	Dose (person-rem)	2.2	
	Cancer fatalities	1.1E-03	
	Cancer incidence	3.7E-03	
	Genetic effects	2.2E-04	
Noninvolved worker MEI	Dose (rem)	3.4E-03	
	Cancer fatalities	1.7E-06	
	Cancer incidence	5.8E-06	
	Genetic effects	3.4E-07	
	Hazard index		
Offsite population	Dose (person-rem)	2.0E+02	
	Cancer fatalities	9.8E-02	
	Cancer incidence	3.3E-01	
	Genetic effects	2.0E-02	
Offsite MEI	Dose (rem)	3.1E-03	
	Cancer fatalities	1.5E-06	
	Cancer incidence	5.2E-06	
	Genetic effects	3.1E-07	
	Hazard index		
WM workers	Dose (FTE-rem)	5.5E+03	
	Cancer fatalities	2.3	
	Cancer incidence	7.7	
	Genetic effects	3.2E-01	
	Exposure index		
	Construction fatalities		1.9
	Construction injuries		8.0E+02
	Operation fatalities		2.2
	Operation injuries		1.8E+03

Table D.3.2-20. Programwide Risks Associated With Treatment of LLW Under the No Action Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
INEL	153,061 2,169	1.4E-06	1.7E-10	6.1E-01	4.7E-06	5.8E-10	8.7E-01
Hanford	377,645 997	4.2E-07	8.6E-12	3.2E-01	1.4E-06	2.9E-11	5.4E-01
KAPL-K	1,290,172 925	5.3E-04	1.2E-08	1.7E-01	1.8E-03	4.0E-08	1.8E-02
LBL	5,856,829 236	7.6E-04	1.2E-08	5.1E-02	2.6E-03	4.1E-08	2.9E-02
LANL	159,152 920	1.9E-04	2.0E-08	3.3E-01	6.6E-04	6.9E-08	6.2E-01
NTS	14,266 78	1.3E-12	3.3E-16	5.4E-03	4.5E-12	1.1E-15	1.3E-03
ORNL	881,652 893	4.6E-06	1.4E-10	1.9E-01	1.6E-05	4.9E-10	3.9E-01
SNL-NM	610,714 277	1.7E-06	6.8E-11	5.1E-02	5.8E-06	2.3E-10	1.8E-03
SRS	620,618 3,032	5.9E-04	5.6E-09	8.5E-01	2.0E-03	1.9E-08	1.2
KCP	1,729,833 13	1.0E-09	4.6E-14	2.4E-03	3.4E-09	1.6E-13	1.3E-04
LLNL	6,324,234 426	3.5E-07	5.8E-12	7.0E-02	1.2E-06	2.0E-11	4.1E-03
Mound	3,032,983 710	9.4E-08	5.5E-12	1.4E-01	3.2E-07	1.9E-11	7.2E-03
K-25	871,406 1,278	5.8E-08	1.3E-12	8.0E-02	2.0E-07	4.3E-12	2.3E-02
Y-12	895,379 724	1.3E-08	4.9E-13	5.7E-02	4.5E-08	1.7E-12	9.7E-03
PGDP	500,502 654	2.0E-08	2.3E-12	1.2E-01	6.9E-08	7.6E-12	7.8E-03
Pantex	265,185 333	8.8E-07	7.5E-11	3.0E-02	3.0E-06	2.5E-10	3.4E-03
Pinellas	2,532,174 26	1.8E-08	3.8E-13	4.7E-03	6.0E-08	1.3E-12	2.4E-04
PORTS	639,602 1,450	1.7E-09	2.1E-13	2.5E-01	5.7E-09	7.2E-13	2.0E-02
RFETS	2,171,877 656	1.2E-07	1.7E-12	1.2E-01	4.1E-07	5.6E-12	6.5E-03
ANL-E	7,939,785 402	2.3E-06	1.3E-11	1.1E-01	8.0E-06	4.4E-11	1.5E-01
BNL	5,738,554 695	2.2E-06	2.9E-11	1.1E-01	7.4E-06	9.9E-11	2.1E-01
WVDP	1,698,391 539	3.5E-06	5.3E-11	5.7E-02	1.2E-05	1.8E-10	6.5E-02
Total		2.0E-03	2.0E-08	3.7	7.0E-03	6.9E-08	4.2

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-21. Programwide Risks Associated With Treatment of LLW Under the Decentralized Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
Hanford	377,645 577	2.7E-06	5.5E-11	2.2E-01	9.1E-06	1.9E-10	3.5E-01
INEL	153,061 677	8.0E-07	9.9E-11	3.2E-01	2.7E-06	3.4E-10	5.8E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LLNL	6,324,234 191	1.0E-02	1.6E-07	5.0E-02	3.4E-02	5.5E-07	8.9E-03
LANL	159,152 653	2.1E-04	2.2E-08	2.8E-01	7.1E-04	7.5E-08	4.9E-01
ORNL	881,652 347	5.0E-06	1.56E-10	1.09E-01	1.71E-05	5.31E-10	2.13E-01
SNL-NM	610,714 187	1.8E-06	7.1E-11	6.5E-02	6.1E-06	2.4E-10	7.6E-02
SRS	620,618 1,986	1.9E-05	1.7E-10	6.6E-01	6.3E-05	5.9E-10	7.9E-01
BNL	5,738,554 273	9.66E-09	1.29E-13	5.8E-02	3.28E-08	4.38E-13	1.27E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,042	1.33E-07	2.9E-12	9.0E-02	4.53E-07	9.97E-12	1.87E-02
Y-12	895,379 503	2.6E-08	9.7E-13	5.4E-02	8.9E-08	3.3E-12	7.1E-03
PGDP	500,502 501	3.2E-07	3.6E-11	1.1E-01	1.1E-06	1.2E-10	5.2E-03
Pantex	265,185 214	4.38E-07	3.73E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
PORTS	639,602 730	2.4E-10	3.1E-14	1.5E-01	8.3E-10	1.1E-13	1.6E-02
RFETS	2,171,877 298	3.6E-07	4.9E-12	7.1E-02	1.2E-06	1.7E-11	4.0E-03
NTS	14,266 64	1.43E-12	3.62E-16	6.5E-03	4.86E-12	1.23E-15	1.03E-03
WVDP	1,698,391 433	1.24E-06	1.86E-11	6.2E-02	4.2E-06	6.3E-11	4.5E-02
Total		2.9E-02	2.9E-07	2.7	9.9E-02	9.7E-07	2.9

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-22. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 1, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 577	2.7E-06	5.5E-11	2.2E-01	9.1E-06	1.9E-10	3.5E-01
INEL	153,061 677	8.0E-07	9.9E-11	3.2E-01	2.7E-06	3.4E-10	5.8E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LLNL	6,324,234 191	1.0E-02	1.6E-07	5.0E-02	3.4E-02	5.5E-07	8.9E-03
LANL	159,152 653	2.1E-04	2.2E-08	2.8E-01	7.1E-04	7.5E-08	4.9E-01
ORNL	881,652 347	5.0E-06	1.6E-10	1.1E-01	1.7E-05	5.3E-10	2.1E-01
PORTS	639,602 730	2.4E-10	3.1E-14	1.5E-01	8.3E-10	1.1E-13	1.6E-02
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 1,986	1.9E-05	1.7E-10	6.6E-01	6.3E-05	5.9E-10	7.9E-01
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,042	1.3E-07	2.9E-12	9.0E-02	4.5E-07	1.0E-11	1.9E-02
Y-12	895,379 503	2.6E-08	9.7E-13	5.4E-02	8.9E-08	3.3E-12	7.1E-03
PGDP	500,502 501	3.2E-07	3.6E-11	1.1E-01	1.1E-06	1.2E-10	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
RFETS	2,171,877 298	3.6E-07	4.9E-12	7.1E-02	1.2E-06	1.7E-11	4.0E-03
NTS	14,266 64	1.4E-12	3.6E-16	6.5E-03	4.9E-12	1.2E-15	1.0E-03
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.0E-10	1.4E-01
WVDP	1,698,391 464	2.1E-06	3.1E-11	6.6E-02	7.0E-06	1.0E-10	4.5E-02
Total		2.9E-02	2.9E-07	2.8	9.8E-02	9.7E-07	2.8

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-23. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 3, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 577	2.7E-06	5.5E-11	2.2E-01	9.1E-06	1.9E-10	3.5E-01
INEL	153,061 677	8.0E-07	9.9E-11	3.2E-01	2.7E-06	3.4E-10	5.8E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 653	2.1E-04	2.2E-08	2.8E-01	7.1E-04	7.5E-08	4.9E-01
NTS	14,266 0	0.00	0.00	0.00	0.00	0.00	0.00
ORNL	881,652 266	5.0E-06	1.6E-10	8.9E-02	1.7E-05	5.3E-10	2.1E-01
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 1,986	1.9E-05	1.7E-10	6.6E-01	6.3E-05	5.9E-10	7.9E-01
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
LLNL	6,324,234 227	1.0E-02	1.6E-07	5.9E-02	3.4E-02	5.5E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,042	1.3E-07	2.9E-12	9.0E-02	4.5E-07	1.0E-11	1.9E-02
Y-12	895,379 503	2.6E-08	9.7E-13	5.4E-02	8.9E-08	3.3E-12	7.1E-03
PGDP	500,502 503	2.1E-08	9.7E-13	5.4E-02	8.9E-08	3.3E-12	7.1E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
PORTS	639,602 1,075	1.8E-09	2.2E-13	2.3E-01	6.0E-09	7.5E-13	1.6E-02
RFETS	2,171,877 344	4.0E-07	5.4E-12	8.1E-02	1.4E-06	1.8E-11	4.0E-03
NTS	14,266 64	1.4E-12	3.6E-16	6.4E-03	4.9E-12	1.2E-15	1.0E-03
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9-06	1.0E-10	1.4E-01
WVDP	1,698,391 464	2.1E-06	3.1E-11	6.6E-02	7.0E-06	1.0E-10	4.5E-02
Total		2.9E-02	2.9E-07	2.8	9.8E-02	9.7E-07	2.8

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-24. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 6, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 577	2.7E-06	5.5E-11	2.2E-01	9.1E-06	1.9E-10	3.5E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 902	2.1E-04	2.2E-08	3.3E-01	7.1E-04	7.5E-08	4.9E-01
ORNL	881,652 382	1.2E-05	3.5E-10	1.2E-01	3.9E-05	1.2E-09	2.5E-01
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 1,986	1.9E-05	1.7E-10	6.6E-01	6.3E-05	5.9E-10	7.9E-01
INEL	153,061 1,032	1.3E-06	1.6E-10	4.3E-01	4.4E-06	5.4E-10	7.2E-01
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
LLNL	6,324,234 227	1.0E-02	1.6E-07	5.9E-02	3.4E-02	5.5E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,259	3.2E-07	7.0E-12	1.2E-01	1.1E-06	2.4E-11	1.9E-02
Y-12	895,379 618	4.0E-08	1.5E-12	6.7E-02	1.4E-07	5.0E-12	7.1E-03
PGDP	500,502 503	2.1E-08	2.3E-12	1.1E-01	7.1E-08	8.0E-12	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
PORTS	639,602 1,075	1.8E-09	2.2E-13	2.3E-01	6.0E-09	7.5E-13	1.6E-02
RFETS	2,171,877 344	4.0E-07	5.4E-12	8.1E-02	1.4E-06	1.8E-11	4.0E-03
NTS	14,266 108	1.6E-12	4.1E-16	1.3E-02	5.5E-12	1.4E-15	1.0E-03
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.0E-10	1.4E-01
WVDP	1,698,391 464	2.1E-06	3.1E-11	6.6E-02	7.0E-06	1.0E-10	4.5E-02
Total		2.9E-02	2.9E-07	3.1	9.8E-02	9.7E-07	3.0

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-25. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 7, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 843	4.2E-06	8.5E-11	2.9E-01	1.4E-05	2.9E-10	3.6E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 902	2.1E-04	2.2E-08	3.3E-01	7.1E-04	7.5E-08	4.9E-01
NTS	14,266 64	1.4E-12	3.6E-16	6.5E-03	4.9E-12	1.2E-15	1.0E-03
ORNL	881,652 382	1.2E-05	3.5E-10	1.2E-01	3.9E-05	1.2E-09	2.5E-01
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 1,986	1.9E-05	1.7E-10	6.6E-01	6.3E-05	5.9E-10	7.9E-01
INEL	153,061 1,032	1.3E-06	1.6E-10	4.3E-01	4.4E-06	5.4E-10	7.2E-01
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
LLNL	6,324,234 227	1.0E-02	1.6E-07	5.9E-02	3.4E-02	5.5E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,259	3.2E-07	7.0E-12	1.2E-01	1.1E-06	2.4E-11	1.9E-02
Y-12	895,379 618	4.0E-08	1.5E-12	6.7E-02	1.4E-07	5.0E-12	7.10E-03
PGDP	500,502 503	2.1E-08	2.3E-12	1.1E-01	7.1E-08	8.0E-12	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
PORTS	639,602 1,075	1.8E-09	2.2E-13	2.3E-01	6.0E-09	7.5E-13	1.6E-02
RFETS	2,171,877 344	4.0E-07	5.4E-12	8.1E-02	1.4E-06	1.8E-11	4.0E-03
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.0E-10	1.40E-01
WVDP	1,698,391 464	2.1E-06	3.1E-11	6.6E-02	7.0E-06	1.0E-10	4.5E-02
Total		2.9E-02	2.9E-07	3.1	9.8E-02	9.7E-07	3.0

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-26. Programwide Risks Associated With Treatment of LLW Under Centralized Alternative 1, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 577	2.7E-06	5.5E-11	2.2E-01	9.1E-06	1.9E-10	3.5E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 902	2.1E-04	2.2E-08	3.3E-01	7.1E-04	7.5E-08	4.9E-01
ORNL	881,652 382	1.2E-05	3.5E-10	1.2E-01	3.9E-05	1.2E-09	2.5E-01
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 2,008	1.9E-05	1.8E-10	6.7E-01	6.3E-05	5.9E-10	8.0E-01
INEL	153,061 1,032	1.3E-06	1.6E-10	4.3E-01	4.4E-06	5.4E-10	7.2E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
LLNL	6,324,234 227	1.0E-02	1.6E-07	5.9E-02	3.4E-02	5.5E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,259	3.2E-07	7.0E-12	1.2E-01	1.1E-06	2.4E-11	1.9E-02
Y-12	895,379 618	4.0E-08	1.5E-12	6.7E-02	1.4E-07	5.0E-12	7.10E-03
PGDP	500,502 503	2.1E-08	2.3E-12	1.1E-01	7.1E-08	8.0E-12	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
PORTS	639,602 1,075	1.8E-09	2.2E-13	2.3E-01	6.0E-09	7.5E-13	1.6E-02
RFETS	2,171,877 344	4.0E-07	5.4E-12	8.1E-02	1.4E-06	1.8E-11	4.0E-03
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.1E-10	1.4E-01
WVDP	1,698,391 464	2.1E-06	3.1E-11	6.6E-02	7.0E-06	1.0E-10	4.5E-02
NTS	14,266 108	1.6E-12	4.1E-16	1.3E-02	5.5E-12	1.4E-15	1.0E-03
Total		2.9E-02	2.9E-07	3.1	9.8E-02	9.7E-07	3.0

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-27. Programwide Risks Associated With Treatment of LLW Under Centralized Alternative 2, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 843	4.2E-06	8.5E-11	2.9E-01	1.4E-05	2.9E-10	3.6E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 902	2.1E-04	2.2E-08	3.3E-01	7.1E-04	7.5E-08	4.9E-01
NTS	14,266 64	1.4E-12	3.6E-16	6.5E-03	4.9E-12	1.2E-15	1.0E-03
ORNL	881,652 382	1.2E-05	3.5E-10	1.2E-01	3.9E-05	1.2E-09	2.5E-01
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 2,008	1.9E-05	1.8E-10	6.7E-01	6.3E-05	5.9E-10	8.0E-01
INEL	153,061 1,032	1.3E-06	1.6E-10	4.3E-01	4.4E-06	5.4E-10	7.2E-01
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
LLNL	6,324,234 227	1.0E-02	1.6E-07	5.9E-02	3.4E-02	5.5E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,259	3.2E-07	7.0E-12	1.2E-01	1.1E-06	2.4E-11	1.9E-02
Y-12	895,379 618	4.0E-08	1.5E-12	6.7E-02	1.4E-07	5.0E-12	7.1E-03
PGDP	500,502 503	2.1E-08	2.3E-12	1.1E-01	7.1E-08	8.0E-12	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
PORTS	639,602 1,075	1.8E-09	2.2E-13	2.3E-01	6.0E-09	7.5E-13	1.6E-02
RFETS	2,171,877 344	4.0E-07	5.4E-12	8.1E-02	1.4E-06	1.8E-11	4.0E-03
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.1E-10	1.4E-01
WVDP	1,698,391 464	2.1E-06	3.1E-11	6.6E-02	7.0E-06	1.0E-10	4.5E-02
Total		2.9E-02	2.9E-07	3.1	9.8E-02	9.7E-07	3.0

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-28. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 2, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Fernald	2,764,589 461	2.3E-01	4.4E-06	1.2E-01	7.9E-01	1.5E-05	2.3E-02
Hanford	377,645 1,569	3.6E-06	7.3E-11	5.2E-01	1.2E-05	2.5E-10	6.9E-01
INEL	153,061 1,809	1.4E-06	1.7E-10	5.4E-01	4.6E-06	5.7E-10	5.8E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LLNL	6,324,234 483	3.9E-01	6.3E-06	1.5E-01	1.3	2.1E-05	1.7E-01
LANL	159,152 1,362	7.8E-03	8.2E-07	4.9E-01	2.7E-02	2.8E-06	6.5E-01
ORNL	881,652 3,660	8.2E-05	2.5E-09	6.9E-01	2.8E-04	8.5E-09	1.1
PORTS	639,602 3,434	5.3E-05	6.6E-09	7.4E-01	1.8E-04	2.2E-08	9.6E-02
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 2,598	6.1E-04	5.7E-09	8.3E-01	2.1E-03	2.0E-08	9.6E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
RFETS	2,171,877 800	1.9E-04	2.5E-09	2.2E-01	6.3E-04	8.6E-09	4.0E-03
K-25	871,406 1,040	6.1E-08	1.3E-12	8.9E-02	2.1E-07	4.5E-12	1.9E-02
Y-12	895,379 498	1.4E-08	5.1E-13	5.4E-02	4.7E-08	1.7E-12	7.1E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
Pantex	265,185 216	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
PGDP	500,502 800	1.9E-06	2.1E-10	1.9E-01	6.4E-06	7.1E-10	5.8E-03
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.1E-10	1.4E-01
WVDP	1,698,391 463	2.1E-06	3.1E-11	6.6E-02	7.2E-06	1.1E-10	4.5E-02
NTS	14,266 108	1.6E-12	4.1E-16	1.3E-02	5.5E-12	1.4E-5	1.0E-03
Total		6.4E-01	6.3E-06	5.2	2.2	2.1E-05	4.6

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-29. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 4, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 1,634	4.7E-02	9.6E-07	5.4E-01	1.6E-01	3.3E-06	7.2E-01
INEL	153,061 1,809	1.4E-06	1.7E-10	5.4E-01	4.6E-06	5.7E-10	5.8E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 2,731	7.8E-03	8.2E-07	9.3E-01	2.7E-02	2.8E-06	1.2
ORNL	881,652 3,579	8.2E-05	2.5E-09	6.7E-01	2.8E-04	8.5E-09	1.1
PORTS	639,602 3,483	1.9E-02	2.3E-06	7.6E-01	6.4E-02	7.9E-06	1.3E-01
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 2,598	6.1E-04	5.7E-09	8.3E-01	2.1E-03	2.0E-08	9.6E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
LLNL	6,324,234 227	4.4E-03	7.1E-08	5.9E-02	1.5E-02	2.4E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
NTS	14,266 108	1.6E-12	4.1E-16	1.3E-02	5.5E-12	1.4E-15	1.0E-03
K-25	871,406 1,040	6.1E-08	1.3E-12	8.9E-02	2.1E-07	4.5E-12	1.9E-02
Y-12	895,379 498	1.4E-08	5.1E-13	5.4E-02	4.7E-08	1.7E-12	7.1E-03
PGDP	500,502 497	2.1E-08	2.4E-12	1.1E-01	7.2E-08	8.0E-12	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
RFETS	2,171,877 800	1.9E-04	2.5E-09	2.2E-01	6.3E-04	8.6E-09	4.0E-03

Table D.3.2-29. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 4, by Site—Continued

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.1E-10	1.4E-01
WVDP	1,698,391 463	2.1E-06	3.1E-11	6.6E-02	7.2E-06	1.1E-10	4.5E-02
Total		9.7E-02	2.3E-06	5.4	3.3E-01	7.9E-06	5.1

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-30. Programwide Risks Associated With Treatment of LLW Under Centralized Alternatives 3 and 4, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 1,634	5.0E-02	1.0E-06	5.4E-01	1.7E-01	3.5E-06	7.2E-01
INEL	153,061 1,809	1.4E-06	1.7E-10	5.4E-01	4.6E-06	5.7E-10	5.8E-01
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 2,731	7.8E-03	8.2E-07	9.3E-01	2.7E-02	2.8E-06	1.2
NTS	14,266 108	1.6E-12	4.1E-16	1.3E-02	5.5E-12	1.4E-15	1.0E-03
ORNL	881,652 3,695	8.9E-05	2.7E-09	7.1E-01	3.0E-04	9.2E-09	1.1
PORTS	639,602 3,481	1.9E-02	2.3E-06	7.6E-01	6.4E-02	7.9E-06	1.3E-01
SNL-NM	610,714 232	1.8E-06	7.2E-11	7.7E-02	6.2E-06	2.4E-10	7.6E-02
SRS	620,618 2,598	6.1E-04	5.7E-09	8.3E-01	2.1E-03	2.0E-08	9.6E-01
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
LLNL	6,324,234 227	4.4E-03	7.1E-08	5.9E-02	1.5E-02	2.4E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,044	8.2E-08	1.8E-12	9.0E-02	2.8E-07	6.1E-12	1.9E-02
Y-12	895,379 507	1.7E-08	6.3E-13	5.5E-02	5.8E-08	2.2E-12	7.1E-03
PGDP	500,502 497	2.1E-08	2.4E-12	1.1E-01	7.2E-08	8.0E-12	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04

Table D.3.2-30. Programwide Risks Associated With Treatment of LLW Under Centralized Alternatives 3 and 4, by Site—Continued

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
RFETS	2,171,877 800	1.9E-04	2.5E-09	2.2E-01	6.3E-04	8.6E-09	4.0E-03
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.E-10	1.4E-01
WVDP	1,698,391 463	2.1E-06	3.1E-11	6.6E-02	7.2E-06	1.E-10	4.5E-02
Total		1.0E-01	2.3E-06	5.4	3.4E-01	7.9E-06	5.1

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-31. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 5, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 1,634	4.7E-02	9.6E-07	5.4E-01	1.6E-01	3.3E-06	7.2E-01
INEL	153,061 3,954	4.1E-04	5.1E-08	1.3	1.4E-03	1.7E-07	1.9
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 902	2.1E-04	2.2E-08	3.3E-01	7.1E-04	7.5E-08	4.9E-01
ORNL	881,652 4,281	3.0E-01	9.3E-06	8.5E-01	1.0	3.2E-05	1.5
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 2,598	6.1E-04	5.7E-09	8.3E-01	2.1E-03	2.0E-08	9.6E-01
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
LLNL	6,324,234 227	4.4E-03	7.1E-08	5.9E-02	1.5E-02	2.4E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
NTS	14,266 108	1.6E-12	4.1E-16	1.3E-02	5.5E-12	1.4E-15	1.0E-03
K-25	871,406 1,040	6.1E-08	1.3E-12	8.9E-02	2.1E-07	4.5E-12	1.9E-02
Y-12	895,379 498	1.4E-08	5.1E-13	5.4E-02	4.7E-08	1.7E-12	7.1E-03
PGDP	500,502 497	2.1E-08	2.4E-12	1.1E-01	7.2E-08	8.0E-12	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
PORTS	639,602 1,087	1.8E-09	2.2E-13	2.4E-01	5.9E-09	7.5E-13	1.6E-02

Table D.3.2–31. Programwide Risks Associated With Treatment of LLW Under Regionalized Alternative 5, by Site—Continued

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
RFETS	2,171,877 344	4.0E–07	5.4E–12	8.1E–02	1.4E–06	1.8E–11	4.0E–03
BNL	5,738,554 417	2.3E–06	3.1E–11	8.3E–02	7.9E–06	1.1E–10	1.4E–01
WVDP	1,698,391 463	2.1E–06	3.1E–11	6.6E–02	7.2E–06	1.1E–10	4.5E–10
Total		3.7E–01	9.3E–06	5.1	1.2	3.2E–05	5.9

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2–32. Programwide Risks Associated With Treatment of LLW Under Centralized Alternative 5, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 9,856	7.5E-02	1.5E-06	3.7	2.5E-01	5.2E-06	5.3
KAPL-K	1,290,172 650	5.3E-04	1.2E-08	1.5E-01	1.8E-03	4.0E-08	2.0E-02
LBL	5,856,829 174	1.8E-02	2.9E-07	5.1E-02	6.2E-02	9.7E-07	2.7E-02
LANL	159,152 902	2.1E-04	2.2E-08	3.3E-01	7.1E-04	7.5E-08	4.9E-01
SNL-NM	610,714 210	1.8E-06	7.2E-11	5.1E-02	6.2E-06	2.4E-10	1.5E-03
SRS	620,618 1,986	1.2E-05	1.2E-10	6.6E-01	4.2E-05	3.9E-10	7.9E-01
INEL	153,061 677	8.0E-07	9.9E-11	3.2E-01	2.7E-06	3.4E-10	5.8E-01
ORNL	881,652 382	1.2E-05	3.5E-10	1.2E-01	3.9E-05	1.2E-09	2.5E-01
KCP	1,729,833 11	1.1E-09	4.8E-14	2.6E-03	3.6E-09	1.6E-13	1.0E-04
ANL-E	7,939,785 224	2.5E-06	1.4E-11	8.3E-02	8.5E-06	4.7E-11	1.1E-01
LLNL	6,324,234 227	4.4E-03	7.1E-08	5.9E-02	1.5E-02	2.4E-07	8.9E-03
Mound	3,032,983 435	1.0E-07	5.9E-12	1.1E-01	3.5E-07	2.0E-11	4.7E-03
K-25	871,406 1,259	3.2E-07	7.0E-12	1.2E-01	1.1E-06	2.4E-11	1.9E-02
Y-12	895,379 618	4.0E-08	1.5E-12	6.7E-02	1.4E-07	5.0E-12	7.1E-03
PGDP	500,502 497	2.1E-08	2.4E-12	1.1E-01	7.2E-08	8.0E-12	5.2E-03
Pantex	265,185 214	4.4E-07	3.7E-11	2.6E-02	1.5E-06	1.3E-10	2.7E-03
Pinellas	2,532,174 21	1.8E-08	3.8E-13	5.1E-03	6.0E-08	1.3E-12	2.0E-04
PORTS	639,602 1,087	1.8E-09	2.2E-13	2.4E-01	5.9E-09	7.5E-13	1.6E-02

Table D.3.2-32. Programwide Risks Associated With Treatment of LLW Under Centralized Alternative 5, by Site—Continued

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
RFETS	2,171,877 344	4.0E-07	5.4E-12	8.1E-02	1.4E-06	1.8E-11	4.0E-03
BNL	5,738,554 417	2.3E-06	3.1E-11	8.3E-02	7.9E-06	1.1E-10	1.4E-01
WVDP	1,698,391 463	2.1E-06	3.1E-11	6.6E-02	7.2E-06	1.1E-10	4.5E-02
NTS	14,266 108	1.6E-12	4.1E-16	1.3E-02	5.5E-12	1.4E-15	1.0E-03
Total		9.8E-02	1.5E-06	6.4	3.3E-01	5.2E-06	7.8

[a] Top number represents the offsite population within an 80-km of the site, while the bottom number represents the total FTEs for WM workers involved in construction and operation activities.
[b] Includes worker fatalities associated with radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-33. Programwide Risks Associated With Disposal of LLW Under the No Action Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)		
	Cancer fatalities	1.2E+01	
	Cancer incidence	5.7E-03	
	Genetic effects	2.0E-02	
	Hazard index	1.2E-03	
All lifetimes	Dose (person-rem)		
	Cancer fatalities	1.5E+02	
	Cancer incidence	7.6E-02	
	Genetic effects	2.6E-01	
	Hazard index	1.5E-02	
WM workers	Dose (FTE-rem)	8.0E+03	
	Cancer fatalities	3.2	
	Cancer incidence	1.1E+01	
	Genetic effects	4.9E-01	
	Exposure index		
	Construction fatalities		1.6
	Construction injuries		7.0E+02
	Operation fatalities		1.8
	Operation injuries		1.4E+02

Table D.3.2-34. Programwide Risks Associated With Disposal of LLW Under the Decentralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	1.3E+02	
	Cancer fatalities	6.7E-02	
	Cancer incidence	2.3E-01	
	Genetic effects	1.3E-02	
	Hazard index		
All lifetimes	Dose (person-rem)	2.6E+03	
	Cancer fatalities	1.3	
	Cancer incidence	4.5	
	Genetic effects	2.6E-01	
	Hazard index		
WM workers	Dose (FTE-rem)	6.5E+03	
	Cancer fatalities	2.6	
	Cancer incidence	9.0	
	Genetic effects	3.9E-01	
	Exposure index		
	Construction fatalities		3.9
	Construction injuries		1.6E+03
	Operation fatalities		1.6
	Operation injuries		1.3E+03

Table D.3.2-35. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 1, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	3.0	
	Cancer fatalities	1.5E-03	
	Cancer incidence	5.1E-03	
	Genetic effects	3.0E-04	
	Hazard index		
All lifetimes	Dose (person-rem)	4.4E+01	
	Cancer fatalities	2.2E-02	
	Cancer incidence	7.4E-02	
	Genetic effects	4.4E-03	
	Hazard index		
WM workers	Dose (FTE-rem)	6.1E+03	
	Cancer fatalities	2.5	
	Cancer incidence	8.6	
	Genetic effects	3.6	
	Exposure index		
	Construction fatalities		3.8
	Construction injuries		1.6E+03
	Operation fatalities		1.6
	Operation injuries		1.3E+03

Table D.3.2-36. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 3, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	2.3	
	Cancer fatalities	1.1E-03	
	Cancer incidence	3.9E-03	
	Genetic effects	2.3E-04	
	Hazard index		
All lifetimes	Dose (person-rem)	3.1E+01	
	Cancer fatalities	1.6E-02	
	Cancer incidence	5.3E-02	
	Genetic effects	3.1E-03	
	Hazard index		
WM workers	Dose (FTE-rem)	6.9E+03	
	Cancer fatalities	2.8	
	Cancer incidence	9.6	
	Genetic effects	4.1E-01	
	Exposure index		
	Construction fatalities		3.5
	Construction injuries		1.5E+03
	Operation fatalities		1.4
	Operation injuries		1.0E+03

Table D.3.2-37. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 6, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	3.3E+01	
	Cancer fatalities	1.6E-02	
	Cancer incidence	5.6E-02	
	Genetic effects	3.3E-03	
	Hazard index		
All lifetimes	Dose (person-rem)	4.3E+02	
	Cancer fatalities	2.2E-01	
	Cancer incidence	7.3E-01	
	Genetic effects	4.3E-02	
	Hazard index		
WM workers	Dose (FTE-rem)	4.4E+03	
	Cancer fatalities	1.8	
	Cancer incidence	6.2	
	Genetic effects	2.6E-01	
	Exposure index		
	Construction fatalities		5.1
	Construction injuries		2.2E+03
	Operation fatalities		1.3
	Operation injuries		1.1E+03

Table D.3.2-38. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 7, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	3.4E-01	
	Cancer fatalities	1.7E-04	
	Cancer incidence	5.9E-04	
	Genetic effects	3.4E-05	
	Hazard index		
All lifetimes	Dose (person-rem)	3.7	
	Cancer fatalities	1.8E-03	
	Cancer incidence	6.3E-03	
	Genetic effects	3.7E-04	
	Hazard index		
WM workers	Dose (FTE-rem)	3.5E+03	
	Cancer fatalities	1.4	
	Cancer incidence	4.9	
	Genetic effects	2.1E-01	
	Exposure index		
	Construction fatalities		4.9
	Construction injuries		2.2E+03
	Operation fatalities		1.1
	Operation injuries		7.8E+02

Table D.3.2–39. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 1, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	9.6	
	Cancer fatalities	4.8E–03	
	Cancer incidence	1.6E–02	
	Genetic effects	9.6E–04	
	Hazard index		
All lifetimes	Dose (person-rem)	1.3E+02	
	Cancer fatalities	6.4E–02	
	Cancer incidence	2.2E–01	
	Genetic effects	1.3E–02	
	Hazard index		
WM workers	Dose (FTE-rem)	6.9E+03	
	Cancer fatalities	2.8	
	Cancer incidence	9.7	
	Genetic effects	4.2E–01	
	Exposure index		
	Construction fatalities		4.0E–01
	Construction injuries		1.7E+02
	Operation fatalities		9.6E–01
	Operation injuries		8.1E+02

Table D.3.2–40. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 2, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	0.0	
	Cancer fatalities	0.0	
	Cancer incidence	0.0	
	Genetic effects	0.0	
	Hazard index		
All lifetimes	Dose (person-rem)	0.0	
	Cancer fatalities	0.0	
	Cancer incidence	0.0	
	Genetic effects	0.0	
	Hazard index		
WM workers	Dose (FTE-rem)	5.5E+03	
	Cancer fatalities	2.2	
	Cancer incidence	7.7	
	Genetic effects	3.3E–01	
	Exposure index		
	Construction fatalities		1.7E–01
	Construction injuries		4.7E–01
	Operation fatalities		4.4E–01
	Operation injuries		1.1E+02

Table D.3.2-41. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 2, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	1.0E+01	
	Cancer fatalities	5.2E-03	
	Cancer incidence	1.8E-02	
	Genetic effects	1.0E-03	
	Hazard index		
All lifetimes	Dose (person-rem)	1.5E+02	
	Cancer fatalities	7.2E-02	
	Cancer incidence	2.5E-01	
	Genetic effects	1.5E-02	
	Hazard index		
WM workers	Dose (FTE-rem)	4.9E+03	
	Cancer fatalities	2.0	
	Cancer incidence	6.9	
	Genetic effects	3.0E-01	
	Exposure index		
	Construction fatalities		3.0
	Construction injuries		1.3E+03
	Operation fatalities		1.1
	Operation injuries		9.1E+02

Table D.3.2-42. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 4, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	2.7E+01	
	Cancer fatalities	1.4E-02	
	Cancer incidence	4.7E-02	
	Genetic effects	2.7E-03	
	Hazard index		
All lifetimes	Dose (person-rem)	3.6E+02	
	Cancer fatalities	1.9E-01	
	Cancer incidence	6.2E-01	
	Genetic effects	3.6E-02	
	Hazard index		
WM workers	Dose (FTE-rem)	5.3E+03	
	Cancer fatalities	2.1	
	Cancer incidence	7.4	
	Genetic effects	3.2E-01	
	Exposure index		
	Construction fatalities		2.8
	Construction injuries		1.2E+03
	Operation fatalities		9.8E-01
	Operation injuries		7.4E+02

Table D.3.2–43. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 3, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	1.8E+01	
	Cancer fatalities	9.2E-03	
	Cancer incidence	3.1E-02	
	Genetic effects	1.8E-03	
	Hazard index		
All lifetimes	Dose (person-rem)	2.5E+02	
	Cancer fatalities	1.2E-01	
	Cancer incidence	4.2E-01	
	Genetic effects	2.5E-02	
	Hazard index		
WM workers	Dose (FTE-rem)	4.4E+03	
	Cancer fatalities	1.8	
	Cancer incidence	6.2	
	Genetic effects	2.7E-01	
	Exposure index		
	Construction fatalities		2.5E-01
	Construction injuries		1.1E+02
	Operation fatalities		6.3E-01
	Operation injuries		5.4E+02

Table D.3.2–44. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 4, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	0.0	
	Cancer fatalities	0.0	
	Cancer incidence	0.0	
	Genetic effects	0.0	
	Hazard index		
All lifetimes	Dose (person-rem)	0.0	
	Cancer fatalities	0.0	
	Cancer incidence	0.0	
	Genetic effects	0.0	
	Hazard index		
WM workers	Dose (FTE-rem)	3.9E+03	
	Cancer fatalities	1.6	
	Cancer incidence	5.5	
	Genetic effects	2.3E-01	
	Exposure index		
	Construction fatalities		1.0E-01
	Construction injuries		2.9E+01
	Operation fatalities		2.9E-01
	Operation injuries		7.4E+01

Table D.3.2-45. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 5, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	2.7E+01	
	Cancer fatalities	1.4E-02	
	Cancer incidence	4.7E-02	
	Genetic effects	2.7E-03	
	Hazard index		
All lifetimes	Dose (person-rem)	3.6E+02	
	Cancer fatalities	1.8E-01	
	Cancer incidence	6.3E-01	
	Genetic effects	3.6E-02	
	Hazard index		
WM workers	Dose (FTE-rem)	5.3E+03	
	Cancer fatalities	2.1	
	Cancer incidence	7.4	
	Genetic effects	3.2E-01	
	Exposure index		
	Construction fatalities		2.8
	Construction injuries		1.2E+03
	Operation fatalities		9.8E-01
	Operation injuries		7.5E+02

Table D.3.2-46. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 5, by Health Endpoint

Receptor	Endpoint	Radionuclides	Physical Hazards
Maximally exposed farm family	Dose (person-rem)	1.8E+01	
	Cancer fatalities	9.2E-03	
	Cancer incidence	3.1E-02	
	Genetic effects	1.8E-03	
	Hazard index		
All lifetimes	Dose (person-rem)	2.5E+02	
	Cancer fatalities	1.2E-01	
	Cancer incidence	4.2E-01	
	Genetic effects	2.5E-02	
	Hazard index		
WM workers	Dose (FTE-rem)	4.4E+03	
	Cancer fatalities	1.8	
	Cancer incidence	6.2	
	Genetic effects	2.6E-01	
	Exposure index		
	Construction fatalities		2.5E-01
	Construction injuries		1.1E+02
	Operation fatalities		6.3E-01
	Operation injuries		5.3E+02

Table D.3.2-47. Programwide Risks Associated With Disposal of LLW Under the No Action Alternative, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
LANL (0)	0.00	0.00	1.2	0.00	0.00	2.9
NTS (0)	0.00	0.00	2.1E-01	0.00	0.00	5.7E-02
SRS (153)	1.5E-04	2.2E-03	2.8	5.0E-04	7.3E-03	2.5
ORR (22)	8.9E-07	1.3E-05	4.9E-01	3.0E-06	4.4E-06	1.2
Hanford (18)	5.6E-03	8.0E-02	1.1	1.9E-02	2.7E-01	2.3
INEL (0)	0.00	0.00	8.5E-01	0.00	0.00	2.2
Total	5.7E-03	7.6E-02	6.6	2.0E-02	2.6E-01	1.1E+01

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-48. Programwide Risks Associated With Disposal of LLW Under the Decentralized Alternative, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
INEL (0)	0.00	0.00	6.6E-01	0.00	0.00	1.5
LLNL (142)	4.4E-06	6.8E-05	2.3E-01	1.5E-05	2.3E-04	5.6E-01
LANL (0)	0.00	0.00	8.8E-01	0.00	0.00	2.0
ORR (22)	7.3E-07	1.1E-05	5.4E-01	2.5E-06	3.6E-05	1.1
SNL-NM (15)	6.3E-02	1.1	9.5E-02	2.1E-01	3.9	2.2E-01
PGDP (42)	3.7E-04	6.1E-03	1.5E-01	1.3E-03	2.1E-02	1.1E-02
Pantex (0)	0.00	0.00	2.1E-02	0.00	0.00	2.0E-03
RFETS (38)	1.1E-07	2.1E-06	1.4E-01	3.7E-07	7.0E-06	9.9E-03
SRS (153)	1.1E-04	1.7E-03	4.1	3.8E-04	5.6E-03	2.0
PORTS (37)	2.4E-07	4.5E-06	4.4E-01	8.2E-07	1.5E-05	4.6E-02
ANL-E (64)	1.1E-04	5.1E-03	1.1E-01	3.9E-04	1.7E-02	1.5E-01
Hanford (18)	1.0E-03	1.4E-02	5.6E-01	3.4E-03	4.7E-02	1.3
NTS (0)	0.00	0.00	1.4E-02	0.00	0.00	1.5E-03
WVDP (90)	5.3E-04	3.8E-02	9.3E-02	1.8E-03	1.3E-01	8.7E-02
BNL (78)	1.8E-03	1.1E-01	6.0E-02	6.3E-03	3.8E-01	1.3E-01
Total	6.5E-02	1.2	8.0	2.2E-01	4.1	9.0

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-49. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 1, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	1.0E-03	1.4E-02	5.6E-01	3.4E-03	4.7E-02	1.3
INEL (0)	0.00	0.00	6.6E-01	0.00	0.00	1.5
LLNL (142)	4.4E-06	6.8E-05	2.3E-01	1.5E-05	2.3E-04	5.6E-01
LANL (0)	0.00	0.00	8.9E-01	0.00	0.00	2.0
ORR (22)	7.3E-07	1.1E-05	5.4E-01	2.5E-06	3.6E-05	1.1
PORTS (145)	2.0E-06	7.7E-05	5.2E-01	6.9E-06	2.6E-04	1.1E-01
PGDP (42)	3.7E-04	6.1E-03	1.5E-01	1.3E-03	2.1E-02	1.1E-02
Pantex (0)	5.8E-10	4.9E-09	3.9E-03	2.0E-09	1.7E-08	6.6E-04
SRS (153)	1.2E-04	1.8E-03	4.1	4.1E-04	6.0E-03	2.0
RFETS (38)	1.1E-07	2.1E-06	1.4E-01	3.7E-07	7.0E-06	9.9E-03
NTS (0)	0.0	0.0	1.4E-02	0.0	0.0	1.5E-03
Total	1.5E-03	2.2E-02	7.8	5.1E-03	7.4E-02	8.6

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-50. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 3, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	1.0E-03	1.4E-02	5.6E-01	3.4E-03	4.7E-02	1.3
INEL (0)	0.00	0.00	6.6E-01	0.00	0.00	1.5
LANL (0)	0.00	0.00	1.2	0.00	0.00	2.7
NTS (0)	0.00	0.00	8.0E-02	0.00	0.00	1.3E-01
ORR (22)	5.0E-07	7.2E-06	9.5E-01	1.7E-06	2.5E-05	1.9E+00
SRS (153)	1.2E-04	1.8E-03	4.1	4.1E-04	6.0E-03	2.0
Total	1.1E-03	1.6E-02	7.6	3.9E-03	5.3E-02	9.6

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-51. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 6, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	1.6E-02	2.2E-01	1.8	5.5E-02	7.3E-01	4.0
SRS (23)	1.7E-04	1.9E-03	6.4	5.9E-04	6.6E-03	2.1
Total	1.6E-02	2.2E-01	8.2	5.6E-02	7.4E-01	6.2

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-52. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 7, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
NTS (0)	0.00	0.00	1.1	0.00	0.00	2.8
SRS (23)	1.7E-04	1.9E-03	6.4	5.9E-04	6.3E-03	2.1
Total	1.7E-04	1.9E-03	7.5	5.9E-04	6.3E-03	4.9

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-53. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 1, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	4.8E-03	6.4E-02	4.1	1.6E-02	2.2E-01	9.7
Total	4.8E-03	6.4E-02	4.1	1.6E-02	2.2E-01	9.7

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-54. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 2, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
NTS (0)	0.00	0.00	2.8	0.00	0.00	7.7
Total	0.00	0.00	2.8	0.00	0.00	7.7

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-55. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 2, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	4.5E-03	6.2E-02	4.3E-01	1.5E-02	2.1E-01	1.1
INEL (0)	0.00	0.00	4.9E-01	0.00	0.00	1.2
LLNL (142)	4.4E-06	6.8E-05	1.9E-01	1.5E-05	2.3E-04	4.7E-01
LANL (0)	0.00	0.00	5.3E-01	0.00	0.00	1.3
ORR (22)	1.6E-06	2.3E-05	3.5E-01	5.3E-06	7.7E-05	7.4E-01
PORTS (145)	3.5E-06	1.3E-04	3.2E-01	1.2E-05	4.5E-04	9.3E-02
PGDP (42)	5.0E-04	8.1E-03	1.3E-01	1.7E-03	2.8E-02	9.7E-03
Pantex (0)	0.00	0.00	2.1E-02	0.00	0.00	2.0E-03
SRS (153)	1.4E-04	2.1E-03	3.5	4.9E-04	7.2E-03	2.0
RFETS (38)	3.2E-07	6.2E-06	6.8E-02	1.1E-06	2.1E-05	5.6E-03
NTS (0)	0.0	0.0	3.8E-03	0.0	0.0	4.0E-04
Total	5.2E-03	7.2E-02	6.1	1.8E-02	2.5E-01	6.9

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-56. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 4, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
LANL (0	0.00	0.00	5.7E-01	0.00	0.00	1.4
ORR (22)	7.4E-07	1.1E-05	7.7E-01	2.5E-06	3.6E-05	1.7
NTS (0)	0.00	0.00	2.2E-02	0.00	0.00	2.7E-02
SRS (153)	1.4E-04	2.1E-03	3.5	4.9E-04	7.2E-03	2.0
INEL (0)	0.00	0.00	5.2E-01	0.00	0.00	1.3
Hanford (18)	1.4E-02	1.8E-01	4.3E-01	4.6E-02	6.1E-01	1.1
Total	1.4E-02	1.9E-01	5.9	4.7E-02	6.2E-01	7.5

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-57. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 3, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	9.2E-03	1.2E-01	2.7	3.1E-02	4.2E-01	6.2
Total	9.2E-03	1.2E-01	2.7	3.1E-02	4.2E-01	6.2

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2–58. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 4, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
NTS (0)	0.00	0.00	2.0	0.00	0.00	5.5
Total	0.00	0.00	2.0	0.00	0.00	5.5

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2–59. Programwide Risks Associated With Disposal of LLW Under Regionalized Alternative 5, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	1.4E–02	1.8E–01	4.3E–01	4.6E–02	6.1E–01	1.1
LANL (0)	0.00	0.00	5.9E–01	0.00	0.00	1.4
ORR (22)	7.4E–07	1.1E–05	7.7E–01	2.5E–06	3.6E–05	1.7
NTS (0)	0.00	0.00	2.2E–02	0.00	0.00	2.7E–02
SRS (153)	1.4E–04	2.1E–03	3.5	4.9E–04	7.2E–03	2.0
INEL (0)	0.00	0.00	4.9E–01	0.00	0.00	1.2
Total	1.4E–02	1.8E–01	5.9	4.7E–02	6.2E–01	7.5

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

Table D.3.2-60. Programwide Risks Associated With Disposal of LLW Under Centralized Alternative 5, by Site

Site (Lifetime)	Fatalities[a]			Cancer Incidence[b]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	9.2E-03	1.2E-01	2.6	3.1E-02	4.2E-01	6.2
Total	9.2E-03	1.2E-01	2.6	3.1E-02	4.2E-01	6.2

[a] Includes cancer fatalities associated with radiation exposure for farm family and fatality associated with radiation exposure and physical hazards for workers.
[b] Indicates cancer incidence associated with radiation exposure.

D.3.2.4 Results of the LLW Human Health Risk Analysis for Routine Operations

D.3.2.4.1 *Programwide Trends in Human Health Risks Associated With LLW Management Alternatives*

In general, No Action presents the lowest health risks for all public populations and for all health risk endpoints. For the offsite population the risks of cancer fatality due to the treatment of LLW are within 2.5 orders of magnitude for all alternatives (2.0E-03 to 6.4E-01). Risks to the noninvolved worker population and to MEIs follow the same general trend. Regionalized Alternative 2 (regionalized volume reduction at 11 installations) produces the highest risk of cancer fatalities, though it is still within an order of magnitude of all the other alternatives. The health risks tend to increase as the level of treatment increases and where a treatment installation is situated in a highly populated area.

Overall, estimated worker health risks associated with management of LLW are similar among alternatives; however, the highest worker risks tend to be for installations with waste consolidation (i.e., larger waste loads) for treatment and for installations with more treatment facility construction.

Estimated impacts to each of the receptor populations are presented below.

Offsite Population. The lowest risks of cancer fatality to the offsite population are from the No Action Alternative (2.0E-03), the Decentralized Alternative, Regionalized Alternatives 1, 3, 6, 7, and Centralized Alternatives 1 and 2. All are in the E-02 order of magnitude and affect a total population of 44 million people. Except for the No Action Alternative, all of these installations perform minimum treatment (although some volume reduction is performed in the No Action Alternative); the only variation is in the various disposal configurations. The risks of cancer fatality associated with Regionalized Alternatives 4 and 5 and Centralized Alternatives 3, 4, and 5 are similar to one another (ranging from 9.7E-02 to 3.7E-01 over a total affected population of approximately 44 million) and are about 0.5 to 2 orders of magnitude higher than for the other alternatives.

Regionalized 2 poses the highest risks to the offsite population by approximately 0.5 orders of magnitude (an estimated 6.4E-01 cancer fatalities over 47 million people). This is because the largest combined population (11 sites totaling about 14.8 million people) is affected by volume reduction (which includes

incineration). The highest installation-specific risks are associated with LLNL (an estimated 3.9E-01 cancer fatalities over a population of approximately 6.3 million); the radionuclide contributing the most risk is tritium, via inhalation and ingestion. The lowest risks to an offsite population at a particular installation are at NTS for all alternatives.

Inspection of Table D.3.2-6 shows that for all alternatives in which incineration is the major volume-reduction treatment (Regionalized 2, 4, and 5, and Centralized 3, 4, and 5), cancer fatality risks in the E-01 order of magnitude are attributable to tritium except in Regionalized 4, and Centralized 3 and 4. In these three alternatives, both tritium and uranium-238 contribute cancer fatality risks on the order of E-01.

Noninvolved Worker Population. The trends in programwide health risks to the noninvolved worker population are similar to those observed for the offsite population; both the programwide risks and the total affected population are lower by approximately 2 orders of magnitude.

The estimated risk of cancer fatality to the noninvolved worker population in Regionalized 2 (6.6E-03 cancer fatalities in a population of 126,415) are about three to six times higher than in the other volume reduction alternatives. The smallest risk of cancer fatality (6.0E-05) occurs in the No Action Alternative.

The risks in the Decentralized, Regionalized 1, 3, 6, 7, and Centralized 1 and 2 Alternatives are identical to one another (1.9E-04) because the treatment is the same at all sites. The risks to the noninvolved worker population are 1 to 1.5 orders of magnitude higher in Regionalized 4, and 5 and Centralized 3, 4, and 5 than in the minimum treatment alternatives.

Maximally Exposed Noninvolved Workers and Maximally Exposed Offsite Individuals. Radiological exposure risks to the noninvolved worker and offsite MEIs are lowest in the No Action Alternative; the Decentralized, Regionalized 1, 3, 6, 7, and Centralized 1 and 2 Alternatives are higher by 2 to 3 orders of magnitude. Another order of magnitude higher occurs in Regionalized 4 and Centralized 3, 4, and 5. The highest radiological exposure risks to the noninvolved worker and offsite MEIs occur in Regionalized 2 and 5.

The programwide risk of cancer incidence for both MEIs is in the E-05 to E-07 range in Regionalized 2, 4, and 5 and Centralized 3, 4, and 5 (see Table D.3.2-5). Across the program, the highest risk of cancer fatality for both MEIs is in Regionalized 5 (an estimated risk of 9.3E-06 for the offsite MEI and 4.1E-06

for the noninvolved worker MEI). At the installation level, the highest risks of cancer fatality to the offsite MEI are at FEMP (4.4E-06) and LLNL (6.3E-06) in Regionalized 2; PORTS (2.3E-06) in Regionalized 4; Hanford (1.0E-06) and PORTS (2.3E-06) in Centralized 3 and 4; ORNL (9.3E-06) in Regionalized 5; and Hanford (1.5E-06) in Centralized 5. These elevated risks are the result of volume reduction (including incineration) of relatively large volumes of volatile waste containing tritium. All cancer fatality risks to both MEIs for minimum treatment alternatives are below E-06.

Workers. The programwide estimated risks of cancer fatality to workers vary by no more than a factor of three across all alternatives. The risks for the minimum treatment alternatives (Decentralized, Regionalized 1, 3, 6, and 7 and Centralized 1 and 2) are nearly identical to one another (approximately 8.3E-01 cancer fatalities across 10,191 to 12,077 FTEs), and are slightly higher in the No Action Alternative and volume reduction alternatives Regionalized 2, 4, and 5, and Centralized 3 and 4). The highest programwide cancer fatality risk is incurred in Centralized Alternative 5 (2.3 over a total population of 20,762 FTEs), in which all waste is treated by volume reduction at Hanford.

Estimated construction fatality risks for workers are lowest in the No Action Alternative (8.2E-01), in which no new treatment facilities are to be built. New facilities will be required at several installations in the volume reduction alternatives (Regionalized 2, 4, and 5, and Centralized 3, 4, and 5); however, the risks in these alternatives are higher than in the remaining alternatives by only a factor of two. Estimated operational fatalities are slightly higher (by about a factor of two or less) for the No Action Alternative (1.7) and the volume reduction alternatives (1.8 to 2.1) than for the minimum treatment alternatives (1.0 to 1.1). This is because more worker person-hours are required for the 20-year No Action treatment period and for the more extensive treatment in the volume reduction alternatives.

Although worker risks are very similar across alternatives, some differences in installation risks are notable. The estimated total fatalities (cancer fatalities plus construction and operational fatalities) in the No Action and minimum treatment alternatives are consistently very similar among installations (E-02 to E-01 range) except at KCP, NTS, and Pinellas (E-03 order of magnitude), which have much smaller waste loads to treat and employ fewer workers (11 to 13, 21 to 26, 64 to 108 FTES, respectively) than are needed at other installations.

By a slight margin, LANL and SRS pose the highest total worker fatality risks in the Regionalized 2, 4, and 5, and Centralized 3 and 4 volume reduction alternatives (total fatalities range from 8.3E-01 to

9.3E-01); however, the risks among installations in these alternatives are within approximately 1 order of magnitude except at KCP and Pinellas, at which worker fatality risks are 1 to 2 orders of magnitude lower in all alternatives. The slight elevation in risks at LANL and SRS in the volume-reduction alternatives reflects consolidation of waste loads at these installations for treatment, additional construction of treatment facilities, and the presence of a large number of FTEs at ORNL in these scenarios. Total fatalities also increase slightly at INEL (1.34) in Regionalized Alternative 5, in which volume reduction is performed at four installations; this is due mainly to larger consolidated waste loads in treatment and a larger exposed work force than for other alternatives. The highest estimated total fatalities are in Centralized Alternative 5 at Hanford (3.65 in 9,856 FTEs), where all volume reduction is performed and the treatment work force is greatly increased compared to other alternatives.

D.3.2.4.2 *Programwide Trends in Human Health Risks Associated With LLW Disposal*

For the MEL of the hypothetical farm family, the health risks associated with the LLW disposal alternatives show no discernable trends. The risk of cancer fatality to all 143 farm family lifetimes across alternatives ranges from 0.0 to 1.3 cancer fatalities over 10,000 years. Estimated cancer fatalities for workers during disposal are very similar across alternatives, ranging from 1.4 to 3.2; worker risks tend to increase as the waste load to be disposed of becomes larger and as more disposal facility construction is required.

Maximally Exposed Lifetime of the Hypothetical Farm Family. For each alternative, with the exception of Centralized Alternatives 2 and 4 (single site disposal at NTS), the risk of cancer incidence to the MEL of the farm family is greater than 1E-04. For the "average" individual member of the farm family, the risk of cancer incidence (determined by dividing the cancer incidence risk in Table D.3.2-3 by the number of family members, four, times the number of disposal sites for that alternative), may be considered above the target exposure level in all alternatives except Centralized 2 and 4.

The highest cancer fatality risks to the MEL are in Decentralized (in which wastes receive minimum treatment and are then disposed of at 12 installations). Estimated programwide cancer fatality risks are 6.5E-02 in Decentralized.

The lowest risks of cancer fatality to the MEL are in Centralized 2 (minimum treatment and disposal at NTS) and Centralized 4 (volume reduction at seven installations and disposal at NTS). The programwide risks of cancer fatality for the four-member farm family are 0.0 in Centralized 2 and in Centralized 4.

At the installation level, the lowest disposal risks are at LANL in the No Action, Decentralized, Regionalized 1, 2, 3, 4, and 5 Alternatives; at NTS in the No Action, Regionalized 2, 3, 4, 5, and 7, and Centralized 2 and 4 Alternatives; at Pantex in the Decentralized and Regionalized 2 Alternatives; and at INEL in the No Action, Decentralized, and Regionalized 1, 2, 3, 4, and 5 Alternatives. The estimated radiological risks at these installations are zero because the wastes being disposed of contain low concentrations of radionuclides and the migration of the contaminants into the groundwater is very slow (all four installations receive little annual rainfall).

The highest "average" disposal installation risk to a farm family member is at SNL-NM in the Decentralized Alternative (average individual risk of cancer fatality is 6.3E-02). The MEL is lifetime 15 at SNL-NM, where uranium-238 contributes over 99% of the dose received by farm family members.

Workers Placing Wastes Into Disposal. The estimated worker risks from disposal are very similar across alternatives, ranging from 1.4 to 3.2 for cancer fatality and 4.9 to 11 for cancer incidence. However, the estimated risk of fatality from construction is more than 1 order of magnitude lower for the one-installation disposal alternatives (the five Centralized Alternatives) than for the other alternatives. In the Centralized scenarios, Hanford and NTS are the single-disposal installations; both have large amounts of existing disposal capacity compared to other installations and, therefore, require less new construction.

The highest construction fatality risks occur in Regionalized 6 and 7; these alternatives involve two-installation disposal at Hanford and SRS and NTS and SRS, respectively. The majority of the construction-related worker risks are at SRS, which has a relatively small amount of existing disposal capacity and, based on the large amount of LLW to be sent there for disposal in these disposal scenarios, would require extensive construction.

The estimated number of operational fatalities is within 1 order of magnitude among alternatives (ranging from 2.9E-01 to 1.8). In general, operational fatalities are slightly higher for scenarios in which multiple installations dispose (the No Action, Decentralized, and Regionalized 1 and 3 Alternatives), and are slightly lower where only one installation disposes (the Centralized Alternatives). This is because the fewer the

disposal installations, the fewer the number of FTEs needed to operate them (therefore, fewer workers are around to be involved in operational accidents).

Although overall risks to workers from disposal do not differ appreciably among alternatives, some trends are apparent in the installation-specific risks associated with disposal. In the multiple-installation disposal alternatives (the No Action, Decentralized, and Regionalized Alternatives), the same four installations, Hanford, INEL, SRS, and LANL, have the highest cancer risks by approximately 0.5 to 2 orders of magnitude; all four are consolidation installations for LLW disposal in these alternatives. The controlling contaminants are cobalt-60 at Hanford, INEL, and SRS, and cesium-137 and daughter products at LANL; external radiation is the predominant exposure route. In the two-installation disposal alternatives (Hanford and SRS in Regionalized 6; NTS and SRS in Regionalized 7), Hanford and NTS cancer risks are approximately twice as high as those for disposal at SRS. The controlling contaminant for disposal at Hanford and NTS in Regionalized 6 and 7 is cobalt-60; the primary exposure route is external radiation. However, there are more estimated fatalities at SRS due to physical hazards because of the construction of new disposal facilities.

D.3.2.4.3 *Comparison Among Treatment Options*

For workers, comparison of minimum treatment and volume reduction scenarios shows very little difference in cancer risks associated with LLW treatment. In all alternatives, estimated worker cancer fatality risks from treatment are very similar, ranging between 8.1E-01 and 2.3. Overall, worker risks at particular installations seem to be driven primarily by waste consolidation and facility construction.

The programwide risk of cancer fatality for all of the minimum treatment alternatives are identical for all receptors. The overall risks associated with the volume reduction alternatives are approximately 0.5 to 1.5 orders of magnitude higher than the risks associated with minimum treatment only. This can be seen at the installation level as well as at the program level; for example, at RFETS, cancer fatalities in the offsite population increase from 4.0E-07 in Regionalized Alternative 5 (which involves minimum treatment) to 1.9E-04 in Regionalized Alternative 4 (which involves volume reduction). This is attributable to increased atmospheric releases associated with the incineration of LLW.

Comparison of the risks for the volume reduction alternatives shows that the risks for all receptors vary by no more than a factor of six between volume reduction at 11 installations and volume reduction at 7, 4, or 1 installation(s).

D.3.2.4.4 *Comparison Among Disposal Scenarios*

Comparisons can be made between the alternatives in which treatment is the same but the number of disposal sites varies from 12 installations to 1. For the minimum treatment alternatives, the cancer fatality risks to all farm family lifetimes range from 0.0 to 1.2. There are no apparent trends as the number of disposal facilities changes. The cancer fatality risks in the single-installation disposal alternatives (Centralized 1 and 2) are 0.0 at NTS and 4.8E–03 at Hanford.

Comparison of disposal risks among alternatives that have the same disposal scenarios but different treatment options shows that the type of LLW treatment has little effect on the cancer risks to all farm family lifetimes or to the MEL. For example, in the 10-installation disposal alternatives (Regionalized 1 and Regionalized 2), the major difference is that minimum treatment is performed at all installations in Regionalized 1, while additional volume reduction is performed at 11 installations in Regionalized 2. Risks of cancer fatality to all farm family lifetimes from disposal are higher in Regionalized 2 by less than a factor of four. This small difference is found for both the MEL and for all lifetimes across Regionalized 3, 4, and 5 (the six-installation disposal alternatives); Centralized 1, 3, and 5 (the alternatives in which disposal takes place at Hanford); and Centralized 2 and 4 (in which LLW is disposed of at NTS).

As previously noted for worker risks associated with LLW treatment, the disposal risks to workers do not differ appreciably among alternatives; however, certain installation-specific risks tend to be higher where waste loads are consolidated for disposal or where more construction of disposal facilities is required.

D.3.2.4.5 *Summary of Results for Routine Treatment and Disposal of LLW*

Treatment by volume reduction slightly increases the cancer risks to offsite and noninvolved worker populations at a particular installation in comparison to minimum treatment. However, the type of treatment does not affect the subsequent disposal risks to the farm family as much as the amount of waste consolidated

at an installation or the hydrogeology and meteorology of the disposal installation (both of which can markedly affect the migration of contaminants into groundwater). Volume reduction tends to concentrate waste, producing slightly higher estimated risks to the farm family.

In all but two disposal alternatives (Centralized 2 and 4), the programwide risks of cancer incidence to the MEL of the hypothetical farm family exceed 1E-06. Recall that this is a conservative disposal scenario in which the farm family residence and drinking water well are situated 300 m downgradient from the center of a disposal facility, and that the well serves as the sole source of water for the family, their livestock, and crops.

Worker risks are very similar across all alternatives, regardless of treatment type or disposal scenario; programwide risks are within 1 order of magnitude across all treatment alternatives and all disposal alternatives. Fatalities associated with radiation exposure are usually fewer than those due to the physical hazards of constructing and operating treatment and disposal facilities, except in the one-site disposal alternatives at NTS and Hanford. As discussed above, these installations have relatively large existing disposal facility capacities and require less construction. Overall, however, worker risks at specific installations seem to be driven primarily by the amount of waste consolidated for treatment and/or disposal and the amount of facility construction needed.

D.3.2.5 Summary of Alternatives for Potential LLW Accidents

For LLW, health risks from potential incinerator accidents were evaluated for the No Action, Regionalized 2, and Centralized 5 Alternatives (see Section D.3.2.1); no storage-related accidents were analyzed. The types of accidents evaluated were (1) a baghouse area facility fire; (2) an earthquake leading to a fire in the incinerator facility; (3) the crash of a large aircraft (at INEL, SRS, and Hanford) or a small aircraft (at RFETS and PGDP) resulting in fire and explosion; and (4) an incinerator explosion. Accidents in "alpha facilities" (incinerators that process LLW contaminated with alpha-emitting radionuclides) were evaluated for RFETS in Regionalized 2 and for Hanford in Centralized 5.

Aircraft impacts were not evaluated for FEMP, LANL, LLNL, Mound Plant, PGDP, or ORR.

For more detailed information on accident scenarios, see Appendix F.

D.3.2.6 Special Assumptions and Considerations Used in the LLW Accident Analysis

All accident releases from incinerator facilities to the outside (i.e., to the offsite and noninvolved worker populations) are assumed to be at ground level with dispersion starting at a lower level rather than from a facility stack. In the incinerator explosion accident scenario, it is assumed that the efficiency of the facility's high-efficiency particulate air filtration system drops to 99.9%. In the assessment of worker risks from incineration accidents, it is assumed that the air in the work area is not ventilated or filtered; the intrafacility source term for this accident is, therefore, 1,000 times higher than the atmospheric source term used to calculate risks to the offsite and noninvolved worker populations. During all accidents, one shift of waste management workers is assumed to be inside the facility. Shift size varies from one to eight workers (see Table D.3.2-64), which can be found at the end of Section D.3.2.7.

Incineration accidents are assumed to result in releases into the operating gallery where the workers are located. Half of the operating gallery (e.g., an area 32 m long × 6 m wide × 6 m high) is assumed to fill with contaminated air. Exposure duration is 1 min, the time necessary for workers to avoid any obstructions and leave the scene.

Each accident type has an associated estimated annual frequency of occurrence as determined by Argonne National Laboratory (see Section D.2.12.1). However, the probability of occurrence is not directly taken into account in the risk calculations. Risks estimates associated with each accident should be interpreted as the consequences if the accident occurred. The incinerator explosion is considered to be "anticipated" (greater than 1.0E-02 per year); the baghouse area fire is considered "unlikely" (1.0E-04 to 1.0E-02 per year); the earthquake with resulting fire is considered "very unlikely" (1.0E-06 to 1.0E-04 per year); and the aircraft impact is regarded as "extremely unlikely" (less than 1.0E-06 per year), (see Appendix F, Table F.2-2). Slightly different labels are assigned to these frequencies in Appendix F.

D.3.2.7 Results Tables for the Risk Analysis of Potential LLW Accidents

Table D.3.2-61 presents a summary of the maximum reasonably foreseeable accident risks to the offsite and noninvolved worker populations, their respective MEIs, and waste management worker populations for treatment facility accidents, by installation and alternative. Table D.3.2-62 provides the sizes of the offsite, noninvolved worker, and worker populations at each installation. Tables D.3.2-63 through D.3.2-75 present more detailed results by health endpoint and installation.

Table D.3.2-61. Risks From Potential Maximum Reasonably Foreseeable LLW Treatment Facility Accidents, by Alternative and Site

Site	Offsite Population		Offsite MEI		Noninvolved Worker Population		Noninvolved Worker MEI		Worker Population	
	CF	CI	CF	CI	CF	CI	CF	CI	CF	CI
No Action										
INEL	5.9E-05	2.0E-04	6.7E-09	2.3E-08	2.2E-05	7.5E-05	1.3E-08	4.5E-08	1.5E-05	5.4E-05
SRS	4.6E-02	1.6E-01	1.4E-06	4.9E-06	9.6E-03	3.3E-02	4.2E-05	1.4E-04	9.5E-03	3.3E-02
Regionalized 2										
FEMP	6.0E-05	2.1E-04	1.6E-08	5.4E-08	2.2E-06	7.6E-06	1.5E-08	5.1E-08	3.6E-07	1.3E-06
Hanford	2.4E-03	8.1E-03	5.5E-08	1.9E-07	1.2E-04	4.2E-04	1.3E-06	4.2E-06	1.0E-05	3.5E-05
INEL	5.9E-05	2.0E-04	6.7E-09	2.3E-08	2.2E-05	7.5E-05	1.3E-08	4.5E-08	1.9E-05	6.7E-05
LANL	8.7E-01	3.0	4.1E-04	1.4E-03	2.5E-01	8.6E-01	7.4E-04	2.5E-03	2.5E-01	8.7E-01
LLNL	2.9	9.8	4.0E-04	1.4E-03	2.1E-01	7.1E-01	3.6E-04	1.2E-03	7.3E-03	2.6E-02
ORR	1.3E-02	4.4E-02	1.1E-06	3.7E-06	8.8E-03	3.0E-02	9.8E-06	3.3E-05	7.8E-04	2.7E-03
PGDP	2.5E-04	8.6E-04	7.4E-08	2.5E-07	4.9E-05	1.7E-04	4.3E-07	1.5E-06	3.8E-05	1.3E-04
PORTS	2.5E-05	8.6E-05	1.7E-08	5.9E-08	1.1E-05	3.8E-05	1.7E-08	5.7E-08	5.2E-06	1.8E-05
RFETS	2.8E-02	9.4E-02	9.8E-07	3.3E-06	4.8E-03	1.6E-02	1.4E-05	4.8E-05	2.1E-03	7.3E-03
SRS	4.6E-02	1.6E-01	1.4E-06	4.9E-06	9.6E-03	3.3E-02	4.2E-05	1.4E-04	1.2E-02	4.1E-02
Centralized 5										
Hanford	4.8	1.6E+01	1.1E-04	3.8E-04	9.1E-01	3.1	9.2E-03	3.1E-02	6.0E-01	2.1

Notes: MEI = maximally exposed individual; each value represents the highest *single* risk (not the sum of all risks) to the MEI from among all accidents at an installation. CF = risk of cancer fatality associated with exposure to radionuclides. CI = risk of cancer incidence associated with exposure to radionuclides.

Table D.3.2-62. Sizes of the Offsite, Noninvolved Worker, and Worker Populations Affected by Risks From Potential LLW Treatment Accidents, by Site

Site	Offsite Population	Noninvolved Worker Population	WM Worker Population		
			No Action	Regionalized 2	Centralized 5
Hanford	377,645	8,674		1	8
FEMP	2,764,589	2,456		4	
INEL	153,061	8,451	4	5	
LANL	159,152	11,552		6	
LLNL	6,324,234	9,504		1	
ORR	881,652	3,809		6	
PGDP	500,502	1,952		4	
PORTS	639,602	3,226		5	
RFETS	2,171,877	6,993		8	
SRS	620,618	15,996	4	5	

Table D.3.2-63. Accident Risks Associated With LLW Treatment at INEL Under the No Action Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, earthquake (VU)[b]	3.9E-05	4.5E-09	1.0E-05	1.3E-04	1.5E-08	3.6E-05
Incineration, incinerator explosion (A)	2.4E-08	2.7E-12	6.1E-06	8.0E-08	9.1E-12	2.2E-05
Incineration, baghouse area fire (U)	5.9E-07	6.7E-11	1.5E-07	2.0E-06	2.3E-10	5.4E-07
Incineration, large aircraft crash (EU)	5.9E-05	6.7E-09	1.5E-05	2.0E-04	2.3E-08	5.4E-05
Maximum reasonably foreseeable accident	5.9E-05	6.7E-09	1.5E-05	2.0E-04	2.3E-08	5.4E-05

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

Table D.3.2-64. Accident Risks Associated With LLW Treatment at SRS Under the No Action Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, large aircraft crash (EU)[b]	4.6E-02	1.4E-06	9.5E-03	1.6E-01	4.9E-06	3.3E-02
Incineration, earthquake (VU)	3.1E-02	9.6E-07	6.3E-03	1.0E-01	3.3E-06	2.2E-02
Incineration, incinerator explosion (A)	1.8E-05	5.8E-10	3.8E-03	6.2E-05	2.0E-09	1.3E-02
Incineration, baghouse area fire (U)	4.6E-04	1.4E-08	9.5E-05	1.6E-03	4.9E-08	3.3E-04
Maximum reasonably foreseeable accident	4.6E-02	1.4E-06	9.5E-03	1.6E-01	4.9E-06	3.3E-02

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

Table D.3.2-65. Accident Risks Associated With LLW Treatment at FEMP Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, earthquake (VU)[b]	6.0E-05	1.6E-08	3.6E-07	2.1E-04	5.4E-08	1.3E-06
Incineration, incinerator explosion (A)	3.6E-08	9.5E-12	2.1E-07	1.2E-07	3.2E-11	7.5E-07
Incineration, baghouse area fire (U)	9.1E-07	2.4E-10	5.4E-09	3.1E-06	8.1E-10	1.9E-08
Maximum reasonably foreseeable accident	6.0E-05	1.6E-08	3.6E-07	2.1E-04	5.4E-08	1.3E-06

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

Table D.3.2-66. Accident Risks Associated With LLW Treatment at Hanford Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, earthquake (VU)[b]	1.6E-03	3.7E-08	6.7E-06	5.4E-03	1.3E-07	2.3E-05
Incineration, incinerator explosion (A)	9.5E-07	2.2E-11	4.0E-06	3.2E-06	7.5E-11	1.4E-05
Incineration, baghouse area fire (U)	2.4E-05	5.5E-10	1.0E-07	8.1E-05	1.9E-09	3.5E-07
Incineration, large aircraft crash (EU)	2.4E-03	5.5E-08	1.0E-05	8.1E-03	1.9E-07	3.5E-05
Maximum reasonably foreseeable accident	2.4E-03	5.5E-08	1.0E-05	8.1E-03	1.9E-07	3.5E-05

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

Table D.3.2-67. Accident Risks Associated With LLW Treatment at INEL Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, large aircraft crash (EU)[b]	5.9E-05	6.7E-09	1.9E-05	2.0E-04	2.3E-08	6.7E-05
Incineration, earthquake (VU)	3.9E-05	4.5E-09	1.3E-05	1.3E-04	1.5E-08	4.5E-05
Incineration, incinerator explosion (A)	2.4E-08	2.7E-12	7.7E-06	8.0E-08	9.1E-12	2.7E-05
Incineration, baghouse area fire (U)	5.9E-07	6.7E-11	1.9E-07	2.0E-06	2.3E-10	6.7E-07
Maximum reasonably foreseeable accident	5.9E-05	6.7E-09	1.9E-05	2.0E-04	2.3E-08	6.7E-05

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

Table D.3.2-68. Accident Risks Associated With LLW Treatment at LLNL Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, earthquake (VU)[b]	2.9	4.0E-04	7.3E-03	9.8	1.4E-03	2.6E-02
Incineration, incinerator explosion (A)	1.7E-03	2.4E-07	4.4E-03	5.9E-03	8.1E-07	1.5E-02
Incineration, baghouse area fire (U)	4.3E-02	6.0E-06	1.1E-04	1.5E-01	2.0E-05	3.8E-04
Maximum reasonably foreseeable accident	2.9	4.0E-04	7.3E-03	9.8	1.4E-03	2.6E-02

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

Table D.3.2-69. Accident Risks Associated With LLW Treatment at LANL Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, earthquake (VU)[b]	8.7E-01	4.1E-04	2.5E-01	3.0	1.4E-03	8.7E-01
Incineration, incinerator (A) explosion	5.2E-04	2.5E-07	1.5E-01	1.8E-03	8.4E-07	5.2E-01
Incineration, baghouse area (U) fire	1.3E-02	6.2E-06	3.7E-03	4.4E-02	2.1E-05	1.3E-02
Maximum reasonably foreseeable accident	8.7E-01	4.1E-04	2.5E-01	3.0	1.4E-03	8.7E-01

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (<1E-06).

Table D.3.2-70. Accident Risks Associated With LLW Treatment at ORR Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, earthquake (VU)[b]	1.8E-02	1.1E-06	7.8E-04	4.4E-02	3.7E-06	2.7E-03
Incineration, incinerator (A) explosion	7.7E-06	6.4E-10	4.7E-04	2.6E-05	2.2E-09	1.6E-03
Incineration, baghouse area (U) fire	1.7E-06	1.4E-10	1.0E-07	5.6E-06	4.7E-10	3.5E-07
Maximum reasonably foreseeable accident	1.3E-02	1.1E-06	7.8E-04	4.4E-02	3.7E-06	2.7E-03

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (<1E-06).

Table D.3.2-71. Accident Risks Associated With LLW Treatment at PGDP Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, earthquake (VU)[b]	2.5E-04	7.4E-08	3.8E-05	8.6E-04	2.5E-07	1.3E-04
Incineration, incinerator explosion (A)	1.5E-07	4.4E-11	2.3E-05	5.2E-07	1.5E-10	7.9E-05
Incineration, baghouse area fire (U)	3.8E-06	1.1E-09	5.6E-07	1.3E-05	3.8E-09	2.0E-06
Incineration, small aircraft crash (EU)	6.3E-05	1.8E-08	9.4E-06	2.2E-04	6.3E-08	3.3E-05
Maximum reasonably foreseeable accident	2.5E-04	7.4E-08	3.8E-05	8.6E-04	2.5E-07	1.3E-04

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (<1E-06).

Table D.3.2-72. Accident Risks Associated With LLW Treatment at PORTS Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, baghouse area fire (U)[b]	3.8E-07	2.6E-10	7.8E-08	1.3E-06	8.8E-10	2.7E-07
Incineration, earthquake (VU)	2.5E-05	1.7E-08	5.2E-06	8.6E-05	5.9E-08	1.8E-05
Incineration, incinerator explosion (A)	1.5E-08	1.0E-11	3.1E-06	5.1E-08	3.5E-11	1.1E-05
Maximum reasonably foreseeable accident	2.5E-05	1.7E-08	5.2E-06	8.6E-05	5.9E-08	1.8E-05

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (<1E-06).

Table D.3.2-73. Accident Risks Associated With LLW Treatment at RFETS Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, small aircraft crash (alpha) (EU)[b]	6.9E-03	2.5E-07	5.2E-04	2.4E-02	8.3E-07	1.8E-03
Incineration, baghouse area fire (alpha) (U)	4.2E-04	1.5E-08	3.1E-05	1.4E-03	5.0E-08	1.1E-04
Incineration, earthquake (alpha) (VU)	2.8E-02	9.8E-07	2.1E-03	9.4E-02	3.3E-06	7.3E-03
Incineration, incinerator explosion (alpha) (A)	1.7E-05	5.9E-10	1.3E-03	5.7E-05	2.0E-09	4.4E-03
Maximum reasonably foreseeable accident	2.8E-02	9.8E-07	2.1E-03	9.4E-02	3.3E-06	7.3E-03

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

Table D.3.2-74. Accident Risks Associated With LLW Treatment at SRS Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[a]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, large aircraft crash (EU)[b]	4.6E-02	1.4E-06	1.2E-02	1.6E-01	4.9E-06	4.1E-02
Incineration, earthquake (VU)	3.1E-02	9.6E-07	7.9E-03	1.0E-01	3.3E-06	2.8E-02
Incineration, incinerator explosion (A)	1.8E-05	5.8E-10	4.7E-03	6.2E-05	2.0E-09	1.7E-02
Incineration, baghouse area fire (U)	4.6E-04	1.4E-08	1.2E-04	1.6E-03	4.9E-08	4.1E-04
Maximum reasonably foreseeable accident	4.6E-02	1.4E-06	1.2E-02	1.6E-01	4.9E-06	4.1E-02

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

Table D.3.2-75. Accident Risks Associated With LLW Treatment at Hanford Under Centralized Alternative 5, by Accident Type

Accident		Cancer Fatalities[a]			Cancer Incidence[a]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Incineration, large aircraft crash (non-alpha)	(EU)[b]	4.8	1.1E-04	6.0E-01	1.6E+01	3.8E-04	2.1
Incineration, large aircraft crash (alpha)	(EU)	2.4E-02	5.6E-07	3.1E-03	8.0E-02	1.9E-06	1.1E-02
Incineration, earthquake (nonalpha)	(VU)	3.2	7.5E-05	4.0E-01	1.1E+01	2.5E-04	1.4
Incineration, earthquake (alpha)	(VU)	1.6E-02	3.7E-07	2.1E-03	5.4E-02	1.3E-06	7.3E-03
Incineration, incinerator explosion (nonalpha)	(A)	1.9E-03	4.5E-08	2.4E-01	6.5E-03	1.5E-07	8.5E-01
Incineration, incinerator explosion (alpha)	(A)	9.5E-06	2.2E-10	1.3E-03	3.2E-05	7.6E-10	4.4E-03
Incineration, baghouse area fire (nonalpha)	(U)	4.8E-02	1.1E-06	6.0E-03	1.6E-01	3.8E-06	2.1E-02
Incineration, baghouse area fire (alpha)	(U)	2.4E-04	5.6E-09	3.1E-05	8.0E-04	1.9E-08	1.1E-04
Maximum reasonably foreseeable accident		4.8	1.1E-04	6.0E-01	1.6E+01	3.8E-04	2.1

[a] Indicates cancer fatality and incidence associated with radiation exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1E-02), "U" for unlikely (1E-04 to 1E-02), "VU" for very unlikely (1E-06 to 1E-04), and "EU" for extremely unlikely (< 1E-06).

D.3.2.8 Summary of the LLW Accident Analysis Results

For all receptors, the dominating accidents are those involving a large airplane crash or an earthquake during incineration (nonalpha). At any installation where both of these accident types are analyzed, the risks associated with them differ by less than a factor of two for offsite and noninvolved worker populations, offsite and noninvolved worker MEIs, and workers. The risks to all receptors from alpha facility accidents are generally lower than the comparable nonalpha facility accident risks at a given installation by about 2 orders of magnitude. This is due to a much smaller inventory of alpha LLW and therefore, much smaller releases associated with alpha incinerator accidents. Note that for workers, the risk of death from latent cancers due to exposure to radioactive materials released in such accidents may be smaller than the risk of fatality due to nonradiological impacts.

D.3.2.8.1 *Risks to the Offsite Population From LLW Accidents*

The lowest installation-specific health risks associated with accidents are for the incinerator explosion at INEL in No Action and Regionalized 2 (2.4E–08 cancer fatalities) and for the same accident at FEMP (3.6E–03 cancer fatalities) and PORTS (1.5E–08 cancer fatalities) in Regionalized 2. The highest accident risks are at Hanford in Centralized 5 for the large airplane crash scenario (4.8 cancer fatalities) and for the earthquake scenario (3.2 cancer fatalities) and at LLNL and LANL in Regionalized 2 for the earthquake during incineration (2.9 and 8.7E–01 cancer fatalities, respectively). The comparatively high risks to these populations are due to the combination of population distribution and waste inventory at each installation. The cancer fatality risk from the maximum reasonably foreseeable accident at Hanford in Centralized 5 increases about 3 orders of magnitude compared to that in Regionalized 2 due to waste consolidation.

In general, the airplane crash (small and large) and the earthquake with subsequent fire are the worst-case accidents in all alternatives and vary by less than 1 order of magnitude at all sites where both accident types are postulated. The associated annual frequencies for these accidents differ somewhat in that an airplane crash is considered "extremely unlikely" (less than 1.0E–06 per year) and an earthquake is considered "very unlikely" (1.0E–06 to 1.0E–04 per year).

The principal contributors to risk are uranium-238 at FEMP, Hanford (Centralized 5), LANL, PGDP, PORTS, and SRS; thorium-232 at LLNL and ORR; cesium-137 at Hanford (Regionalized 2); cobalt-60 at INEL; and plutonium-238 at Hanford (alpha incineration only in Centralized 5) and RFETS. The primary exposure route is internal exposure in all alternatives.

D.3.2.8.2 *Risks to the Noninvolved Worker Population From LLW Accidents*

Noninvolved worker risks are slightly lower than offsite population risks, but are distributed over a much smaller affected population. The general trend in risks by accident type, dominating accident type, controlling contaminants and exposure route, and highest-risk sites are the same as for offsite population.

D.3.2.8.3 *Risks to the Maximally Exposed Noninvolved Worker and Maximally Exposed Offsite Individual From LLW Accidents*

Radiological risks to the offsite and noninvolved worker MEIs generally parallel the trends for their respective populations but are 2 to 5 orders of magnitude lower. For the noninvolved worker MEI, the highest cancer fatality risks are at Hanford in Centralized 5 (9.2E-03) and at LLNL and LANL in Regionalized 2 (3.6E-04 and 7.4E-04, respectively). The highest cancer fatality risks to the offsite MEI are at LLNL and LANL in Regionalized 2 (4.0E-04 and 4.1E-04, respectively) and at Hanford in Centralized 5 (1.1E-04). The cancer risks to the offsite population in Regionalized 2 are among the highest primarily because of the relatively large contaminant releases in the accidents at LANL and LLNL combined with the relatively large number of residents living very close to each of these sites (ORNL, 1995d). The cancer risks in Centralized 5 are among the highest primarily because of the large volume of waste consolidated at Hanford (higher than the cancer risks to MEIs in Regionalized 2 by almost 4 orders of magnitude).

Controlling contaminants for both MEIs at these three sites are the same as for their respective populations, uranium-238 at LANL and Hanford and thorium-232 at LLNL. The exposure route is internal exposure for both receptors at all sites.

D.3.2.8.4 *Risks to Waste Management Workers From LLW Accidents*

The cancer fatality risks to workers from maximum reasonably foreseeable accidents range from 3.6E–07 to 6.0E–01; shift size varies from one to eight workers. In all alternatives, the large aircraft crash into an incinerator and an earthquake at an incinerator are the highest-risk accidents. For any installation where both of these accident types were analyzed, the difference in risks between them is less than a factor of two. The next highest accident risks to workers are associated with the incinerator explosion scenario. (If the large aircraft crash is not postulated for an installation, then the earthquake and incinerator explosion scenarios are the highest-risk accident types; cancer risks differ by less than a factor of two for these two scenarios.) Risks from the baghouse fire scenario are generally 1 or more orders of magnitude lower than those associated with the aircraft crash, earthquake, and incinerator explosion scenarios. The accident types that result in higher risks to workers involve larger releases of radionuclides than the baghouse fire scenario. Recall that the estimated annual frequency of the aircraft crash accidents occurring is "extremely unlikely" (less than 1.0E–06 per year); the earthquake scenario is considered "very unlikely" (1.0E–06 to 1.0E–04 per year); the baghouse fire is considered "unlikely" (1.0E–04 to 1.0E–02 per year); and the incinerator explosion is "anticipated" (greater than 1.0E–02 per year).

The highest worker cancer fatality risk is for the maximum reasonably foreseeable accident at Hanford in Centralized 5. The cancer fatality risk at Hanford in Centralized 5 is about 5 orders of magnitude higher than at Hanford in Regionalized 2 due to the consolidation of LLW for treatment at Hanford (which would result in a larger release in the event of an accident). Exposure to uranium-238 via inhalation is the risk driver at Hanford in Centralized 5. The highest-risk sites in No Action and Regionalized 2 are SRS and LANL (Regionalized 2 only). Worker cancer fatality risks at the other sites are lower by 1 to 6 orders of magnitude. Inhalation of uranium-238 is also the driving contributor to worker risk at SRS and LANL in No Action and Regionalized 2.

D.3.2.9 Risks to the Hypothetical Intruder From LLW Disposal

The health risks to the hypothetical intruder who drills a well through an LLW disposal facility were evaluated for the Decentralized, Regionalized 3, and Centralized 1 Alternatives, for intrusion 100 years and 300 years after the cessation of disposal activities at each installation. Tables D.3.2-76 and D.3.2-77 present summaries of the risk evaluations at 100 and 300 years, respectively. Tables D.3.2-78 through D.3.2-83 contain the health risks by health endpoint and installation for each alternative in both time frames.

Table D.3.2-76. Summary Table for the Intruder Scenario for LLW (100 years)

Alternative	Radionuclides			
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects
Decentralized	160	8.0E-02	2.7E-01	1.6E-02
Regionalized 3	110	5.3E-02	1.8E-01	1.1E-02
Centralized 1	1.7	8.3E-03	2.8E-02	1.7E-03

Table D.3.2-77. Summary Table for the Intruder Scenario for LLW (300 years)

Alternative	Radionuclides			
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects
Decentralized	1.7	8.4E-04	2.8E-03	1.7E-04
Regionalized 3	1.1	5.7E-04	1.9E-03	1.1E-04
Centralized 1	1.7E-01	8.4E-05	2.9E-04	1.7E-05

Table D.3.2–78. Intruder Scenario Risk Results for the Decentralized Alternative (100 years)

Site	Radionuclides			
	Dose (rem)	**Cancer Fatality**	**Cancer Incidence**	**Genetic Effects**
ANL-E	6.6E-01	3.3E-04	1.1E-03	6.6E-05
Hanford	6.8	3.4E-03	1.2E-02	6.8E-04
INEL	7.0E-01	3.5E-04	1.2E-03	7.0E-05
LANL	142	7.1E-02	2.4E-01	1.4E-02
LLNL	5.8	2.9E-03	9.8E-03	5.8E-04
ORR	1.3	6.6E-04	2.2E-03	1.3E-04
PGDP	6.7E-03	3.3E-06	1.1E-05	6.7E-07
Pantex	5.2E-03	2.6E-06	8.9E-06	5.2E-07
PORTS	4.8E-01	2.4E-04	8.2E-04	4.8E-05
RFETS	2.4E-03	1.2E-06	4.1E-06	2.4E-07
SNL-NM	1.5	7.3E-04	2.5E-03	1.5E-04
SRS	2.3	1.2E-03	4.0E-03	2.3E-04
Total	160	8.0E-02	2.7E-01	1.6E-02

Table D.3.2–79. Intruder Scenario Risk Results for the Decentralized Alternative (300 years)

Site	Radionuclides			
	Dose (rem)	**Cancer Fatality**	**Cancer Incidence**	**Genetic Effects**
ANL-E	7.6E-03	3.8E-06	1.3E-05	7.6E-07
Hanford	5.8E-02	2.9E-05	9.9E-05	5.8E-06
INEL	1.3E-01	6.6E-05	2.2E-04	1.3E-05
LANL	1.2	5.9E-04	2.0E-03	1.2E-04
LLNL	1.0E-01	5.0E-05	1.7E-04	1.0E-05
ORR	1.1E-02	5.3E-06	1.8E-05	1.1E-06
PGDP	6.6E-03	3.3E-06	1.1E-05	6.6E-07
Pantex	5.2E-03	2.6E-06	8.9E-06	5.2E-07
PORTS	1.2E-01	6.0E-05	2.0E-04	1.2E-05
RFETS	1.9E-03	9.5E-07	3.2E-06	1.9E-07
SNL-NM	2.6E-02	1.3E-05	4.4E-05	2.6E-06
SRS	2.6E-02	1.3E-05	4.5E-05	2.6E-06
Total	1.7	8.4E-04	2.8E-03	1.7E-04

Table D.3.2-80. Intruder Scenario Risk Results for Regionalized Alternative 3 (100 years)

Site	Radionuclides			
	Dose (rem)	**Cancer Fatality**	**Cancer Incidence**	**Genetic Effects**
Hanford	6.8	3.4E-03	1.2E-02	6.8E-04
INEL	7.0E-01	3.5E-04	1.2E-03	7.0E-05
LANL	91	4.5E-02	1.5E-01	9.1E-03
NTS	5.8	2.9E-03	9.8E-03	5.8E-04
ORR	8.1E-01	4.1E-04	1.4E-03	8.1E-05
SRS	2.3	1.2E-03	4.0E-03	2.3E-04
Total	110	5.3E-02	1.8E-01	1.1E-02

Table D.3.2-81. Intruder Scenario Risk Results for Regionalized Alternative 3 (300 years)

Site	Radionuclides			
	Dose (rem)	**Cancer Fatality**	**Cancer Incidence**	**Genetic Effects**
Hanford	5.8E-02	2.9E-05	9.9E-05	5.8E-06
INEL	1.3E-01	6.6E-05	2.2E-04	1.3E-05
LANL	7.6E-01	3.8E-04	1.3E-03	7.6E-05
NTS	1.0E-01	5.0E-05	1.7E-04	1.0E-05
ORR	6.1E-02	3.0E-05	1.0E-04	6.1E-06
SRS	2.6E-02	1.3E-05	4.5E-05	2.6E-06
Total	1.1	5.7E-04	1.9E-03	1.1E-04

Table D.3.2-82. Intruder Scenario Risk Results for Centralized Alternative 1 (100 years)

Site	Radionuclides			
	Dose (rem)	**Cancer Fatality**	**Cancer Incidence**	**Genetic Effects**
Hanford	1.7	8.3E-03	2.8E-02	1.7E-03
Total	1.7	8.3E-03	2.8E-02	1.7E-03

Table D.3.2-83. Intruder Scenario Risk Results for Centralized Alternative 1 (300 years)

Site	Radionuclides			
	Dose (rem)	**Cancer Fatality**	**Cancer Incidence**	**Genetic Effects**
Hanford	1.7E-01	8.4E-05	2.9E-04	1.7E-05
Total	1.7E-01	8.4E-05	2.9E-04	1.7E-05

D.3.2.9.1 *Results of the Human Health Risk Analysis for the Intruder*

In the Decentralized Alternative, LLW is disposed of at 12 sites. One hundred years after the end of disposal operations, the highest intruder cancer fatality risk is at LANL (7.1E–02). This is due to both the large volume of waste disposed at LANL in this alternative and the presence of strontium-90 in the inventory. Strontium is a bone-seeking radionuclide; hence, its internal dose conversion factors are high.

The lowest intruder cancer fatality risk is at RFETS (1.2E–06), which disposes of only its own waste in this alternative. Three hundred years after disposal operations end, the highest and lowest intruder risks are still at LANL (5.9E–04) and RFETS (9.5E–07), respectively; strontium-90 continues to be the driving contaminant at LANL. In the Regionalized Alternative 3, LLW is consolidated and disposed of at six sites. One hundred years after the completion of disposal operations, the highest intruder cancer fatality risk is at LANL (4.5E–02). Again, this is due to the large volume of waste that is disposed of and the presence of strontium-90 in the inventory. In Regionalized 3, LANL receives waste from SNL-NM, Pantex, and RFETS. The lowest intruder cancer fatality risk is at INEL (3.5E–04), which disposes of only its own waste. Three hundred years after the end of disposal operations, the highest intruder cancer fatality risk remains at LANL (3.8E–04). The lowest intruder cancer fatality risk is at SRS (1.3E–05), which receives waste from Pinellas. INEL is no longer the lowest-risk installation because of the accumulation of higher-risk daughter (radioactive decay) products at this installation during the intervening 200 years.

In the Centralized Alternative 1, all LLW is consolidated and disposed of at Hanford. One hundred years after disposal operations end, the intruder's risk of cancer fatality is 8.3E–03. Three hundred years after disposal operations, the risks are 2 orders of magnitude lower.

Overall, Centralized 1 results in the lowest collective risks to the intruder among the three alternatives. This result may seem counterintuitive. However, when relatively low-activity wastes from other sites are added to the higher-activity Hanford wastes, the resulting *average* waste concentration at Hanford is lower than in Decentralized and Regionalized 3. Consequently, the risks to the intruder are lowest in Centralized 1.

D.3.3 HAZARDOUS WASTE

Hazardous waste (HW) is broadly defined in the Resource Conservation and Recovery Act (RCRA) as a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may: (1) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (2) pose a substantial or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

The EPA has more specifically defined and identified HW according to considerations such as acute and chronic toxicity, persistence, and degradability in nature; potential for bioaccumulation; and other characteristics such as ignitability, corrosiveness, and reactivity. Based on these factors, the EPA promulgated regulations under 40 CFR 261, classifying HW as "listed" waste, "characteristic" waste, or "other" waste. Listed wastes are those specifically identified on one of the lists in 40 CFR 261, Subpart D. These include wastes from nonspecific sources, wastes from specific sources or industries, and a rigidly defined list of commercial chemical products. Examples of listed wastes are spent solvents, spent sludges, and discarded commercial chemicals such as cyanides, benzene, and chloroform. Characteristic wastes are defined by 40 CFR 261, Subpart C, as exhibiting ignitability, corrosiveness, reactivity, or toxicity. Other HW includes mixtures that contain HW and residues from HW treatment. HW contains no radioactive component; wastes that meet the RCRA definition of HW and are also radioactive are addressed as low-level mixed waste (see Section D.3.5).

HW is generated by a variety of DOE activities including those associated with defense, nuclear energy, and energy research programs. The following 11 sites generate the majority of the DOE inventory of HW and are considered in this human health risk evaluation (note that the abbreviations given here are used throughout this appendix):

- Argonne National Laboratory-East (ANL-E), Argonne, Illinois
- Hanford Site (Hanford), Richland, Washington
- Fermi National Accelerator Laboratory (Fermi), Batavia, Illinois
- Idaho National Engineering Laboratory (INEL), Idaho Falls, Idaho
- Kansas City Plant (KCP), Kansas City, Missouri
- Los Alamos National Laboratory (LANL), Los Alamos, New Mexico
- Lawrence Livermore National Laboratory (LLNL), Livermore, California

- Oak Ridge Reservation (ORR), Oak Ridge, Tennessee
- Pantex Plant (Pantex), Amarillo, Texas
- Sandia National Laboratories-New Mexico (SNL-NM), Albuquerque, New Mexico
- Savannah River Site (SRS), Aiken, South Carolina

The quantities and types of HW generated vary throughout the DOE complex. Laboratory facilities generate wastes (e.g., laboratory solutions, acids, and caustics) as a result of research and development activities, processing operations, and other activities associated with their mission. Production facilities generate HW as a result of manufacturing weapons and weapons materials, nuclear fuel, and other production operations. Many sites also generate reportable quantities of industrial solvents, paints, oils, rags, and wipes contaminated with hazardous cleaning compounds, and other hazardous materials that are byproducts of routine maintenance, degreasing, and machine-shop operations (ANL, 1996d). The current HW management strategy is based on minimizing (or eliminating) HW generation, and on proper characterization, treatment, and disposal.

Environmental restoration activities also contribute substantially to HW generation. While an installation may produce very little HW in the course of routine operations, remediation of environmental problems such as leaking petroleum underground storage tanks may generate thousands of pounds of HW-contaminated soil.

For more detailed information on HW, including HW inventories at DOE sites, estimated release rates, treatment categories used in the PEIS, and the process for developing PEIS HW alternatives, see Chapters 3 and 10 of the PEIS and the HW technical report (ANL, 1996d).

D.3.3.1 Summary of HW Alternatives

The PEIS waste management alternatives (No Action, Regionalized 1 and 2) and the rationale for developing the various HW analysis alternatives are discussed rigorously in the main body of the PEIS.

- The No Action Alternative demonstrates the baseline risks of treating some of the DOE inventory of HW by incineration only (no waste fuel burning) at existing facilities at INEL and the ORR, while the remainder is treated by permitted commercial facilities.

- In the Regionalized Alternative 1, approximately 50% of the complexwide, commercially treated HW is instead treated by incineration and waste fuel burning at Hanford, INEL, LANL, ORR, and SRS. The remaining HW is treated and disposed of by permitted commercial facilities.
- In the Regionalized Alternative 2, approximately 80% to 90% of the complexwide, commercially treated HW is instead treated by incineration and waste fuel burning at INEL and ORR. The remainder is treated and disposed of by a limited number of permitted commercial facilities.

Table D.3.3-1 presents the consolidation and treatment schemes for these three alternatives.

Note that Section 10.3 of Volume I describes a Decentralized Alternative for HW management. The main difference between the No Action and Decentralized Alternatives is a 6% shift in the waste totals for thermal treatment and fuel substitution from offsite treatment, under the No Action Alternative, to onsite treatment, under the Decentralized Alternative. Because of this relatively small difference, the potential impacts of these two alternatives are expected to be quite similar. Therefore, health risk estimates for the Decentralized Alternative are not presented in this section of the WM PEIS. However, Section 10.4 of Volume I and the Volume II site data tables include risk estimates for the Decentralized Alternative, which are the same as those presented for the No Action Alternative.

D.3.3.2 Special Assumptions and Considerations Used in the HW Risk Analysis

The source term for chlorinated organics and inorganics emitted in incinerator flue gases was developed from a set of RCRA trial burn data from the Rollins Deer Park, Texas, waste incinerator (one of the commercial facilities that currently processes DOE-generated HW); the constituents in the flue gases are shown in Table D.3.3-2. Although the chemistry of the industrial wastes used in the trial burn was unknown, they were waste types generally typical of DOE HW and were assumed to be reasonably similar to DOE HW in organic composition (ANL, 1996d). The results of those burns were scaled up based on each installation's HW waste volume.

It was assumed that the composition of HW and the relative proportions of its components are the same at all sites. Because of this, the controlling contaminants and their percentage contribution to risk are the same across all sites and alternatives.

Table D.3.3-1. PEIS Alternatives for HW

Alternative	ANL-E	Hanford	Fermi	INEL	KCP	LANL	LLNL	ORR	Pantex	SNL-NM	SRS
No Action—Treatment of own HW (by incineration) at current 2 sites; remainder treated commercially				T				T			
Regionalized 1—50% of DOE HW treated (by incineration and fuel burning) at 5 sites; remainder treated commercially		T		T		T		T			T
Regionalized 2—80-90% of DOE HW treated (by incineration and fuel burning) at 2 sites; remainder treated commercially				T				T			

Note: T = treatment installation.

Table D.3.3-2 HW Source Term Constituents Derived From Analysis of Deer Park, Texas, Incinerator Flue Gases

Constituents in HW Source Term	
Bromodichloromethane	Chlorine
Chlorobenzene	Vinyl chloride
Chloromethane	Cadmium
Chloroform	Chromium (VI)
Dibromochloromethane	Copper
1,2-Dichloroethane	Lead
Methylene chloride	Mercury
1,1,2,2-Tetrachloroethane	Nickel
1,1,1-Trichloroethane	Zinc
1,1,2-Trichloroethane	Arsenic
Trichlorofluoromethane	Dioxins (PCDD)
Hydrogen chloride	Furans (PCDF)

Consistent with the other waste streams, the duration of the No Action Alternative is assumed to be 20 years. For the Regionalized 1 and 2 Alternatives, construction of treatment facilities is assumed to take place for 10 years and HW treatment for 10 years.

The RfDs/RfCs and cancer potency factors for the various HW constituents, where available, were obtained from the EPA's Health Effects Assessment Summary Tables and Integrated Risk Information System. If the EPA values were not available, toxicity values derived by PNL were used (Droppo et al., 1989).

It was assumed that an FTE (see Section D.2) would not be exposed to concentrations of hazardous chemicals that exceed the time-weighted average threshold limit value (TWA-TLV) for full-time workers exposed 8 hours/day, 40 hours/week (ACGIH, 1992).

The chemicals used as surrogates in evaluating the health effects to the public from polychlorinated dibenzo-dioxins and polychlorinated dibenzofurans were hexachlorodibenzo-p-dioxin and hexachlorodibenzofuran, respectively. Due to the lack of better information, it was also assumed that the chromium in the source term was present as 100% chromium (VI), an inhalation carcinogen. This is a conservative assumption; therefore, health risks associated with chromium in the HW source term may be overestimated.
No TLVs or immediately-dangerous-to-life-and-health (IDLH) values were found for bromodichloro-methane, dibromochloromethane, hexachlorodibenzofuran, or hexachlorodibenzo-p-dioxin; therefore, the health effects to workers associated with these chemicals were not evaluated. However, the first two compounds comprise only 0.01% each of the source term, the third is 2.6E–05% of the source term, and the fourth is 3E–06% of the source term. The offsite and noninvolved worker populations were evaluated for all chemicals in the source term.

Note that the human health risks for commercial treatment are not addressed in this analysis. Therefore, the greater the percentage of waste treated commercially, the lower the human health risk estimates for the DOE complex and the less information this analysis can supply about the overall risks to human health from combined public and private HW waste management activities.

D.3.3.3 Results Tables for the HW Human Health Risk Analysis

This section contains the results tables for the HW human health risk analysis. A discussion of the results is presented in Section D.3.4.4. The risks in the tables are displayed in the standard scientific (exponential) notation used in risk assessment; directions on reading this notation and a more complete description of the types of information in the tables are given in Section D.2.

- Table D.3.3–3 presents an overview, by alternative, of the *total*, programwide risks of cancer incidence for the offsite and noninvolved worker populations; and the risks of cancer incidence and construction and operational fatalities for waste management workers. These tables provide the estimated *total number* of people in the three receptor populations who will develop cancers from exposure to HW over a lifetime if a particular alternative is implemented nationwide. In addition, it shows the estimated total number of workers who will be killed in construction and operational activities.
- Table D.3.3–4 shows the sizes of the total affected populations for each alternative.
- Table D.3.3–5 summarizes the risks to the offsite and noninvolved worker MEIs for each HW alternative. The numbers in this table are the estimated *probabilities* that the offsite and noninvolved worker MEIs will develop cancer from chemical exposure or are indicators that the MEIs will suffer adverse health effects from exposure to noncarcinogenic, hazardous constituents.
- Tables D.3.3–6 through D.3.3–8 show the programwide risks for all receptors and health effect endpoints, by alternative.
- Tables D.3.3–9 through D.3.3–11 present offsite and worker population risks for each installation, by alternative.
- Table D.3.3–12 lists the hazardous constituents that contribute most of the risk of cancer incidence to the offsite population, by installation and alternative.

Table D.3.3–3 Summary of Programwide Risks Associated With Routine Management of HW: Risks to Total Populations, by Alternative

Alternative	Offsite Population	WM Workers		Noninvolved Worker Population
	Chem CI	Chem CI	C&OF	Chem CI
No Action	7.5E–03	9.4E–02	8.2E–03	2.5E–03
Regionalized 1	6.0E–02	1.2	6.9E–02	2.5E–02
Regionalized 2	9.6E–02	1.8	7.3E–02	3.3E–02

Notes: Chem CI = cancer incidence associated with exposure to hazardous chemicals; C&OF = fatalities due to physical hazards during construction and operation of waste treatment facilities.

Table D.3.3–4 Size of Total Offsite, Noninvolved Worker, and Worker Populations Affected by the Risks From Routine Management of HW, by Alternative

Alternative	Offsite Population	WM Workers	Noninvolved Worker Population
No Action	1,034,713	52	12,260
Regionalized 1	2,192,128	355	48,482
Regionalized 2	1,034,713	372	12,260

Table D.3.3–5 Summary of Programwide Risks Associated With Managing HW to the Offsite and Noninvolved Worker Maximally Exposed Individuals, by Alternative

Alternative	Offsite MEI		Noninvolved Worker MEI	
	Chem CI	HI	Chem CI	HI
No Action	3.9E-07	2.6E-03	2.4E-06	1.6E-02
Regionalized 1	2.4E-06	3.2E-02	1.1E-05	5.1E-01
Regionalized 2	5.0E-06	6.6E-02	3.1E-05	4.1E-01

Notes: MEI = maximally exposed individual; Chem CI = cancer incidence associated with exposure to hazardous chemical.
HI = hazard index.

Table D.3.3-6 Programwide Risks Associated With the Routine Management of HW Under the No Action Alternative, by Health Endpoint

Receptor	Endpoint	Hazardous Chemicals		Physical Hazards
		Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects	2.5E-03		
Noninvolved worker MEI	Dose (rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	2.4E-06	 1.6E-02	
Offsite population	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects	7.5E-03		
Offsite MEI	Dose (rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	3.9E-07	 2.6E-03	
WM workers	Dose (FTE-rem) Cancer fatalities Cancer incidence Genetic effects Exposure index Construction fatalities Construction injuries Operation fatalities Operation injuries	9.4E-02	 4.3	 1.9E-03 8.4E-01 6.3E-03 5.3

Table D.3.3-7. Programwide Risks Associated With the Routine Management of HW Under Regionalized Alternative 1, by Health Endpoint

Receptor	Endpoint	Hazardous Chemicals		Physical Hazards
		Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects	2.5E-02		
Noninvolved worker MEI	Dose (rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	1.1E-05	 1.5E-01	
Offsite population	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects	6.0E-02		
Offsite MEI	Dose (rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	2.4E-06	 3.2E-02	
WM workers	Dose (FTE-rem) Cancer fatalities Cancer incidence Genetic effects Exposure index Construction fatalities Construction injuries Operation fatalities Operation injuries	1.2	 6.1	 2.6E-02 1.2E+01 4.3E-02 3.7E+01

Table D.3.3-8. Programwide Risks Associated With the Routine Management of HW Under Regionalized Alternative 2, by Health Endpoint

Receptor	Endpoint	Hazardous Chemicals		Physical Hazards
		Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects	3.3E-02		
Noninvolved worker MEI	Dose (rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	3.1E-05	4.1E-01	
Offsite population	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects	9.6E-02		
Offsite MEI	Dose (rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	5.0E-06	6.6E-02	
WM workers	Dose (FTE-rem) Cancer fatalities Cancer incidence Genetic effects Exposure index Construction fatalities Construction injuries Operation fatalities Operation injuries	1.8	6.2	2.8E-02 1.2E+01 4.5E-02 3.8E+01

Table D.3.3-9. Risks Associated With the Routine Management of HW Under the No Action Alternative, by Site

Site	Population[a]	Fatalities[b]	Cancer Incidence				
		Workers	Offsite Population	Offsite MEI	Noninvolved Worker Population	Noninvolved Worker MEI	Workers
INEL	153,061	2.6E-03	3.4E-05	4.6E-09	4.4E-05	3.7E-08	1.8E-02
	16						
ORR	881,652	5.6E-03	7.4E-03	3.9E-07	2.5E-03	2.4E-06	7.6E-02
	36						
Total		8.2E-03	7.5E-03	3.9E-07	2.5E-03	2.4E-06	9.4E-02

Note: MEI = maximally exposed individual.
[a] Top number represents the offsite population within an 80-km (50-mi) radius of the site, while the bottom number represents the total FTEs for waste management workers involved in both construction and operation activities.
[b] Risk of cancer fatality from exposure to hazardous chemicals cannot be assessed; worker fatality risks reflect risks from physical hazards only.

Table D.3.3-10. Risks Associated With the Routine Management of HW Under Regionalized Alternative 1, by Site

Site	Population[a]	Fatalities[b]	Cancer Incidence				
		Workers	Offsite Population	Offsite MEI	Noninvolved Worker Population	Noninvolved Worker MEI	Workers
Hanford	377,645	1.8E-02	4.3E-03	1.4E-07	2.6E-03	5.0E-06	2.9E-01
	91						
INEL	153,061	6.8E-03	1.0E-04	1.4E-08	1.4E-04	1.1E-07	7.6E-02
	35						
LANL	159,152	1.7E-02	1.9E-02	2.4E-06	9.5E-03	5.9E-06	3.0E-01
	88						
ORR	881,652	2.0E-02	3.6E-02	1.8E-06	1.1E-02	1.1E-05	4.2E-01
	101						
SRS	620,618	7.9E-03	1.2E-03	1.5E-08	5.9E-04	6.7E-07	9.3E-02
	40						
Total		6.9E-02	6.0E-02	2.4E-06	2.5E-02	1.1E-05	1.2

Note: MEI = maximally exposed individual.
[a] Top number represents the offsite population within an 80-km (50-mi) radius of the site, while the bottom number represents the total FTEs for waste management workers involved in both construction and operation activities.
[b] Risk of cancer fatality from exposure to hazardous chemicals cannot be assessed; worker fatality risks reflect risks from physical hazards only.

Table D.3.3-11. Risks Associated With the Routine Management of HW Under Regionalized Alternative 2, by Site

Site	Population[a]	Fatalities[b]	Cancer Incidence				
		Workers	Offsite Population	Offsite MEI	Noninvolved Worker Population	Noninvolved Worker MEI	Workers
INEL	153,061 160	3.1E-02	9.7E-04	1.3E-07	1.3E-03	1.1E-06	7.4E-01
ORR	881,652 212	4.1E-02	9.5E-02	5.0E-06	3.2E-02	3.1E-05	1.1
Total		7.3E-02	9.6E-02	5.0E-06	3.3E-02	3.1E-05	1.8

Note: MEI = maximally exposed individual.
[a] Top number represents the offsite population within an 80-km (50-mi) radius of the installation, while the bottom number represents the total FTEs for waste management workers involved in both construction and operation activities.
[b] Risk of cancer fatality from exposure to hazardous chemicals cannot be assessed; worker fatality risks reflect risks from physical hazards only.

Table D.3.3-12. Constituents in HW Contributing the Highest Risk of Cancer Incidence to the Offsite Population at Each Site, by Alternative

Alternative	Installation				
	Hanford	INEL	LANL	ORR	SRS
No Action	—	Chromium (VI)[a] 2.7E-05[b]	—	Chromium (VI) 5.9E-03	—
Regionalized 1	Chromium (VI) 3.5E-03	Chromium (VI) 8.3E-05	Chromium (VI) 1.5E-02	Chromium (VI) 2.9E-02	Chromium (VI) 9.4E-04
Regionalized 2	—	Chromium (VI) 7.8E-04	—	Chromium (VI) 7.7E-02	—

[a] Chromium in the source term was assumed to be 100% chromium (VI).
[b] Risk of cancer incidence contributed by this constituent.

D.3.3.4 Results of the HW Human Health Risk Analysis for Routine Operations

The following sections present a summary of the estimated programwide impacts to each receptor population and a discussion of the overall results of the HW human health risk analysis.

D.3.3.4.1 *Programwide Trends in Human Health Risks Associated With HW Management Alternatives*

Offsite Population. For the offsite population, the programwide risk of cancer incidence associated with routine treatment of HW is lowest for No Action (7.5E-03 cancer incidences distributed over a total affected population of approximately 1 million), and slightly higher for Regionalized 1 and 2 (6.0E-02 over a total population of approximately 2 million and 9.6E-02 over approximately 1 million, respectively). As would be expected based on the waste consolidation and treatment scenarios, cancer incidence risks at INEL and ORR are slightly higher in Regionalized 2 than Regionalized 1 (recall that in Regionalized 2,80% to 90% of the DOE inventory of commercially treatable HW is consolidated and treated at these two sites).

Noninvolved Worker Population. The programwide risk of cancer incidence to the noninvolved worker population follows the same pattern as for the offsite population: Regionalized 1 and 2 risks are similar to one another (both are in the E-02 order of magnitude) and approximately 1 order of magnitude higher than in No Action. However, the total affected noninvolved worker populations (approximately 12,260 in No Action and Regionalized 2 and 48,482 in Regionalized 1) are substantially smaller than the total offsite populations. Therefore, the relative risks "per capita" (the risks to an average member of the noninvolved worker population compared to an average member of the offsite population) are concomitantly higher. This higher individual risk to members of the noninvolved worker population is also reflected in the results for the offsite and noninvolved worker MEIs.

Maximally Exposed Noninvolved Worker and Offsite Individual. For the offsite and noninvolved worker MEIs, risk of cancer incidence follows the same pattern as for their respective populations. However, the risks of cancer incidence for both of these receptors in Regionalized 1 and 2 are in the E-05 to E-06 range.

Most of the MEI risk in these alternatives is attributable to the presence of the inhalation carcinogen chromium (VI) in the source term (ANL, 1996d). The hazard indices for both MEIs (indicating the greatest individual exposure to noncarcinogenic chemicals per scenario) follow the trend for cancer incidence but are less than 1.0 in all alternatives. This indicates a low probability that these receptors will suffer adverse effects from exposure to noncarcinogenic, toxic contaminants.

Workers. Programwide health risks to workers follow the same general trends as for the offsite and noninvolved worker populations. The total risks of cancer incidence in Regionalized 1 and 2 are slightly more than 1 order of magnitude higher than in No Action, and range from 1.8E-02 to 1.1. While the air concentrations of each HW constituent component are estimated to be at or below TLVs, the sum of the exposures from those concentrations yields exposure indices that are consistently above 1.0 (ranging from 4.1 to 8.2) in all alternatives. This indicates that the worker receiving the worst-case exposure is potentially at risk of adverse health effects from the daily inhalation of fugitive chemical emissions in all three alternatives. These results indicate that the risk of cancer incidence to the total worker population increases as a greater percentage of the DOE HW inventory is treated and as treatment is performed at fewer consolidation sites, while the highest individual exposure to hazardous, noncarcinogenic chemicals differs little from alternative to alternative.

As can be seen in Tables D.3.3-9 through D.3.3-11, the highest risks of cancer incidence to workers result at INEL and ORR under Regionalized 2, in which these two sites treat 80% to 90% of the DOE inventory of commercially treatable HW. The difference in risks at these sites between Regionalized 1 and 2 is about 0.5 to 1 order of magnitude.

Construction and operational injuries and fatalities follow the same pattern as exposure risks to workers and other populations (see Tables D.3.3-6 through D.3.3-8). No Action involves the least construction, the smallest volume of waste in treatment, and the fewest workers. Accordingly, the No Action risks from physical hazards are the lowest among the three alternatives. The risks from physical hazards in Regionalized 1 and 2 are almost identical to one another and reflect increased person-hours spent building and operating waste processing facilities compared to No Action.

D.3.3.4.2 *Summary of Results for Routine Treatment of HW*

For the offsite population, ORR poses the highest risk of cancer incidence in No Action and Regionalized 2; ORR and LANL pose the highest risks in Regionalized 1 (see Tables D.3.3-9 through D.3.3-11). INEL presents the lowest cancer incidence risks in all alternatives. Inhaled chromium (VI) contributes the most risk of cancer incidence to the offsite population at all sites across all alternatives (see Table D.3.3-12). Cancer incidence risks to the offsite MEI are in the E-06 order of magnitude at LANL in Regionalized 1 and ORR in Regionalized 1 and 2.

Risks to the various noninvolved worker populations tend to parallel the risks to the site-specific offsite populations. ORR presents the highest risk of cancer incidence in No Action and Regionalized 2; and ORR, LANL, and Hanford pose the highest risks in Regionalized 1. Inhalation of chromium (VI) contributes most of the cancer incidence risk at all sites in all alternatives (ORNL, 1996).

The cancer incidence risk to the noninvolved worker MEI is between 1.0E-06 and 1.0E-04 at ORR in No Action; ORR, LANL, and Hanford in Regionalized 1; and ORR and INEL in Regionalized 2. Hazard indices for both MEIs are below 1.0 in all alternatives, indicating a low probability of adverse effects from exposure to noncarcinogenic, toxic contaminants.

The highest site cancer incidence risks are always at ORR for workers, although differences between sites in cancer incidence for workers are consistently less than 1 order of magnitude. The controlling contaminants at ORR for worker cancer incidence are chromium (VI) in No Action and vinyl chloride and chromium (VI) in Regionalized 1 and 2. In No Action, the exposure index at ORR is slightly higher than at INEL; the controlling contaminants at ORR are chlorine and cadmium. In Regionalized 1 and 2, exposure indices at all sites are approximately equal; controlling contaminants are hydrogen chloride, chlorine, cadmium, copper, lead, and nickel.

D.3.3.4.3 *Discussion*

As noted in the summary of HW alternatives (Section D.3.3.1), No Action involves only the incineration of the INEL and ORR inventories of HW, while Regionalized 1 and 2 involve treatment of consolidated HW waste loads (50% and 80 to 90%, respectively) by incineration and waste fuel burning. Accordingly,

risks to the various receptors would be expected to increase as the amount of waste treated at DOE sites and the degree of consolidation increase. While the differences among alternatives are relatively small, this trend is apparent. Health risks associated with Regionalized 1 and 2 are slightly higher than those associated with No Action by about 1 order of magnitude. The risks for Regionalized 1 and 2 are approximately the same for all populations and health effects endpoints. In other words, treating 50% of the DOE inventory of HW at five sites and treating 80% to 90% at two sites results in nearly the same overall health risks to all populations. Within each alternative, the highest-risk sites for exposure are also the highest-risk sites for construction and operational risks. This indicates that the volume of waste being treated and, consequently, the number of hours workers spend constructing facilities and processing the waste, are the determining factors for health risks.

Comparison of the risks to the overall populations and MEIs in Regionalized 1 and 2 (see Tables D.3.3-10 and D.3.3-11) shows that risks generally differ by less than a factor of 2 between the two alternatives (which is reasonable since the difference in the amount of waste processed does not quite double between the alternatives). However, the risks in Regionalized 1 are distributed over twice as many members of the offsite population and four times as many members of the noninvolved worker population as in Regionalized 2.

D.3.3.5 Summary of Alternatives for Potential HW Accidents

Three categories of potential HW accidents were analyzed for Regionalized 1 and 2: single-drum, single-contaminant accidents occurring during storage; multiple-contaminant storage facility accidents; and multiple-contaminant treatment facility accidents.

D.3.3.5.1 *Single-Drum Accidents*

Thirty-one storage accidents involving the release of a single chemical (either a carcinogen or a hazardous noncarcinogen) from a single drum were postulated for each site and each alternative. These single-drum accident scenarios are summarized in Table D.3.3-13.

There were three general types of single-drum accidents: a spill; a spill plus fire; and other combinations of events (spill plus explosion, fire only, fire plus explosion, etc.). Because of the large number of accidents to be analyzed, only the results of the four accidents for which the attendant risks are highest at each site for each alternative are reported in Table D.3.3-15, which can be found in Section D.3.3.7. These results are:

- The estimated cancer incidence in the site's offsite population for an accident involving a carcinogen.
- The hazard index for the offsite MEI for an accident involving a hazardous noncarcinogen.
- The estimated cancer incidence for the shift of six FTEs (hypothetical workers) working during an accident involving a carcinogen.
- The IDLH index (see Section D.2.11) for the maximally exposed FTE working during an accident involving a hazardous noncarcinogen.

The consequences of a single-drum accident release (if the accident occurred) do not differ among alternatives. However, the estimated annual frequency of the accident may differ among alternatives (i.e., an accident may become more likely as more drums are stored at a site).

Note that the single-drum accident that poses the highest risks to the offsite population may not be the same as the maximum reasonably foreseeable accident for workers (because exposure scenarios and pathways often differ between workers and the other receptors).

D.3.3.5.2 *Storage Facility Accidents*

Potential storage facility HW accidents include (1) a facility fire that engulfs a significant fraction of the containers in storage, releasing some or all of these contaminants: 2A, 2B, 2C, 2D, 5E, and 5F (see Table D.3.3-13); (2) an earthquake that ruptures a significant number of drums, releasing some or all of these contaminants: 1A, 1B, 1C, 1D, 4E, 4F, and 4G in Table D.3.3-13; and (3) the crash of a large aircraft (at Hanford, INEL, and SRS) or small aircraft (at LANL and ORR) resulting in a fire that burns a significant portion of the storage drums releasing some or all of these contaminants: 2A, 2B, 2C, 2D, 3A, 3D, 5E, and 5F in Table D.3.3-13. Earthquake-related storage accidents were postulated for Hanford and LANL only in Regionalized 1 and for INEL and ORR in Regionalized 2.

Table D.3.3-13. Summary of Single-Drum Accident Scenarios for HW

Scenario	Accident Category	Toxic Gases Released
Spill	1A	Ammonia
	1B	Hydrogen chloride
	1C	Hydrogen fluoride
	1D	Sulfur oxides
Spill and fire	2A	Polyaromatic hydrocarbon soot, unburnt hydrocarbons and carbon monoxide
	2B	Hydrogen fluoride
	2C	Cyanide
	2D	Mercury vapor
Spill, fire, and gas cylinder explosion	3A	Ammonia
Fire and gas cylinder breach	3B	Ammonia
Fire and gas cylinder breach	3C	Ammonia
Spill and explosion	3D	Ammonia
Fire and explosion	3E	Ammonia
Spill	4A	Ammonia
	4B	Hydrogen chloride
	4C	Hydrogen fluoride
	4D	Sulfur oxides
	4E	Acetic acid
	4F	Carbon disulfide
	4G	1,1,1-Trichloroethane
Fire	5A	Polyaromatic hydrocarbon soot and unburnt hydrocarbons
	5B	Hydrogen fluoride
	5C	Cyanide
	5D	Mercury vapor
	5E	Cadmium fumes
	5F	Dust from burnt and unburnt potassium and sodium dichromate salts
Spill, fire, and gas cylinder explosion	6A	Ammonia
Fire and gas cylinder breach	6B	Ammonia
Fire and gas cylinder breach	6C	Ammonia
Spill and explosion	6D	Ammonia
Fire and gas cylinder explosion	6E	Ammonia

D.3.3.5.3 *Treatment Facility Accidents*

The treatment facility accidents analyzed for HW include (1) an incinerator explosion and resulting fire; (2) an earthquake with subsequent fire; and (3) a large or small aircraft impact (assuming the same scenarios as for the storage facility accidents) and resulting fire. All three types of incinerator accidents involve a fire and a release of some or all of these contaminants: 2A, 2B, 2C, 2D, 5E, and 5F.

D.3.3.6 Special Assumptions and Considerations Used in the HW Accident Analysis

The source terms for the HW accidents include the period of time over which a particular accident release occurs. For assessing risks to offsite and noninvolved worker receptors from single-drum and facilitywide accidents, all releases have been averaged for a 1-h release (i.e., for contaminant releases greater than 60 min in duration, the amount released was scaled to reflect a 60-min release; for contaminant releases of less than 60 min in duration, the total amount of contaminant is assumed to be released in 60 min).

In estimating the risks to the offsite and noninvolved worker populations, releases from storage facility accidents are assumed to be ground releases without flow (i.e., releases at ground level); releases from incinerator facility accidents are assumed to be stack releases with flow (i.e., release from the stack of an operating facility).

All storage accidents are assumed to involve six workers, the average number of workers needed to place waste in storage facilities (EG&G, 1992). For treatment (incineration) accidents, one shift of workers is assumed to be present in the facility when the accident occurs; shift size varies with the waste processing rate. For HW, from one to five workers are present during treatment accidents (see Table D.3.3-20 in Section D.3.3.7) (EG&G, 1992).

All releases from storage accidents are assumed to take place outside at an outdoor storage facility. A 5-min worker exposure duration is assumed for outdoor exposures to accidents that are readily visually detectable (fires, explosions, spills plus fire, etc.). For spills alone (which may not be noticed as quickly), a 10-min exposure period is assumed. Outdoor worker exposure concentrations were calculated using the INEXPLC

model for close-in atmospheric dispersion, explosive releases, and particle deposition (ORNL, 1993), using the following assumptions:

- The worker is standing directly downwind of the release.
- The release height is 0 m (i.e., at ground level).
- The receptor height is 1.5 m (i.e., the height of the person's nose).
- The radius of the source is 1.5 m.
- Receptor distances were varied from 1 m to 25 m at 1-m intervals and concentrations calculated at each interval; an average of these concentrations was used as the exposure concentration.
- Simple gas dispersion with no particle settling takes place.

Incineration accidents are accompanied by releases into an indoor operating gallery where the workers are located. Half the gallery (e.g., an area 32 m long × 6 m wide × 6 m high) is assumed to fill with contaminated air. An exposure duration of 1 min is assumed, during which workers avoid any obstructions and leave the scene. Indoor worker exposure concentrations are estimated using a room model with no ventilation.

Cancer potency factors from the EPA Integrated Risk Information System and Health Effects Assessment Summary Tables were used for determining the cancer incidence resulting from accidents that released carcinogenic chemicals. RfCs and lethality concentrations for acute exposure to toxic chemicals are derived from the methodology developed by Hartmann et al. (1994). Cadmium and benzene are considered to be the carcinogens in the HW accident source terms. Cadmium is toxic as well as carcinogenic, so it is incorporated into both the IDLH index and cancer incidence risk for workers. For the offsite and noninvolved worker populations exposed to cadmium, only the risk of cancer incidence is evaluated because no acute RfD is available to calculate a hazard index. The toxicity and slope factors and IDLH values for cadmium dust are used for accident subcategory 5E because no analogous values are available for cadmium fumes.

The chemical surrogates in Table D.3.3-14 are used in the HW accident risk estimates for all receptors. Hazardous waste manifests for the transport of HW were often not explicit as to exact chemical components, giving only general categories. As a result, a more toxic chemical in a general category was chosen as a conservative representative of the entire category.

Table D.3.3-14. Chemical Surrogates Used in Risk Analysis for Potential HW Accidents

Chemical Hypothetically Released in Accident	Surrogate Used in Risk Analysis
Cyanides (hydrogen, potassium, etc.)	Hydrogen cyanide
Dichromate salts (potassium, sodium, etc.)	Potassium dichromate
Polyaromatic hydrocarbon soot and unburnt hydrocarbons	Benzene
Sulfur oxides	Sulfur dioxide

There is an associated estimated annual frequency of occurrence for each accident type (see Section D.2.12.1). However, the probability of occurrence is not taken into account in the risk calculations. Risk estimates associated with each accident should be interpreted as the consequences if the accident occurred. The various single drum accidents have estimated annual frequencies of occurrence ranging from "unlikely" (1.0E-04 to 1.0E-02) to "very unlikely"(1.0E-06 to 1.0E-04). The incinerator explosion and fire is considered to be "anticipated" (greater than 1.0E-02); the earthquake causing a storage facility spill or an incinerator fire is considered "unlikely" to "very unlikely," depending on the location of the site; and aircraft impact is regarded as "extremely unlikely" (less than 1.0E-06), depending on site location (see Appendix F).

D.3.3.7 Results Tables for the Risk Analysis of Potential HW Accidents

Table D.3.3-15 shows a summary of the risks to the offsite and waste management worker populations from the most conservative single-drum, single-contaminant releases, by site and alternative. Tables D.3.3-16 through D.3.3-19 present a summary of risks to the offsite, noninvolved worker, and waste management worker populations for treatment and storage facility accidents, by site and alternative. Table D.3.3-20 provides the sizes of the offsite, noninvolved worker, and worker populations at each site.

Table D.3.3-15. Summary of Risks to the Offsite and Waste Management Worker Populations From Potential Single-Drum HW Accidents, by Alternative and Site

Site	Alternative	Receptor and Endpoint							
		Offsite Population		Offsite MEI		Worker Population		Maximally Exposed Worker	
		Accident[a]	CI	Accident	HI	Accident	CI	Accident	IDLH Index
Hanford	Reg. 1	5E (U)[b]	3.2E-04	2D (U)	8.1E-02	5E (U)	2.5E-03	5F (VU)	6.4E+01
INEL	Reg. 1	5E (U)	2.1E-04	2D (U)	5.3E-01	5E (U)	2.5E-03	5F (U)	6.4E+01
LANL	Reg. 1	5E (U)	3.0E-04	2D (U)	9.9E-01	5E (U)	2.5E-03	5F (U)	6.4E+01
ORR	Reg. 1	5E (VU)	5.9E-03	2D (U)	5.8	5E (VU)	2.5E-03	5F (VU)	6.4E+01
SRS	Reg. 1	5E (U)	2.6E-05	2D (U)	8.1E-02	5E (U)	2.5E-03	5F (0)[c]	6.4E+01
INEL	Reg. 2	5E (U)	2.1E-04	2D (U)	5.3E-01	5E (U)	2.5E-03	5F (U)	6.4E+01
ORR	Reg. 2	5E (U)	5.9E-03	2D (U)	5.8	5E (U)	2.5E-03	5F (U)	6.4E+01

Notes: MEI = maximally exposed individual; CI = risk of cancer incidence associated with exposure to chemical carcinogens; HI = hazard index associated with exposure to noncarcinogenic, hazardous chemicals; Reg.1 = Regionalized Alternative 1; Reg. 2 = Regionalized Alternative 2.

[a] Maximum reasonably foreseeable single-drum accident type.

[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

[c] The annual frequency of this accident occurring at SRS is 0.

Table D.3.3-16. Risks Associated With Potential Facilitywide HW Storage Accidents Under Regionalized Alternative 1, by Accident and Site

Site	Offsite Pop CI	Offsite MEI HI	Noninvolved Worker Pop CI	Noninvolved Worker MEI HI	Worker CI	Worker IDLH Index
Storage Facility Fire						
Hanford (U)[a]	2.8E-03	1.1	1.5E-05	5.6	1.8E-02	9.0E+02
INEL (U)	1.7E-03	1.5	6.8E-03	1.4E+01	2.0E-02	5.1E+02
LANL (U)	8.3E-03	3.1E+01	1.8E-03	4.4E+02	6.6E-02	2.4E+03
ORR (U)	1.8E-02	7.6E+01	2.3E-02	8.4E+02	5.3E-03	6.0E+02
SRS (U)	5.6E-04	1.7	2.8E-03	1.1E+02	5.4E-02	1.3E+03
Large or Small Aircraft Impact and Storage Facility Fire						
Hanford (EU) (large)	2.8E-03	1.2	1.4E-05	6.2	1.8E-02	1.4E+03
INEL (EU) (large)	1.7E-03	1.6	6.9E-03	1.4E+01	2.0E-02	5.3E+02
LANL (EU) (small)	8.3E-03	3.2E+01	1.8E-03	4.5E+02	6.6E-02	2.7E+03
ORR (EU) (small)	1.8E-02	7.7E+01	2.3E-02	8.5E+02	5.3E-03	6.8E+02
SRS (EU) (large)	5.9E-04	1.7	2.8E-03	1.1E+02	5.4E-02	1.3E+03
Earthquake and Resulting Spill of Multiple Storage Containers						
Hanford (VU)	0.0[b]	1.6E-03	0.0[b]	8.5E-03	0.0[b]	1.2
LANL (U)	0.0[b]	2.0E-02	0.0[b]	2.8E-01	0.0[b]	1.2

Notes: CI = risk of cancer incidence associated with exposure to chemical carcinogens; MEI = maximally exposed individual; HI = hazard index associated with exposure to noncarcinogenic, hazardous chemicals.
[a] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).
[b] Zero indicates that no carcinogen is released in accident scenario.

Table D.3.3-17. Risks Associated With Potential Facilitywide HW Storage Accidents Under Regionalized Alternative 2, by Accident and Site

Site	Offsite Pop CI	Offsite MEI HI	Noninvolved Worker Pop CI	Noninvolved Worker MEI HI	Worker CI	Worker IDLH Index
Storage Facility Fire						
INEL (U)[a]	1.2E-02	3.6E+01	4.8E-02	3.2E+02	1.4E-01	5.1E+03
ORR (U)	1.6E-01	2.4E+02	2.1E-01	2.6E+03	6.1E-02	2.2E+03
Large or Small Aircraft Impact With Resulting Fire						
INEL (EU) (large)	1.2E-02	3.7E+01	4.8E-02	3.3E+02	1.4E-01	6.2E+03
ORR (EU) (small)	1.6E-01	2.4E+02	2.1E-01	2.6E+03	6.1E-02	2.3E+03
Earthquake and Resulting Spill of Multiple Storage Containers						
INEL (U)	0.0[b]	1.9E-01	0.0[b]	1.7	0.0[b]	8.0
ORR (U)	0.0[b]	1.1E-01	0.0[b]	1.3	0.0[b]	1.2

Notes: CI = risk of cancer incidence associated with exposure to chemical carcinogens; MEI = maximally exposed individual; HI = hazard index associated with exposure to noncarcinogenic, hazardous chemicals.
[a] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).
[b] Zero indicates that no carcinogen is released in accident scenario.

Table D.3.3-18. Risks Associated With Potential Facilitywide HW Treatment Accidents Under Regionalized Alternative 1, by Accident and Site

Site		Offsite Pop CI	Offsite MEI HI	Noninvolved Worker Pop CI	Noninvolved Worker MEI HI	Worker CI	Worker IDLH Index
Incinerator Explosion and Fire							
Hanford	(A)[a]	1.9E-05	8.0E-02	9.8E-08	4.3E-01	1.0E-06	3.9E+01
INEL	(A)	2.0E-04	0.0[b]	4.7E-04	0.0[b]	2.5E-04	7.9E+01
LANL	(A)	3.1E-04	9.5E-01	6.1E-05	7.3	7.5E-04	1.2E+02
ORR	(A)	5.5E-03	3.5	4.8E-04	3.7	1.0E-03	2.0E+02
SRS	(A)	7.6E-07	8.0E-02	3.4E-06	4.4	5.0E-07	3.9E+01
Large or Small Aircraft Impact With Resulting Fire							
Hanford (large)	(EU)	5.6E-05	1.8E-01	2.9E-07	9.8E-01	3.0E-06	3.6E+02
INEL (large)	(EU)	4.1E-04	8.3E-02	9.4E-04	4.6E-01	5.0E-04	2.3E+02
LANL (small)	(EU)	3.4E-04	1.3	6.6E-05	9.9	7.6E-04	4.8E+02
ORR (small)	(EU)	1.1E-02	6.8	9.7E-04	7.1	2.0E-03	3.2E+02
SRS (large)	(EU)	2.9E-05	8.1E-02	1.3E-04	4.4	5.0E-04	1.2E+02
Earthquake With Resulting Fire							
Hanford	(VU)	3.7E-05	1.0E-01	2.0E-07	5.5E-01	2.0E-06	3.2E+02
INEL	(VU)	2.1E-04	8.3E-02	4.8E-04	4.6E-01	2.5E-04	1.6E+02
LANL	(VU)	3.5E-04	1.0	6.8E-05	7.8	7.8E-04	2.0E+02
ORR	(VU)	1.1E-02	6.8	9.7E-04	7.1	2.0E-03	3.2E+02
SRS	(VU)	2.7E-05	8.1E-02	1.2E-04	4.4	5.0E-04	1.2E+02

Notes: CI = risk of cancer incidence associated with exposure to chemical carcinogens; MEI = maximally exposed individual; HI = hazard index associated with exposure to noncarcinogenic, hazardous chemicals.
[a] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).
[b] Zero indicates that no acute RfD was available for contaminant; cancer incidence only was calculated.

Table D.3.3-19. Risks Associated With Potential Facilitywide HW Treatment Accidents Under Regionalized Alternative 2, by Accident and Site

Site	Offsite Pop CI	Offsite MEI HI	Noninvolved Worker Pop CI	Noninvolved Worker MEI HI	Worker CI	Worker IDLH Index
Incinerator Explosion and Fire						
INEL (A)[a]	2.3E-04	4.9E-01	5.2E-04	2.7	1.3E-03	2.0E+02
ORR (A)	6.0E-03	6.6	5.2E-04	6.9	1.3E-03	1.6E+02
Large or Small Aircraft Impact With Resulting Fire						
INEL (large) (EU)	4.5E-04	1.5	1.0E-03	8.5	2.5E-03	6.4E+02
ORR (small) (EU)	1.2E-02	1.1E+01	1.0E-03	1.1E+01	2.5E-03	5.6E+02
Earthquake With Resulting Fire						
INEL (VU)	8.6E-04	2.1	2.0E-03	1.2E+01	5.0E-03	9.9E+02
ORR (VU)	1.2E-02	1.1E+01	1.0E-03	1.1E+01	2.5E-03	5.6E+02

Notes: CI = risk of cancer incidence associated with exposure to chemical carcinogens; MEI = maximally exposed individual; HI = hazard index associated with exposure to noncarcinogenic, hazardous chemicals.
[a] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.3-20. Size of Offsite, Noninvolved Worker, and Worker Populations Affected by Risks From Potential HW Treatment and Storage Accidents, by Site

Site	Offsite Population	Noninvolved Worker Population	Storage Worker Population		Treatment Worker Population	
			Regionalized 1	Regionalized 2	Regionalized 1	Regionalized 2
Hanford	377,645	8,674	6		2	
INEL	153,061	8,451	6	6	1	5
LANL	159,152	11,552	6		3	
ORR	881,652	3,809	6	6	4	5
SRS	620,618	15,996	6		2	

D.3.3.8 Summary of the HW Accident Analysis Results

In general, the accident analyses indicate the same trend as seen in routine waste management operations: as the volume of waste is increased at a site, the risks to the public and workers during treatment and storage increase. In Regionalized Alternative 2, approximately 80% of DOE-generated HW is treated at two sites, while treatment of 50% of DOE HW is distributed across five sites in Regionalized 1. Accordingly, the accident risks to all receptors at INEL and ORR in Regionalized 2 tend to be higher than the Regionalized 1 risks at these sites by roughly 1 order of magnitude for storage accidents and by only a slight margin for treatment accidents.

The single-drum storage accidents with the greatest risks to the offsite population and MEI involve releases of cadmium and mercury vapor. The single-drum accidents with the greatest risks to workers involve releases of cadmium and dichromate salts. The facility-wide storage accidents that would produce the highest risks to all receptors are the storage facility fire and the crash of an aircraft into a storage facility followed by fire. However, the storage facility fire is considered "unlikely" (1.0E-04 to 1.0E-02), whereas the aircraft impact scenario is designated "extremely unlikely" (less than 1.0E-06). For treatment facility accidents, consequences are generally similar among accident types at a given site; however, the incinerator explosion is considered much more likely (greater than 1.0E-02 or "anticipated") than other scenarios. The most common controlling contaminants in HW accident scenarios are cadmium and mercury vapor. The highest-risk sites are usually INEL, ORR, and LANL.

D.3.3.8.1 *Risks to the Offsite Population From Accidents During Storage*

Single-Drum Accidents. For the offsite population at each site, the highest cancer incidence risks are associated with a forklift accident resulting in a spill and fire involving a release of cadmium fumes (5E) (see Table D.3.3-15). These risks of cancer incidence range from 2.6E-05 to 5.9E-03 in Regionalized 1 and from 2.1E-04 to 5.9E-03 in Regionalized 2. The highest cancer incidence is at ORR in both Regionalized 1 and 2 (5.9E-03 occurrences affecting a population of 881,652). The next highest risks of cancer incidence are at Hanford and LANL in Regionalized 1 and at INEL in both alternatives (3.2E-04, 3.0E-04, and 2.1E-04, respectively). The lowest cancer incidence risks are at SRS in Regionalized 1 (2.6E-05). The consequences at a site of the maximum reasonably foreseeable single-drum accident (if it occurred) do not differ between alternatives. However, the estimated annual frequency of the accident

increases almost 2 orders of magnitude at ORR from "very unlikely" (1.0E-06 to 1.0E-04) to "unlikely" (1.0E-04 to 1.0E-02) in Regionalized 2. The accident is considered "unlikely" at all other sites in both alternatives.

Storage Facility Accidents. For the offsite population, storage facility fires and aircraft impacts with subsequent fires would pose about the same risks of cancer incidence if they occurred at a site (see Tables D.3.3-16 and D.3.3-17). However, facility fires are projected to occur more frequently than airplane crashes ("unlikely" [1.0E-04 to 1.0E-02] versus "extremely unlikely" [less than 1.0E-06], respectively). In general, the risks at each site are 1 order of magnitude higher in Regionalized 2 than in Regionalized 1. This is because approximately 80% of DOE-generated HW is treated at two sites in Regionalized 2 while treatment of 50% of DOE HW is distributed across five sites in Regionalized 1.

The highest cancer incidence risks from a storage facility fire or an airplane impact affecting a storage facility are at ORR in Regionalized 1 and 2 (1.8E-02 and 1.6E-01, respectively, in an affected population of 881,652), INEL in Regionalized 2 (1.2E-02 in a population of 153,061), and LANL in Regionalized 1 (8.3E-03 in a population of 159,152) (ANL, 1996f). At all three sites, the controlling contaminant is cadmium.

D.3.3.8.2 *Risks to the Offsite Population From Accidents During Treatment*

The risks of cancer incidence to the offsite population from facility-wide accidents during incineration range from 7.6E-07 to 1.1E-02 in Regionalized 1 and from 2.3E-04 to 1.2E-02 in Regionalized 2. In Regionalized 1, cancer incidence risks to the offsite population are similar among accident types (incinerator explosion, aircraft crash into a incinerator facility, and earthquake and fire affecting an incinerator facility) at a given site, differing by only a factor of three or less in most instances. One exception is the incinerator explosion scenario at SRS, which results in a cancer incidence to the offsite population (7.6E-07) that is more than 1 order of magnitude lower than other accident types at SRS. (This is because the carcinogen cadmium is released in the other accident types, but not in the incinerator explosion scenario.) Cancer incidence risks to the offsite population are also similar among accident types at INEL and ORR in Regionalized 2, differing by less than a factor of four. However, in both alternatives, the estimated annual

frequency associated with each of the three treatment facility accident scenarios is different: the incinerator explosion is considered "anticipated" (estimated annual frequency greater than 1E-02); the aircraft impact scenario is "extremely unlikely" (less than 1E-06); and the earthquake scenario is "very unlikely" (1E-06 to 1E-04).

ORR is the highest-risk site for all accident types and alternatives. The highest cancer incidence risks are for the aircraft impact or the earthquake at ORR in both alternatives (1.1E-02 in Regionalized 1 and 1.2E-02 in Regionalized 2). The driving contaminant at ORR for these accident types is cadmium.

D.3.3.8.3 *Risks to the Noninvolved Worker Population From Accidents During Storage*

The risk of cancer incidence in the noninvolved worker population due to accident-related releases follows a similar pattern to that for the offsite population. At each site, storage facility fires and aircraft impacts with subsequent fires pose about the same risks of cancer incidence (see Tables D.3.3-16 and D.3.3-17); however, facility fires are projected to occur more frequently than airplane crashes ("unlikely" versus "extremely unlikely," respectively). Accident risks in Regionalized 2 are approximately 1 order of magnitude higher than those in Regionalized 1 for each site. This is due to a greater number of breached containers involved in the Regionalized 2 accident scenarios. Cancer incidence due to storage accidents ranges from 1.4E-05 to 2.3E-02 in Regionalized 1 and from 4.8E-02 to 2.1E-01 in Regionalized 2.

For the airplane impact affecting a storage facility and the storage facility fire, the highest cancer incidence risks are at ORR in Regionalized 1 and 2 (2.3E-02 and 2.1E-01, respectively, in an affected population of 3,809). The next highest cancer incidence risks are from an airplane impact or storage facility fire at INEL (approximately 7.0E-03 in Regionalized 1 and 4.8E-02 in Regionalized 2). Cadmium is the controlling contaminant at both sites. The site with the lowest cancer incidence risks to noninvolved workers from storage accidents is Hanford in Regionalized 1.

D.3.3.8.4 *Risks to the Noninvolved Worker Population From Accidents During Treatment*

The risks of cancer incidence to the noninvolved worker population from facility-wide accidents during incineration range from 9.8E-08 to 9.7E-04 in Regionalized 1 and from 5.2E-04 to 2.0E-03 in

Regionalized 2. In both alternatives, cancer incidence risks to noninvolved workers are similar among accident types at a given site, differing by only a factor of three or less in most instances. One exception is the incinerator explosion scenario at SRS which results in a cancer incidence (3.4E–06) that is nearly 2 orders of magnitude lower than other accident types at SRS. (This is because the carcinogen cadmium is released in the other accident types, but not in the incinerator explosion scenario.)

The highest site risks of cancer incidence are at ORR and INEL for all accident types. Cancer incidence risks to noninvolved workers at INEL range from 4.7E–04 to 9.4E–04 in Regionalized 1 and from 5.2E–04 to 2.0E–03 in Regionalized 2. ORR cancer incidence risks are very similar to those at INEL, ranging from 4.8E–04 to 9.7E–04 in Regionalized 1 and from 5.2E–04 to 1.0E–03 in Regionalized 2. The controlling contaminant is cadmium at both sites.

D.3.3.8.5 *Risks to the Maximally Exposed Offsite Individual From Single-Drum Accidents*

The maximum reasonably foreseeable single-drum accident involving the release of a noncarcinogenic chemical is a forklift accident that results in a spill and fire with release of mercury vapor (2D) (see Table D.3.3-15). The highest hazard index is at ORR in both alternatives (5.8), indicating an increased likelihood of adverse health effects. The next highest hazard index resulting from this accident type is 9.9E–01 at LANL in Regionalized 1; this value approaches the threshold value of 1.0 beyond which adverse health effects become more likely. All other hazard indices are below 1.0. The estimated annual frequency of occurrence for this accident type is "unlikely" for all sites and alternatives.

D.3.3.8.6 *Risks to the Maximally Exposed Noninvolved Worker and Maximally Exposed Offsite Individual From Storage Facility Accidents*

Accidents During Storage. The highest hazard indices for the offsite MEI from an airplane impact affecting a storage facility or a storage facility fire are at ORR in Regionalized 1 and 2 (approximately 7.7E+01 and 2.4E+02, respectively); INEL in Regionalized 2 (approximately 3.7E+01); and LANL in Regionalized 1 (approximately 3.2E+01). The same trend holds true for the noninvolved worker MEI. At all three sites the controlling contaminant is mercury vapor.

Hazard indices associated with earthquake scenarios that affect storage facilities are usually less than 1.0 with the exception of the noninvolved worker MEI at ORR and INEL in Regionalized 2 (1.3 and 1.7, respectively). The hazard index from an earthquake-related accident is generally 2 to 3 orders of magnitude less than those associated with other storage facility accidents at the same site. In terms of annual accident frequency, earthquake and facility fire scenarios are considered "unlikely" (with the exception of the earthquake scenario at Hanford in Regionalized 1 which is considered "very unlikely"), while aircraft impacts are "extremely unlikely" to happen.

Accidents During Treatment. The highest hazard indices to the offsite MEI for all accident types are at ORR in Regionalized 1 and 2 (ranging from 3.5 to 1.1E+01); the aircraft impact and earthquake scenarios at INEL in Regionalized 2 (1.5 and 2.1, respectively); and the aircraft impact and earthquake scenarios at LANL in Regionalized 1 (1.3 and 1.0, respectively). The controlling contaminant at these sites is mercury vapor. The highest hazard indices to the noninvolved worker MEI are for all accident types at ORR in both alternatives (ranging from 3.7 to 1.1E+01); LANL in Regionalized 1 (ranging from 7.3 to 9.9); SRS in Regionalized 1 (4.4 for all accident types); and INEL in Regionalized 2 (ranging from 2.7 to 12). Each of these accidents, were it to occur, would result in exposures that might lead to adverse health effects to the MEIs. Recall, however, that the incinerator explosions are considered "anticipated," while the earthquake and aircraft impact scenarios are considered "very unlikely" and "extremely unlikely," respectively.

D.3.3.8.7 *Risks to Waste Management Workers From Storage and Treatment Facility Accidents*

Accidents During Storage. The single-drum accident scenario resulting in the highest cancer incidence risk to workers (2.5E-03) is 5E, the forklift accident leading to a spill and fire with release of cadmium fumes (see Table D.3.3-13). The single-drum accident with the greatest risks to workers and involving the release of a noncarcinogen is 5F, a forklift accident resulting in a spill and fire with a release of dust from burnt and unburnt dichromate salts (analyzed as potassium dichromate). The IDLH index associated with this accident is 6.4E+01, which is 64 times the exposure concentration that could cause irreversible health effects if exposure were to last as long as 30 min. However, the accident scenario assumes a much shorter exposure duration, which could reduce the severity of health effects. For each site, the consequences of the maximum reasonably foreseeable single-drum accidents for workers are the same across alternatives. However, the estimated annual frequency of accident types 5E and 5F increases at ORR from "very

unlikely" in Regionalized 1 to "unlikely" in Regionalized 2. Note that the estimated annual frequency of 5F is zero (i.e., 5F is assumed not to occur) at SRS in Regionalized 1.

Storage facility fires and aircraft impacts with subsequent fires would pose very similar risks of cancer incidence and IDLH indices were they to occur at an site (see Tables D.3.3-16 and D.3.3-17). However, facility fires are projected to occur more frequently than airplane crashes ("unlikely" versus "extremely unlikely," respectively). Both cancer incidence risk and IDLH index increase by about 1 order of magnitude at INEL and ORR from Regionalized 1 to Regionalized 2 due to centralization of waste loads. The highest risk of cancer incidence is associated with the storage facility fire or aircraft crash at INEL in Regionalized 2 (1.4E-01 for each accident). The highest IDLH indices are also for the storage facility fire and aircraft crash at INEL in Regionalized 2 (5.1E+03 and 6.2E+03, respectively). These IDLH indices indicate that, were one of these accidents to occur, contaminant concentrations would greatly exceed the level considered immediately dangerous to life and health for exposures of 30 min. However, the accident scenarios assume a much shorter exposure duration, which could reduce the severity of health effects. The controlling contaminants at INEL are cadmium and mercury vapor.

Earthquake-related accidents result in IDLH indices greater than 1.0, but 2 to 3 orders of magnitude less than those resulting from other storage facility accidents. The highest IDLH index for earthquake-related releases from storage is also at INEL in Regionalized 2 (8.0). No carcinogens are assumed to be released in earthquake scenarios.

Accidents During Treatment. In both alternatives, cancer incidence risks to workers are similar among treatment accident types at a given site. However, similar to the trend for offsite and noninvolved worker populations, there is one exception: the incinerator explosion at SRS in Regionalized 1 results in a cancer incidence risk to workers of 5.0E-07; this is 3 orders of magnitude lower than other treatment facility accidents at SRS. As previously discussed, this is because there is no cadmium in the source term for the incinerator explosion. The highest site risks are for all accident types at ORR in both alternatives (ranging from 1.0E-03 to 2.0E-03) and INEL in Regionalized 2 (ranging from 1.3E-03 to 5.0E-03). The controlling contaminant is cadmium at both sites.

IDLH indices are similar among accident types at a given site in both alternatives. One notable exception is the incinerator explosion at Hanford in Regionalized 1, which results in an IDLH index approximately 1 order of magnitude lower than for other accident types. This is primarily because there is no cyanide in

the incinerator explosion source term (in contrast to the other accident types), since cyanide is converted to less toxic cyanates (ANL, 1996f). All IDLH indices associated with treatment facility accidents are greater than 1.0 by 1 to 3 orders of magnitude, indicating exposures to workers that could lead to irreversible health effects.

D.3.4 TRANSURANIC WASTE

DOE Order 5820.2A defines transuranic waste (TRUW) as, "[w]ithout regard to source or form, waste that is contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years, and concentrations greater than 100 nCi/g [nanocuries per gram] at the time of assay" (DOE, 1988). This lower activity limit is interpreted as being per gram of actual waste matrix, excluding the weight of added external shielding, liners, or packaging. By definition, TRUW includes neptunium, plutonium, americium, curium, and californium. DOE Order 5820.2A also provides for the management of some other alpha-contaminated wastes as TRUW, such as wastes containing uranium-233 and radium-226, as necessary. In this appendix the term "TRUW" refers to all materials meeting the DOE definition including TRUW that contain hazardous constituents regulated by the Resource Conservation and Recovery Act (RCRA). The principal focus of the PEIS is on TRUW generated since 1970, which has been packaged and retrievably stored in various trench, pit, vault, and pad configurations. (TRUW generated before 1970 was buried onsite in shallow landfills and may be addressed through environmental restoration activities.)

TRUW is generated primarily in research and development, weapons manufacturing, and plutonium recovery; some TRUW is also retrieved during environmental restoration and decontamination and decommissioning. DOE sites that generate or store TRUW (note that the abbreviations given here are used throughout this appendix) include the following:

- Argonne National Laboratory-East (ANL-E), Argonne, Illinois
- Argonne National Laboratory-West (ANL-W), Idaho Falls, Idaho
- Energy Technology Engineering Center (ETEC), Canoga Park, California
- Hanford Site (Hanford), Richland, Washington
- Idaho National Engineering Laboratory (INEL), Idaho Falls, Idaho
- Inhalation Toxicology Research Institute (ITRI), Albuquerque, New Mexico
- Lawrence Berkeley Laboratory (LBL), Berkeley, California
- Lawrence Livermore National Laboratory (LLNL), Livermore, California

- Los Alamos National Laboratory (LANL), Los Alamos, New Mexico
- Mound Plant (Mound), Miamisburg, Ohio
- Nevada Test Site (NTS), Las Vegas, Nevada
- Oak Ridge Reservation (ORR), Oak Ridge, Tennessee
- Paducah Gaseous Diffusion Plant (PGDP), Paducah, Kentucky
- Rocky Flats Environmental Technology Site (RFETS), Golden, Colorado
- Sandia National Laboratories-New Mexico (SNL-NM), Albuquerque, New Mexico
- Sandia National Laboratories-California (SNL-CA), Livermore, California
- Savannah River Site (SRS), Aiken, South Carolina
- University of Missouri (Columbia) (UofMO), Columbia, Missouri
- West Valley Demonstration Project (WVDP), West Valley, New York
- Waste Isolation Pilot Plant (WIPP), Carlsbad, New Mexico

This list includes the 12 major sites considered for TRUW management described in Section 8.4.1 of Volume I. Treatment risks were also estimated separately later in this section in Tables D.3.4–12 through D.3.4–17 for several other sites in addition to the 12 major TRUW management sites. Note that for the purposes of this risk analysis, the waste loads from three smaller generators were added to the inventories of larger generators. Specifically, the ITRI waste load was combined with the SNL-NM inventory, the ANL-W waste load was added to the INEL inventory, and the SNL-CA waste load was combined with the LLNL inventory. Also, source terms were not available for ETEC, UofMO, and WVDP, so risks at these installations were not evaluated (ANL, 1996b). Treatment risks at LBL and Mound are contained in the programwide risk tables (Tables D.3.4–6 through D.3.4–11) presented in this section of the WM PEIS and in the alternative summary risk tables presented in Section 8.4 of Volume I.

Most TRUW is solid waste (such as contaminated tools, machine parts, protective clothing, and laboratory glassware) but some is in liquid or sludge forms. Perhaps 50 to 60 % of the DOE inventory of TRUW is mixed waste, containing both radioactive and hazardous constituents regulated under RCRA. Examples of this mixed waste include sludges contaminated with spent solvents, debris contaminated with solvents and radionuclides, and discarded contaminated lead shielding. Depending on its chemical and physical properties, TRUW can be grouped into waste stream categories, such as aqueous liquids, organic liquids, solid process residues, soils, or debris, according to the type of treatment needed.

Packaged TRUW with a surface dose rate of less than 200 mrem/h is categorized as contact-handled TRUW (CH-TRUW). Packaged TRUW with a surface dose rate greater than 200 mrem/h emits sufficient penetrating beta, gamma, or neutron radiation to require remote handling, and is classified as remote-handled TRUW (RH-TRUW). The handling category determines the level of protective shielding needed to store and process the waste safely. The distinction between CH-TRUW and RH-TRUW is maintained in the human health risk analysis for both routine operations and accidents. Therefore, the results for CH-TRUW are presented separately from the results for RH-TRUW.

The DOE Waste Isolation Pilot Plant (WIPP), located near Carlsbad, New Mexico, has been identified as the permanent disposal site for DOE-generated TRUW. To ensure that TRUW can be disposed of safely at WIPP, DOE has developed a set of waste acceptance criteria (referred to as "WIPP-WAC" in the risk analysis tables) that waste generators and treatment and storage sites must meet before shipping TRUW to WIPP. These waste acceptance criteria were taken into account in developing the PEIS alternatives. However, because the final WIPP disposal criteria will likely be more stringent than current criteria, two additional treatment standards were evaluated in this analysis. The first of these was treatment to an intermediate waste form that generates less gas from the degradation of organic chemicals and corrodible metals than is mandated by current WIPP waste acceptance criteria. This is accomplished mainly by shredding and grouting the wastes and packaging them in containers that are not expected to release significant amounts of gases when disposed of at WIPP. The second was treatment to meet RCRA land disposal restrictions (LDRs) as promulgated in 1986 in Title 40, Chapter 268 of the Code of Federal Regulations. This is the most extensive of the three treatment standards; wastes are incinerated to destroy most of the hazardous organic chemical components. Inorganic components such as metals remain in ash after incineration. Small quantities of radioactive or hazardous constituents would be released into the environment from treatment facilities considered in this study. On the basis of the releases, human health risks were evaluated; the results are presented in this appendix.

Chapters 3 and 8 of the PEIS and the TRUW technical report (ANL, 1996b) provide more detailed information on this waste, including TRUW inventories at DOE sites, estimated release rates, treatment categories used in the PEIS, and the process for developing PEIS TRUW alternatives.

D.3.4.1 Summary of CH-TRUW Alternatives

The PEIS waste management alternatives (No Action, Decentralized, Regionalized, and Centralized) and the rationale for developing the various CH-TRUW analysis alternatives are discussed rigorously in the main body of the PEIS.

- The No Action Alternative demonstrates the baseline risks of newly generated CH-TRUW packaging, certification, and indefinite interim storage at all generator sites. Treatment is not considered, and it is assumed that TRUW will not be disposed of at WIPP, although it will be prepared as though it were going to WIPP. The No Action Alternative does not assess the health risks, environmental impacts, or costs of removing TRUW from retrievable storage and packaging it.
- The Decentralized Alternative presents the risks of treating wastes to WIPP waste acceptance criteria and storing them at 10 sites.
- In Regionalized Alternative 1, CH-TRUW is consolidated, treated to minimize gas generation, and stored at five sites.
- In Regionalized Alternatives 2 and 3, CH-TRUW is consolidated, treated to meet RCRA LDRs, and stored at five and three sites, respectively.
- In the Centralized Alternative, CH-TRUW is consolidated, treated to meet RCRA LDRs, and stored at one site.

In Regionalized 1 and 2, consolidation, treatment, and storage take place at the same five sites. Comparison of these alternatives makes it possible to contrast the risks of treatment to minimize gas generation versus treatment to meet RCRA LDRs. Comparison of Regionalized 2, 3, and the Centralized Alternative demonstrates the differences in risks when the same treatment method is used but treatment and storage are performed at five, three, and one site(s), respectively.

Table D.3.4–1 presents the overall treatment and storage schemes for these six alternatives. Table D.3.4–2 shows which sites ship their wastes to regionalized or centralized consolidation sites for treatment and storage.

Table D.3.4-1. PEIS Alternatives for CH-TRUW

Alternative	ANL-E	ETEC[a]	Hanford	INEL[b]	LANL	LBL	LLNL[c]	Mound	NTS	ORR	PGDP	RFETS	SNL-NM[d]	SRS	UofMO[a]	WVDP[a]	WIPP
No Action Alternative	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	
No treatment/store at 16	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	
Decentralized Alternative	T		T	T	T		T	T	T	T		T		T			
Treat to WIPP-WAC/store at 10	S		S	S	S		S	S	S	S		S		S			
Regionalized Alternative 1			T	T	T							T		T			
Treat to reduce gas/store at 5			S	S	S							S		S			
Regionalized Alternative 2			T	T	T							T		T			
Treat to LDRs/store at 5			S	S	S							S		S			
Regionalized Alternative 3			T	T										T			
Treat to LDRs/store at 3			S	S										S			
Centralized Alternative																	T
Treat to LDRs/store at 1																	S

Notes: T = treatment site. S = storage site.
[a] Data for ETEC, UofMO, and WVDP were not available so risks at these sites were not evaluated.
[b] Includes CH-TRUW from ANL-W.
[c] Includes CH-TRUW from SNL-CA.
[d] Includes CH-TRUW from ITRI.

Table D.3.4-2. PEIS Consolidation and Treatment Strategies for CH-TRUW

Alternative	Origin	Treatment and Storage Destination
No Action Alternative No treatment; store at 16 sites	All sites	Generators store own waste
Decentralized Alternative Treat to WIPP-WAC and store at 10 sites	ANL-E Hanford, LBL INEL/ANL-W[a] LANL, SNL-NM/ITRI[a] LLNL/SNL-CA[a] Mound, WVDP[b] NTS, ETEC[c] ORR, PGDP, UofMO[c] RFETS SRS	ANL-E Hanford INEL LANL LLNL Mound NTS ORR RFETS SRS
Regionalized Alternative 1 Treat to minimize gas generation and store at 5 sites	Hanford, LBL, LLNL/SNL-CA INEL/ANL-W, ETEC, NTS LANL, SNL-NM/ITRI RFETS SRS, ANL-E, Mound, ORR, PGDP, UofMO, WVDP	Hanford INEL LANL RFETS SRS
Regionalized Alternative 2 Treat to RCRA LDRs and store at 5 sites	Hanford, LBL, LLNL/SNL-CA INEL/ANL-W, ETEC, NTS LANL, SNL-NM/ITRI RFETS SRS, ANL-E, Mound, ORR, PGDP, UofMO, WVDP	Hanford INEL LANL RFETS SRS
Regionalized Alternative 3 Treat to RCRA LDRs and store at 3 sites	Hanford, LBL, LLNL/SNL-CA INEL/ANL-W, ETEC, LANL, NTS, RFETS, SNL-NM/ITRI SRS, ANL-E, Mound, ORR, PGDP, UofMO, WVDP	Hanford INEL SRS
Centralized Alternative Treat to RCRA LDRs and store at WIPP	All sites	WIPP

[a] For the purpose of the human health risk analysis, the ANL-W waste load is added to the INEL inventory, the ITRI waste load is added to the SNL-NM inventory, and the SNL-CA waste load is added to the LLNL inventory.
[b] Source terms for WVDP were not available because the wastes at WVDP were special types that were not analyzed (see Section 8.2.1.1 of the WM PEIS). The new data in Appendix I shows some solid process residues and debris wastes, but in relatively small increments.
[c] Source terms for ETEC and UofMO were not evaluated (see Section 8.1.2 of the WM PEIS).

D.3.4.2 Special Assumptions and Considerations Used in the TRUW Risk Analysis

For all alternatives except the No Action Alternative (for CH-TRUW and RH-TRUW), it is assumed that new facilities will be operational in the year 2003. All current inventory, retrievably stored waste, and waste generated between 1993 to 2013 will be treated from approximately 2003 to 2013. Waste generated after 2013 will be treated as necessary (ANL, 1996b). Therefore, all alternatives except No Action were evaluated to estimate human health risks for a 10-year period of treatment and storage, while No Action was evaluated for a 20-year period. Disposal risks were not estimated for TRUW since it is assumed that all TRUW will be disposed of at WIPP.

It is assumed that WIPP will accept TRUW for disposal from 1998 to 2018. The acceptance rate for waste will average 7,080 m^3/year (250,000 ft^3/year) for 20 years. Because WIPP waste acceptance criteria may change over time, the human health risk assessment was performed for treatment to three increasingly stringent standards to obtain a clearer picture of the full range of potential impacts, (current WIPP waste acceptance criteria, treatment for reduced gas generation, and RCRA LDRs).

In the No Action Alternative, wastes are retrieved where necessary, packaged, certified for shipment to WIPP, and placed in interim storage. There is no treatment of waste other than packaging, but health risks to public receptors and WM workers are assessed for retrieval and packaging operations. Retrieval potentially poses exposure risk due to emissions from corroding waste containers. Therefore, contaminant emissions during both retrieval and packaging were considered as part of routine waste management for TRUW.

Waste containers were assumed to be 55-gal drums for CH-TRUW; 6-in.-wall concrete casks for RH-TRUW; and Transuranic Package Transporter-II (TRUPACT II) containers for packaging wastes to be shipped to WIPP.

A hazard index is reported for the noninvolved worker MEI and offsite MEI, while an exposure index is reported for workers. The HI reflects the highest exposure of the noninvolved worker MEI and offsite MEI to noncarcinogenic, hazardous chemicals. The EI indicates the analogous exposure to an individual FTE.

Staffing requirements, expressed as FTEs, were estimated for the TRUW module for polymer solidification using the FTE data for grout solidification; and for the TRUW module for wet-air oxidation using the FTE

data for wet-air oxidation of alpha-contaminated LLW and LLMW. For more information on the treatment modules, see ORNL (1995b).

D.3.4.3 Results Tables for the CH-TRUW Human Health Risk Analysis

This section contains the results tables for the CH-TRUW human health risk analysis. A discussion of the results is presented in Section D.3.4.4. The fatality and cancer incidence numbers in the tables are displayed in the standard exponential notation used in risk assessment; directions on reading this notation and a more complete description of the types of information in the tables are given in Section D.2.

- Table D.3.4–3 presents an overview, by alternative, of the *total*, programwide risks of cancer fatalities and cancer incidence for the offsite and noninvolved worker populations; and the risks of cancer fatalities, cancer incidence, and construction and operational fatalities for waste management workers. This table provides the estimated *total number* of people in the three populations who will develop or die of cancers caused by exposure to CH-TRUW over the next 50 years if a particular alternative is implemented nationwide. In addition, it shows the estimated total number of workers who will be killed in construction and operational activities.
- Table D.3.4–4 shows the sizes of the total affected populations for each alternative.
- Table D.3.4–5 summarizes the risks to the noninvolved worker MEI and offsite MEI for each CH-TRUW alternative. The numbers in this table are the estimated *probabilities* that the offsite and noninvolved worker MEIs will die of cancer or develop cancer from radionuclide or chemical exposure, and indicators of the likelihood of suffering adverse health effects from exposure to noncarcinogenic, hazardous constituents.
- Tables D.3.4–6 through D.3.4–11 show the programwide risks for all receptors and health effect endpoints, by alternative.
- Tables D.3.4–12 through D.3.4–17 present offsite and worker population risks for each installation, by alternative.
- Table D.3.4–18 lists the radionuclides that contribute most of the risk of cancer fatality to the offsite population, by site and alternative.

Table D.3.4-3. Summary of Programwide Risks Associated With Routine Management of CH-TRUW: Risks to Total Populations, by Alternative

Alternative	Offsite Population		Noninvolved Worker Population		WM Workers		
	CF	CI	CF	CI	CF	CI	C&OF
No Action Alternative	3.5E-05	1.2E-04	3.1E-06	1.1E-05	1.0E-01	3.4E-01	2.5E-01
Decentralized Alternative	1.6E-04	5.5E-04	1.4E-05	5.0E-05	6.1E-01	2.1	2.0
Regionalized Alternative 1	2.6E-04	8.6E-04	2.4E-05	7.9E-05	6.2E-01	2.2	2.3
Regionalized Alternative 2	8.7E-01	2.8	6.8E-02	2.9E-01	5.8E-01	2.0	3.6
Regionalized Alternative 3	1.7E-01	6.5E-01	1.8E-02	7.8E-02	6.3E-01	2.2	2.9
Centralized Alternative	2.6E-01	8.9E-01	2.1E-02	7.2E-02	7.0E-01	2.5	1.6

Notes: CF = cancer fatality associated with radionuclide exposure; CI = cancer incidence associated with exposure to radionuclides and carcinogenic chemicals; C&OF = fatalities due to the physical hazards of constructing and operating waste management facilities.

Table D.3.4-4. Size of Total Offsite, Noninvolved Worker, and Worker Populations Affected by Risks From Routine Management of CH-TRUW, by Alternative

Alternative	Offsite	Noninvolved Worker	WM Worker
No Action	27,716,666	70,681	1,696
Decentralized	28,643,318	92,462	6,485
Regionalized 1	27,716,666	88,653	8,366
Regionalized 2	27,716,666	88,653	14,047
Regionalized 3	27,716,666	88,653	11,469
Centralized	27,861,555	89,713	8,238

Table D.3.4-5. Summary of Programwide Risks Associated With Routine Management of CH-TRUW: Risks to the Offsite and Noninvolved Worker Maximally Exposed Individuals, by Alternative

Alternative	Offsite MEI				Noninvolved Worker MEI			
	CF	Rad CI	Chem CI	HI	CF	Rad CI	Chem CI	HI
No Action	4.4E-10	1.3E-09	3.1E-13	2.6E-11	2.0E-09	6.9E-09	2.7E-10	1.2E-11
Decentralized	5.7E-09	1.9E-08	2.8E-12	1.6E-10	6.8E-09	2.3E-08	8.9E-12	1.4E-09
Regionalized 1	6.9E-09	2.3E-08	4.8E-12	2.2E-10	1.3E-08	4.3E-08	1.5E-11	2.5E-09
Regionalized 2	6.7E-05	2.3E-04	4.8E-12	1.1E-08	4.4E-05	1.5E-04	1.5E-11	2.8E-08
Regionalized 3	5.1E-06	1.7E-05	4.8E-12	7.9E-10	1.4E-05	4.8E-05	1.5E-11	6.3E-09
Centralized	6.9E-05	2.3E-04	2.1E-13	4.9E-11	8.8E-05	2.8E-04	1.3E-12	3.0E-10

Notes: CF = cancer fatality associated with exposure to radionuclides; Rad CI = cancer incidence associated with exposure to radionuclides; Chem CI = cancer incidence associated with exposure to carcinogenic chemicals; HI = hazard index associated with exposure to noncarcinogenic, toxic chemicals.

Table D.3.4-6. Programwide Risks Associated With Managing CH-TRUW Under the No Action Alternative

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	6.3E-03			
	Cancer fatalities	3.1E-06			
	Cancer incidence	1.1E-05	3.4E-09		
	Genetic effects	6.3E-07			
Noninvolved worker MEI	Dose (rem)	4.1E-06			
	Cancer fatalities	2.0E-09			
	Cancer incidence	6.9E-09	2.7E-10		
	Genetic effects	4.1E-10			
	Hazard index			1.2E-11	
Offsite population	Dose (person-rem)	7.0E-02			
	Cancer fatalities	3.5E-05			
	Cancer incidence	1.2E-04	1.4E-08		
	Genetic effects	7.0E-06			
Offsite MEI	Dose (rem)	8.7E-07			
	Cancer fatalities	4.4E-10			
	Cancer incidence	1.5E-09	3.1E-13		
	Genetic effects	8.7E-11			
	Hazard index			2.6E-11	
WM workers	Dose (FTE-rem)	2.5E+02			
	Cancer fatalities	1.0E-01			
	Cancer incidence	3.4E-01	2.8E-07		
	Genetic effects	1.5E-02			
	Exposure index			2.1E-06	
	Construction fatalities				1.1E-01
	Construction injuries				4.2E-01
	Operation fatalities				1.4E-01
	Operation injuries				9.1E-01

Table D.3.4-7. Programwide Risks Associated With Managing CH-TRUW Under the Decentralized Alternative

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	3.0E-02			
	Cancer fatalities	1.4E-05			
	Cancer incidence	5.0E-05	3.4E-08		
	Genetic effects	3.0E-06			
Noninvolved worker MEI	Dose (rem)	1.4E-05			
	Cancer fatalities	6.8E-09			
	Cancer incidence	2.3E-08	8.9E-12		
	Genetic effects	1.4E-09			
	Hazard index			1.4E-09	
Offsite population	Dose (person-rem)	3.2E-01			
	Cancer fatalities	1.6E-04			
	Cancer incidence	5.5E-04	1.3E-07		
	Genetic effects	3.2E-05			
Offsite MEI	Dose (rem)	1.1E-03			
	Cancer fatalities	5.7E-09			
	Cancer incidence	1.9E-08	2.8E-12		
	Genetic effects	1.1E-09			
	Hazard index	1.5E-10		1.5E-10	
WM workers	Dose (FTE-rem)	1.5E+03			
	Cancer fatalities	6.1E-01			
	Cancer incidence	2.1	9.8E-06		
	Genetic effects	9.1E-02			
	Exposure index			3.0E-05	
	Construction fatalities				1.3
	Construction injuries				5.0E+02
	Operation fatalities				6.9E-01
	Operation injuries				5.3E+02

Table D.3.4–8. Programwide Risks Associated With Managing CH-TRUW Under Regionalized Alternative 1

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	4.6E–02			
	Cancer fatalities	2.4E–05			
	Cancer incidence	7.9E–05	5.6E–08		
	Genetic effects	4.6E–06			
Noninvolved worker MEI	Dose (rem)	2.5E–05			
	Cancer fatalities	1.3E–08			
	Cancer incidence	4.3E–08	1.5E–11		
	Genetic effects	2.5E–09			
	Hazard index			2.5E–09	
Offsite population	Dose (person-rem)	5.1E–01			
	Cancer fatalities	2.6E–04			
	Cancer incidence	8.6E–04	2.3E–07		
	Genetic effects	5.1E–05			
Offsite MEI	Dose (rem)	1.4E–05			
	Cancer fatalities	6.9E–09			
	Cancer incidence	2.3E–08	4.8E–12		
	Genetic effects	1.4E–09			
	Hazard index			2.2E–10	
WM workers	Dose (FTE-rem)	1.6E+03			
	Cancer fatalities	6.2E–01			
	Cancer incidence	2.2	1.8E–05		
	Genetic effects	9.2E–02			
	Exposure index			2.4E–05	
	Construction fatalities				1.5
	Construction injuries				6.2E+02
	Operation fatalities				8.1E–01
	Operation injuries				5.9E+02

Table D.3.4-9. Programwide Risks Associated With Managing CH-TRUW Under Regionalized Alternative 2

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	1.5E-02			
	Cancer fatalities	6.8E-02			
	Cancer incidence	2.9E-01	5.5E-08		
	Genetic effects	1.5E-02			
Noninvolved worker MEI	Dose (rem)	8.7E-02			
	Cancer fatalities	4.4E-05			
	Cancer incidence	1.5E-04	1.5E-11		
	Genetic effects	8.7E-06			
	Hazard index			2.8E-08	
Offsite population	Dose (person-rem)	1.9E+03			
	Cancer fatalities	8.7E-01			
	Cancer incidence	2.8	2.2E-07		
	Genetic effects	1.9E-01			
Offsite MEI	Dose (rem)	1.3E-01			
	Cancer fatalities	6.7E-05			
	Cancer incidence	2.3E-04	4.8E-12		
	Genetic effects	1.3E-05			
	Hazard index			1.1E-08	
WM workers	Dose (FTE-rem)	1.4E+03			
	Cancer fatalities	5.8E-01			
	Cancer incidence	2.0	2.4E-05		
	Genetic effects	8.8E-02			
	Exposure index			2.1E-06	
	Construction fatalities				2.2
	Construction injuries				8.6E+02
	Operation fatalities				1.4
	Operation injuries				1.1E+03

Table D.3.4–10. Programwide Risks Associated With Managing CH-TRUW Under Regionalized Alternative 3

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	3.6E+01			
	Cancer fatalities	1.8E–02			
	Cancer incidence	7.8E–02	5.6E–08		
	Genetic effects	3.6E–03			
Noninvolved worker MEI	Dose (rem)	2.8E–02			
	Cancer fatalities	1.4E–05			
	Cancer incidence	4.8E–05	1.5E–11		
	Genetic effects	2.8E–06			
	Hazard index			1.4E–10	
Offsite population	Dose (person-rem)	3.8E+02			
	Cancer fatalities	1.7E–01			
	Cancer incidence	6.5E–01	2.2E–07		
	Genetic effects	3.8E–02			
Offsite MEI	Dose (rem)	1.0E–02			
	Cancer fatalities	5.1E–06			
	Cancer incidence	1.7E–05	4.8E–12		
	Genetic effects	1.0E–06			
	Hazard index			7.9E–10	
WM workers	Dose (FTE-rem)	1.5E+03			
	Cancer fatalities	6.3E–01			
	Cancer incidence	2.2	3.5E–05		
	Genetic effects	9.4E–02			
	Exposure index			2.1E–06	
	Construction fatalities				1.8
	Construction injuries				7.0E+02
	Operation fatalities				1.1
	Operation injuries				7.9E+02

Table D.3.4-11. Programwide Risks Associated With Managing CH-TRUW Under the Centralized Alternative

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	4.2E-01			
	Cancer fatalities	2.1E-02			
	Cancer incidence	7.2E-02	6.3E-08		
	Genetic effects	4.2E-03			
Noninvolved worker MEI	Dose (rem)	1.6E-01			
	Cancer fatalities	8.2E-05			
	Cancer incidence	2.8E-04	1.3E-12		
	Genetic effects	1.6E-05			
	Hazard index			3.0E-10	
Offsite population	Dose (person-rem)	5.2E+02			
	Cancer fatalities	2.6E-01			
	Cancer incidence	8.9E-01	2.2E-07		
	Genetic effects	5.0E-02			
Offsite MEI	Dose (rem)	1.4E-01			
	Cancer fatalities	6.9E-05			
	Cancer incidence	2.3E-04	2.1E-13		
	Genetic effects	1.4E-05			
	Hazard index			4.9E-11	
WM workers	Dose (FTE-rem)	1.8E+03			
	Cancer fatalities	7.0E-01			
	Cancer incidence	2.5	5.1E-05		
	Genetic effects	1.0E-01			
	Exposure index			5.1E-04	
	Construction fatalities				1.1
	Construction injuries				4.3E-02
	Operation fatalities				5.0E-01
	Operation injuries				4.0E+02

Table D.3.4-12. Risks Associated With Managing CH-TRUW Under the No Action Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 457	4.6E-06	9.5E-11	9.2E-02	1.6E-05	3.2E-10	2.1E-01
INEL	153,061 55	2.6E-09	3.3E-13	1.1E-02	8.9E-09	1.1E-12	3.8E-06
LBL	5,856,829 0	4.8E-10	7.0E-15	3.4E-05	1.7E-09	2.5E-14	3.2E-12
LLNL	6,324,234 148	1.1E-06	1.8E-11	3.0E-02	3.8E-06	6.1E-11	2.5E-05
LANL	159,152 257	4.1E-06	4.4E-10	5.3E-02	1.4E-05	1.5E-09	1.2E-03
PGDP	500,502 0	0.00	0.00	0.00	0.00	0.00	0.00
Mound	3,032,983 0	0.00	0.00	0.00	0.00	0.00	0.00
NTS	14,266 0	0.00	0.00	0.00	0.00	0.00	0.00
RFETS	2,171,877 353	3.0E-06	4.1E-11	7.3E-02	1.0E-05	1.4E-10	2.9E-04
SNL-NM	610,714 0	0.00	0.00	0.00	0.00	0.00	0.00
SRS	620,618 320	2.2E-05	2.0E-10	6.3E-02	7.4E-05	6.9E-10	1.3E-01
ANL-E	7,939,785 106	5.5E-07	3.1E-12	2.2E-02	1.9E-06	1.0E-11	3.3E-06
Total		3.5E-05	4.4E-10	3.5E-01	1.2E-04	1.5E-09	3.4E-01

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs ("worker equivalents") for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.4-13. Risks Associated With Managing CH-TRUW Under the Decentralized Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 275	1.8E-06	9.9E-12	1.0E-01	6.1E-06	3.4E-11	3.0E-02
INEL	153,061 2,303	1.1E-06	1.4E-10	1.0	3.8E-06	4.8E-10	8.7E-01
LBL	5,856,829 1	6.3E-09	9.4E-14	8.4E-03	2.1E-08	3.2E-13	7.6E-09
LLNL	6,324,234 354	3.5E-06	5.7E-11	1.1E-01	1.2E-05	2.0E-10	2.0E-03
LANL	159,152 1,064	5.4E-05	5.7E-09	4.9E-01	1.8E-04	1.9E-08	5.0E-01
ORR	881,652 2	0.00	0.00	4.7E-04	0.00	0.00	7.9E-14
Mound	3,032,983 84	8.4E-07	4.8E-11	3.2E-02	2.9E-06	1.6E-10	4.8E-04
NTS	14,266 204	1.1E-10	3.0E-14	6.8E-02	3.9E-10	1.0E-13	7.3E-04
PGDP	500,502 15	3.5E-09	3.9E-13	1.3E-02	1.2E-08	1.3E-12	1.6E-06
RFETS	2,171,877 664	9.3E-06	1.3E-10	2.2E-01	3.2E-05	4.3E-10	2.7E-02
SNL-NM	610,714 2	2.7E-09	1.1E-13	8.7E-03	9.1E-09	3.6E-13	2.1E-08
SRS	620,618 550	7.2E-05	6.8E-10	1.5E-01	2.5E-04	2.3E-09	2.4E-01
Hanford	377,645 967	1.7E-05	3.5E-10	2.8E-01	5.7E-05	1.2E-09	4.4E-01
Total		1.6E-04	5.7E-09	2.5	5.5E-04	1.9E-08	2.1

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs ("worker equivalents") for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.4-14. Risks Associated With Managing CH-TRUW Under Regionalized Alternative 1, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 121	1.5E-06	8.5E-12	4.5E-02	5.2E-06	2.9E-11	3.0E-02
Hanford	377,645 1,330	3.0E-05	6.1E-10	3.5E-01	1.0E-04	2.1E-09	4.5E-01
INEL	153,061 3,100	1.4E-06	1.8E-10	1.2	4.9E-06	6.0E-10	8.7E-01
LBL	5,856,829 1	9.8E-09	1.5E-13	1.8E-04	3.4E-08	5.0E-13	7.5E-09
LLNL	6,324,234 186	3.6E-06	5.9E-11	5.7E-02	1.3E-05	2.1E-10	2.0E-03
LANL	159,152 1,502	6.5E-05	6.9E-09	6.4E-01	2.2E-04	2.3E-08	5.0E-01
PGDP	500,502 8	5.3E-09	5.9E-13	2.5E-03	1.8E-08	2.0E-12	1.7E-06
Mound	3,032,983 47	1.5E-06	8.6E-11	1.4E-02	5.1E-06	2.9E-10	4.7E-04
NTS	14,266 137	1.5E-10	3.9E-14	4.2E-02	5.1E-10	1.3E-13	7.0E-04
RFETS	2,171,877 989	1.5E-05	2.0E-10	3.4E-01	5.1E-05	6.9E-10	2.7E-02
SNL-NM	610,714 1	3.5E-09	1.4E-13	4.5E-04	1.2E-08	4.8E-13	2.1E-08
SRS	620,618 944	1.4E-04	1.3E-09	2.2E-01	4.6E-04	4.3E-09	2.7E-01
Total		2.6E-04	6.9E-09	3.0	8.6E-04	2.3E-08	2.2

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs ("worker equivalents") for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.4-15. Risks Associated With Managing CH-TRUW Under Regionalized Alternative 2, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 121	1.5E-06	8.5E-12	4.5E-02	5.2E-06	2.9E-11	3.0E-02
Hanford	377,645 2,150	1.7E-01	3.4E-06	4.3E-01	5.6E-01	1.2E-05	4.3E-01
INEL	153,061 5,364	7.3E-03	9.1E-07	1.8	2.5E-02	3.1E-06	8.3E-01
LBL	5,856,829 1	9.8E-09	1.5E-13	1.8E-04	3.4E-08	5.0E-13	7.5E-09
LLNL	6,324,234 186	3.6E-06	5.9E-11	5.7E-02	1.3E-05	2.1E-10	2.0E-03
LANL	159,152 2,772	6.4E-01	6.7E-05	9.6E-01	2.2	2.3E-04	4.8E-01
PGDP	500,502 8	5.3E-09	5.9E-13	2.5E-03	1.8E-08	2.0E-12	1.7E-06
Mound	3,032,983 47	1.5E-06	8.6E-11	1.4E-02	5.1E-06	2.9E-10	4.7E-04
NTS	14,266 137	1.5E-10	3.9E-14	4.2E-02	5.1E-10	1.3E-13	7.0E-04
RFETS	2,171,877 1,852	1.1E-01	1.5E-06	5.7E-01	3.7E-01	5.0E-06	2.5E-02
SNL-NM	610,714 1	3.5E-09	1.4E-13	4.5E-04	1.2E-08	4.8E-13	2.1E-08
SRS	620,618 1,408	2.3E-03	2.1E-08	2.6E-01	7.7E-03	7.2E-08	2.6E-01
Total		8.7E-01	6.7E-05	4.2	2.8	2.3E-04	2.0

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs ("worker equivalents") for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.4-16. Risks Associated With Managing CH-TRUW Under Regionalized Alternative 3, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 121	1.5E-06	8.5E-12	4.5E-02	5.2E-06	2.9E-11	3.0E-02
Hanford	377,645 2,150	1.7E-01	3.4E-06	4.3E-01	5.6E-01	1.2E-05	4.3E-01
INEL	153,061 6,277	4.1E-02	5.1E-06	2.1	1.4E-01	1.7E-05	8.7E-01
LBL	5,856,829 1	9.8E-09	1.5E-013	1.8E-04	3.4E-08	5.0E-13	7.5E-09
LLNL	6,324,234 186	3.6E-06	5.9E-11	5.7E-02	1.3E-05	2.1E-10	2.0E-03
LANL	159,152 713	7.1E-05	7.4E-09	3.8E-01	2.4E-04	2.5E-08	5.0E-01
PGDP	500,502 8	5.3E-09	5.9E-13	2.5E-03	1.8E-08	2.0E-12	1.7E-06
Mound	3,032,983 47	1.5E-06	8.6E-11	1.4E-02	5.1E-06	2.9E-10	4.7E-04
NTS	14,266 137	1.5E-10	3.9E-14	4.2E-02	5.1E-10	1.3E-13	7.0E-04
RFETS	2,171,877 420	1.2E-05	1.6E-10	1.6E-01	4.1E-05	5.6E-10	1.0E-01
SNL-NM	610,714 1	3.5E-09	1.4E-13	4.5E-04	1.2E-08	4.8E-13	2.1E-08
SRS	620,618 1,408	2.3E-03	2.1E-08	2.6E-01	7.7E-03	7.2E-08	2.6E-01
Total		1.7E-01	5.1E-06	3.5	6.5E-01	1.7E-05	2.2

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs ("worker equivalents") for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.4-17. Risks Associated With Managing CH-TRUW Under the Centralized Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
WIPP	99,889 4,132	2.6E-01	6.9E-05	4.6E-01	8.9E-01	2.3E-04	5.7E-02
ANL-E	7,939,785 121	1.5E-06	8.5E-12	4.5E-02	5.2E-06	2.9E-11	3.0E-02
Hanford	377,645 522	7.6E-06	1.6E-10	2.7E-01	2.6E-05	5.3E-10	5.6E-01
INEL	153,061 1,586	1.6E-06	2.0E-10	7.6E-01	5.3E-06	6.6E-10	8.5E-01
LBL	5,856,829 1	9.8E-09	1.5E-13	1.8E-04	3.4E-08	5.0E-13	7.5E-09
LLNL	6,324,234 186	3.6E-06	5.9E-11	5.7E-02	1.3E-05	2.1E-10	2.0E-03
LANL	159,152 713	7.1E-05	7.4E-09	3.8E-01	2.4E-04	2.5E-08	5.0E-01
PGDP	500,502 8	5.3E-09	5.9E-13	2.5E-03	1.8E-08	2.0E-12	1.7E-06
Mound	3,032,983 47	1.5E-06	8.6E-11	1.4E-02	5.1E-06	2.9E-10	4.7E-04
NTS	14,266 137	1.5E-10	3.9E-14	4.2E-02	5.1E-10	1.3E-13	7.0E-04
RFETS	2,171,877 420	1.2E-05	1.6E-10	1.6E-01	4.1E-05	5.6E-10	1.0E-01
SNL-NM	610,714 1	3.5E-09	1.4E-13	4.5E-04	1.2E-08	4.8E-13	2.1E-08
SRS	620,618 364	3.4E-05	3.2E-10	1.7E-01	1.2E-04	1.1E-09	3.6E-01
Total		2.6E-01	6.9E-05	2.3	8.9E-01	2.3E-04	2.5

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs ("worker equivalents") for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.4–18. CH-TRUW Radionuclides Contributing the Highest Risk of Cancer Fatality to the Offsite Population at Each Site, by Alternative

Alternative	Installation													
	ANL-E	Hanford	INEL	LANL	LBL	LLNL	Mound	NTS	PGDP	RFETS	SNL-NM	SRS	ORR	WIPP
No Action	Pu-239[a] 4.21E-07[b]	Pu-238 3.05E-06	Am-241 1.34E-09	Am-241 2.14E-06	Pu-239 2.53E-10	Pu-239 5.68E-07	Pu-238 0.00	Pu-242 0.00	Pu-242 0.00	Am-241 1.59E-06	Pu-242 0.00	Pu-238 2.09E-05		
Decentralized	Pu-239 1.37E-06	Pu-238 1.12E-05	Am-241 5.84E-07	Am-241 2.80E-05	Pu-239 3.25E-09	Pu-239 1.79E-06	Pu-238 8.38E-07	Pu-239 2.29E-10	Pu-239 1.82E-09	Am-241 4.94E-06	Pu-239 1.38E-09	Pu-238 6.95E-05	Pu-242 0.00	
Regionalized 1	Pu-239 1.18E-06	Pu-238 1.93E-05	Am-241 7.39E-07	Am-241 3.42E-05	Pu-239 5.11E-09	Pu-239 1.88E-06	Pu-238 1.50E-06	Pu-239 3.01E-10	Pu-239 2.76E-09	Am-241 7.94E-06	Pu-239 1.81E-09	Pu-238 1.29E-04		
Regionalized 2	Pu-239 1.18E-06	Pu-238 1.06E-01	Am-241 3.80E-03	Am-241 3.33E-01	Pu-239 5.11E-09	Pu-239 1.88E-06	Pu-238 1.50E-06	Pu-239 3.01E-10	Pu-239 2.76E-09	Am-241 5.82E-02	Pu-239 1.81E-09	Pu-238 1.65E-03		
Regionalized 3	Pu-239 1.18E-06	Pu-238 1.06E-01	Am-241 2.13E-02	Am-241 3.68E-05	Pu-239 5.11E-09	Pu-239 1.88E-06	Pu-238 1.50E-06	Pu-239 3.01E-10	Pu-239 2.76E-09	Am-241 6.45E-06	Pu-239 1.81E-09	Pu-238 1.65E-03		
Centralized	Pu-239 1.18E-06	Pu-238 5.0E-06	Am-241 8.11E-07	Am-241 3.68E-05	Pu-239 5.11E-09	Pu-239 1.88E-06	Pu-238 1.50E-06	Pu-239 3.01E-10	Pu-239 2.76E-09	Am-241 6.45E-06	Pu-239 1.81E-09	Pu-238 3.28E-05		Pu-238 1.09E-01

[a] Radionuclide contributing most risk.
[b] Associated risk of cancer fatality to the offsite population within 80 km (50 mi) of this site.

D.3.4.4 Results of the CH-TRUW Human Health Risk Analysis for Routine Operations

In general, No Action presents the lowest health risks for all public and worker populations and for all health risk endpoints because no waste treatment is performed other than packaging. For offsite and noninvolved worker receptors, the health risks associated with the other CH-TRUW alternatives generally increase as more extensive waste treatment is assumed; the alternatives with the highest estimated health risks are those involving treatment to meet RCRA LDRs. For workers, all alternatives that include waste treatment involve similar health risks. Overall, the health risks from exposure to chemicals in CH-TRUW are considerably lower than from exposure to radionuclides. In addition, the probability of adverse effects from noncarcinogenic, hazardous chemicals is very low. Estimated impacts to each receptor population are summarized below.

D.3.4.4.1 *Programwide Trends in Human Health Risks Associated With CH-TRUW Management Alternatives*

Offsite Population. Radiological and chemical exposure risks to the offsite population are lowest for No Action in which CH-TRUW is stored, without treatment, at the 16 generator sites in existing or approved facilities. The programwide risk of cancer fatality for this alternative is 3.5E-05 distributed over a total affected offsite population of approximately 28 million (see Tables D.3.4-3 and D.3.4-4). The exposure risks to offsite populations in Decentralized (in which wastes are treated to WIPP waste acceptance criteria and stored at 10 installations) and Regionalized 1 (in which wastes are treated to reduce gas generation and stored at 5 installations) are slightly higher than those for No Action and are distributed over a similar total population. Regionalized 2, 3, and Centralized, the three alternatives in which CH-TRUW receives the extensive treatment necessary to meet RCRA LDRs, show markedly higher risks to offsite populations than other alternatives, with 0.17 to 0.87 estimated cancer fatalities over a total population of approximately 28 million people.

The highest risks to the offsite population are associated with Regionalized 2 and 3 (in which wastes are treated to RCRA LDRs and stored at five and three sites, respectively). Estimated programwide cancer fatalities for all 12 sites in Regionalized 2 and 3 are 0.87 and 0.17, respectively, for a total offsite population of approximately 28 million. Tables D.3.4-15 and D.3.4-16 show that the predominant portion of the estimated cancer risks in Regionalized 2 and 3 are attributed to LANL and Hanford, respectively.

At LANL, 0.64 cancer fatalities are estimated to occur in the Regionalized 2 Alternative, while 4.1E-02 cancer fatalities are estimated to occur in Regionalized 3. These fatalities are estimated to occur in a population of 159,152 over a 10-year treatment period. In both the Regionalized 2 and 3 Alternatives, 0.17 cancer fatalities in a population of 377,645 at Hanford are estimated to occur over the 10-year treatment period. The higher estimated cancer risks at Hanford and LANL are linked to their relatively large inventory of plutonium-238 and americium-241, respectively (the larger the contaminant inventory with respect to other sites, the larger the amount of contaminant assumed to be released during treatment).

The risks of radionuclide-related cancer incidence and genetic effects follow the same general trend as for cancer fatalities. Estimated programwide risk of cancer incidence due to exposure to carcinogenic chemicals remains fairly consistent (in the E-07 order of magnitude) across alternatives except for No Action in which this estimated risk is slightly lower by approximately 1 order of magnitude.

Noninvolved Worker Population. The programwide health risks to noninvolved worker populations parallel the trends observed for offsite populations but are slightly lower and involve much smaller affected populations (see Table D.3.4-4). Regionalized 2 poses the highest programwide risk to noninvolved worker populations (6.8E-02 total estimated cancer fatalities); however, the estimated cancer fatality risk for Regionalized 3 (1.8E-02) is only slightly lower than for Regionalized 2. The programwide risk of cancer incidence due to exposure to carcinogenic chemicals is in the E-08 order of magnitude in all except No Action, where it is slightly lower (by approximately 1 order of magnitude).

Maximally Exposed Noninvolved Worker and Offsite Individual. As shown in Table D.3.4-5, radiological exposure risks to the noninvolved worker and offsite MEIs are lowest for No Action, slightly higher for Decentralized and Regionalized 1, and highest by approximately 4 to 5 orders of magnitude for Regionalized 2, 3, and Centralized. This trend generally parallels that seen for noninvolved worker and offsite populations. The risk of cancer fatality for an MEI in Regionalized 2 and 3 are in the E-06 to E-05 range, and the highest risk of cancer fatality for an MEI is in the Centralized Alternative (8.8E-05 for the noninvolved worker MEI and 6.9E-05 for the offsite MEI). In the alternatives involving treatment to LDRs (Regionalized 2, 3, and Centralized), the risks of cancer incidence to the noninvolved worker and offsite MEIs from radionuclides exceed 1.0E-04.

Tables D.3.4-15 through D.3.4-17 show that the highest risks of cancer fatality to the offsite MEI are at LANL, Hanford, and RFETS in Regionalized 2; Hanford and INEL in Regionalized 3; and WIPP in the

Centralized Alternative. The elevated risks to the MEIs at these sites are due to two factors. First, in Regionalized 2 and 3, elevated cancer risks to the MEIs at LANL, Hanford, and RFETS result from increased exposure to emissions during treatment to LDRs. Second, in Regionalized 3 and Centralized, elevated cancer risks to the MEIs at INEL and WIPP result from a combination of increased emissions from treatment to LDRs and increased waste loads from consolidation.

All health risks due to chemical exposures are relatively low compared to radiation risks. Estimated risk of cancer incidence to each MEI due to chemical exposure is similar among alternatives and does not exceed the E-11 order of magnitude. In addition, the hazard indices for both MEIs are at least 9 orders of magnitude below 1.0 in all alternatives, indicating that adverse health effects from noncarcinogenic chemicals are unlikely.

Workers. As observed for public receptor populations, programwide radiological and chemical exposure risks to workers are lowest in No Action. Worker health risks for No Action are lower than for the other alternatives by approximately 1 order of magnitude (1.0E-01 estimated cancer fatalities over a population of 1,696 FTEs). No treatment is performed and fewer FTEs are required than in the other alternatives, resulting in less collective exposure. The estimated risk of cancer fatality (approximately 6.0E-01) and cancer incidence (approximately 2.0) due to radiation exposure are approximately equal in all but No Action, indicating that collective worker radiation exposure is relatively independent of the type of CH-TRUW treatment involved.

Worker health risks associated with chemical exposure vary slightly among alternatives. The exposure index, or the highest individual worker exposure to noncarcinogenic chemicals, follows the trend for the noninvolved worker and offsite MEIs (No Action is the lowest; Decentralized and Regionalized 1 are slightly higher; and Regionalized 2, 3, and Centralized are substantially higher). However, the exposure indices in all alternatives are at least 5 orders of magnitude below 1.0, indicating a low probability of adverse health effects from noncarcinogenic, hazardous constituents. The risk of worker cancer incidence from chemical exposure rises gradually across alternatives (lowest in No Action and slightly higher in the other alternatives). As seen with public receptor populations, chemical exposure contributes much less to worker health risk estimates than radiation exposure.

Estimated construction and operational fatalities are always higher than those associated with radiation exposure, regardless of alternative. No Action results in lower worker health risks from physical hazards because fewer person-hours are spent in construction and operation of facilities; therefore, injuries and fatalities are less likely. Regionalized 2 poses the highest risk of construction and operation fatalities of all the alternatives (3.6), reflecting the greatest number of person-hours devoted to these activities (see Table D.3.4–4).

Discussion. Radiation exposure risks from the routine management of CH-TRUW are substantially greater for all populations than chemical exposure risks; in addition, risks of worker fatalities due to physical hazards are always greater than those due to exposure.

For the offsite population, SRS consistently poses the highest estimated cancer fatalities for the No Action, Decentralized, and Regionalized 1 Alternatives. For the Regionalized 2, Regionalized 3, and Centralized Alternatives, LANL, Hanford, and WIPP pose the highest estimated cancer fatalities. The radionuclides contributing the most risk to the offsite population at Hanford and LANL in Regionalized 2 and 3 are americium and plutonium isotopes through inhalation and ingestion (see Table D.3.4–18). The controlling radionuclides are the same at WIPP in the Centralized Alternative, reflecting the consolidation of all installations' CH-TRUW at WIPP. Note that the cancer fatality risk to the offsite population is more than 4 orders of magnitude higher when Hanford treats its own waste than when its waste is treated at WIPP. This reflects the larger size and higher density of the population surrounding Hanford (compare the population distributions for Hanford and WIPP as shown in Tables D.3.4–19 and D.3.4–20).

For workers, the highest estimated total fatalities (cancer fatalities plus construction and operational fatalities) are associated with INEL in every alternative except No Action, where Hanford has the highest worker fatality risks, and Centralized, where WIPP has the highest number of total fatalities. As might be expected, for each alternative, the installation with the highest worker risk also has the highest number of FTEs involved in CH-TRUW management. The radionuclides contributing the most risk for workers at these sites are uranium-238 and uranium-235 at INEL via inhalation; and cesium-137 at Hanford and WIPP via external exposure.

Table D.3.4–19. Population Distribution Around Hanford on the Basis of the 1990 U.S. Census

Direction From Site	Distance From Site										
	0.8 km	2.4 km	4.0 km	5.6 km	7.2 km	12 km	24 km	40 km	56 km	72 km	Total
S	0.00	0.00	0.00	0.00	0.00	0.00	3,063.00	1,277.00	211.00	3,006.00	7,557.00
SSW	0.00	0.00	0.00	0.00	0.00	0.00	303.00	8,841.00	138.00	202.00	9,484.00
SW	0.00	0.00	0.00	0.00	0.00	0.00	24.00	[illegible]654.00	4,298.00	90.00	30,066.00
WSW	0.00	0.00	0.00	0.00	0.00	0.00	35.00	[illegible]012.00	18,451.00	5,004.00	25,502.00
W	0.00	0.00	0.00	0.00	0.00	0.00	23.00	[illegible]38.00	2,833.00	101,475.00	104,369.00
WNW	0.00	0.00	0.00	0.00	0.00	0.00	764.00	[illegible]159.00	0.00	3,669.00	4,592.00
NW	0.00	0.00	0.00	0.00	0.00	0.00	299.00	1,405.00	114.00	460.00	2,278.00
NNW	0.00	0.00	0.00	0.00	0.00	0.00	284.00	516.00	1,030.00	5,804.00	7,634.00
N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,121.00	369.00	2,003.00	4,493.00
NNE	0.00	0.00	0.00	0.00	0.00	0.00	75.00	721.00	3,623.00	19,894.00	24,313.00
NE	0.00	0.00	0.00	0.00	0.00	0.00	55.00	8,779.00	2,491.00	369.00	11,694.00
ENE	0.00	0.00	0.00	0.00	0.00	0.00	571.00	703.00	2,371.00	187.00	3,832.00
E	0.00	0.00	0.00	0.00	0.00	0.00	1,377.00	844.00	125.00	294.00	2,640.00
ESE	0.00	0.00	0.00	0.00	0.00	0.00	678.00	995.00	207.00	271.00	2,151.00
SE	0.00	0.00	0.00	0.00	0.00	0.00	183.00	42,497.00	55,888.00	297.00	98,865.00
SSE	0.00	0.00	0.00	0.00	0.00	0.00	2,342.00	28,710.00	556.00	6,567.00	38,175.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	10,076.00	125,272.00	92,705.000	149,592.00	377,645.00

Table D.3.4–20. Population Distribution Around the Waste Isolation Pilot Plant (WIPP) on the Basis of the 1990 U.S. Census

Direction From Site	Distance From Site										
	0.8 km	2.4 km	4.0 km	5.6 km	7.2 km	12 km	24 km	40 km	56 km	72 km	Total
S	0.00	0.00	0.00	0.00	0.00	0.00	3.00	2.00	46.00	20.00	71.00
SSW	9.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	43.00	8.00	62.00
SW	0.00	0.00	0.00	0.00	0.00	0.00	37.00	57.00	0.00	5.00	99.00
WSW	0.00	0.00	0.00	0.00	0.00	0.00	1,622.00	191.00	57.00	62.00	1,932.00
W	0.00	0.00	0.00	0.00	0.00	0.00	138.00	25,291.00	197.00	3.00	25,629.00
WNW	0.00	0.00	0.00	0.00	0.00	0.00	38.00	5,765.00	242.00	63.00	6,108.00
NW	0.00	0.00	0.00	0.00	0.00	0.00	6.00	7.00	14.00	12,401.00	12,428.00
NNW	0.00	0.00	0.00	0.00	0.00	9.00	4.00	66.00	104.00	56.00	239.00
N	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	63.00	12.00	78.00
NNE	0.00	0.00	0.00	0.00	0.00	0.00	4.00	3.00	122.00	7,353.00	7,482.00
NE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.00	37.00	9,115.00	9,163.00
ENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	282.00	30,877.00	31,169.00
E	0.00	0.00	0.00	0.00	0.00	0.00	6.00	5.00	2,982.00	19.00	3,012.00
ESE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	2,173.00	97.00	2,286.00
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	20.00	35.00
SSE	0.00	0.00	0.00	0.00	0.00	1.00	3.00	14.00	5.00	73.00	96.00
TOTAL	9.00	0.00	0.00	0.00	0.00	10.00	1,864.00	31,440.00	6,382.00	60,184.00	99,889.00

D.3.4.4.2 *Comparison of the Decentralized Alternative and Regionalized Alternative 1: Treatment to WIPP Waste Acceptance Criteria Versus Treatment to Reduce Gas Generation*

A comparison of the Decentralized Alternative, in which CH-TRUW is stored and treated to WIPP waste acceptance criteria at 10 installations, and Regionalized 1, in which CH-TRUW is stored and treated to reduce gas generation at five installations, shows few differences in the health risks associated with these two treatment and consolidation options. The major difference between treating to WIPP waste acceptance criteria and treating to reduce gas generation is the addition of a waste shredding step in Regionalized 1, therefore, treatment risks should not be substantially different. The number of installations at which waste is consolidated also does not greatly affect the overall health risks.

D.3.4.4.3 *Comparison of Regionalized Alternatives 1 and 2: Treatment to Reduce Gas Generation Versus Treatment to Meet Land Disposal Restrictions*

A more controlled comparison of treatment risks can be made between Regionalized 1 and 2 since consolidation schemes are identical (wastes are treated and stored at the same five sites in both alternatives) but treatments differ (treatment to reduce gas generation in Regionalized 1 versus treatment to LDRs in Regionalized 2). As previously noted, the programwide risks of cancer fatalities, cancer incidence, and genetic effects from radiation exposure associated with treatment to LDRs in Regionalized 2 are approximately 3 orders of magnitude greater for the offsite and noninvolved worker populations and MEIs than the risks from treatment for minimization of gas generation in Regionalized 1. While these radionuclide-related health effects differ between the two alternatives, the contribution of chemical carcinogens to cancer incidence is almost the same in each alternative for each population.

The programwide risks to workers from radionuclide exposure are nearly the same in Regionalized 1 and 2. In addition, the risk of chemical-related cancer incidence in workers is nearly identical between alternatives. This reflects the fact that collective worker exposure is similar between the alternatives, regardless of the different treatment options.

The offsite and noninvolved worker MEI hazard indices for Regionalized 2 are approximately 1 order of magnitude higher than in Regionalized 1, and the Regionalized 2 worker exposure index is about 1 order of magnitude higher than in Regionalized 1. This trend reflects the potential for higher individual exposure

to noncarcinogenic hazardous chemicals when CH-TRUW is treated to LDRs. However, in all alternatives, exposures to noncarcinogenic, hazardous chemicals yield hazard indices well below 1.0.

D.3.4.4.4 *Comparison of the Regionalized 2, 3, and Centralized Alternatives: Differences in Consolidation Configuration*

Examination of the Regionalized 2 and Centralized Alternatives provides a comparison of consolidation and interim storage configurations; in these three alternatives, wastes are treated to LDRs but are consolidated and stored at five, three, and one site(s), respectively. As discussed above, the programwide radiation exposure risks to all populations are very similar across all three alternatives with certain exceptions: In the Centralized Alternative, the risk of cancer fatality, cancer incidence, and genetic effects to offsite populations is less than 1 order of magnitude lower than the risks in Regionalized 2 and 3 because of the smaller population size and lower population density at WIPP compared to sites such as LANL, INEL, and Hanford. Also, the population at only one site, rather than several, is being exposed. However, the risks to the offsite and noninvolved worker MEIs are slightly higher in the Centralized Alternative than in Regionalized 2 and 3. These higher risks could be due to a combination of factors including the proximity of neighboring ranches to WIPP and the influence of weather conditions such as wind speed and direction. As previously noted, the estimated cancer incidence risks to the offsite and noninvolved worker MEIs are 2.3E–04 and 2.8E–04, respectively.

Risk of cancer incidence due to chemical exposure is within the same order of magnitude for all public receptor populations in all three alternatives. The hazard index for the offsite MEI in Regionalized 3 is slightly lower than the Regionalized 2 or Centralized estimates.

Worker radiation and chemical exposure risks are similar among the Regionalized 2, 3, and Centralized Alternatives.

D.3.4.4.5 *Summary of the Human Health Risk Analysis for Routine Management of CH-TRUW*

In summary, the No Action Alternative presents the fewest health risk to all populations. Health risks generally increase for the public receptors as more extensive treatment of CH-TRUW is assumed. Overall health risks to workers do not differ appreciably with different treatment options. The primary risk drivers for the public receptor populations are radiation exposure (as opposed to chemical exposure) and treatment option. For workers, the primary risk drivers are the size of the waste load and the person-hours necessary to process it.

D.3.4.5 Summary of RH-TRUW Alternatives

The PEIS waste management alternatives (No Action, Decentralization, Regionalization, and Centralization) and the rationale for developing the various RH-TRUW analysis alternatives are discussed rigorously in the main body of the PEIS. Four alternatives are analyzed for the RH-TRUW human health risk analysis:

- The No Action Alternative demonstrates the baseline risks of RH-TRUW retrieval, packaging, certification, and indefinite interim storage at ANL-E, Hanford, INEL, LANL, ORR and SRS. Treatment is not considered and it is assumed that TRUW will not be disposed of at WIPP.
- In the Decentralized Alternative, risks are estimated for building additional treatment facilities as required, treating wastes to WIPP waste acceptance criteria, and storing them at the six sites pending disposal at WIPP.
- In the Regionalized Alternative 1, RH-TRUW is consolidated, treated to minimize gas generation, and stored at Hanford and ORR.
- In the Regionalized 2, 3, and Centralized Alternatives, RH-TRUW is consolidated, treated to meet RCRA LDRs, and stored at Hanford and ORR. (This scenario makes it possible to contrast the risks of different levels of treatment of RH-TRUW by comparison with Regionalized Alternative 1.)

Table D.3.4–21 presents the overall treatment and storage schemes for these RH-TRUW alternatives. Table D.3.4–22 shows which sites will ship their wastes to regionalized or centralized consolidation sites for treatment and storage. Note that for the purposes of this risk analysis, the waste load from a smaller generator, ANL-W, was added to the inventory of INEL, a larger generator (ANL, 1996b), as the two sites are in close proximity to one another.

The discussion of the risk analysis results will address the overall health risk trends across the alternatives discussed above, comparisons among alternatives, higher-risk sites and alternatives, and major factors driving the estimated risks.

Table D.3.4–21. PEIS Alternatives for RH-TRUW

Alternative	ANL-E	Hanford	INEL	LANL	ORR	SRS
No Action Alternative No treatment; store at 6 sites	T	T	T	T	T	T
	S	S	S	S	S	S
Decentralized Alternative Treat to WIPP-WAC and store at 6 sites	T	T	T	T	T	T
	S	S	S	S	S	S
Regionalized Alternative 1 Treat to reduce gas and store at 2 sites		T			T	
		S			S	
Regionalized Alternatives 2, 3, and Centralized Alternative Treat to RCRA LDRs and store at 2 sites		T			T	
		S			S	

Notes: T = treatment installation; S = storage installation.

Table D.3.4–22. PEIS Consolidation and Treatment Strategies for RH-TRUW

Alternative	Origin	Treatment and Storage Destination
No Action Alternative No treatment; store at 6 sites	All sites	Generators store own waste
Decentralized Alternative Treat to WIPP-WAC and store at 6 sites	All sites	Generators treat and store own waste
Regionalized Alternative 1 Treat to minimize gas generation and store at 2 sites	Hanford, INEL/ANL-W[a], LANL, ORR, ANL-E, SRS	Hanford ORR
Regionalized Alternatives 2, 3, and Centralized Alternative Treat to RCRA LDRs and store at 2 sites	Hanford, INEL/ANL-W[a], LANL, ORR, ANL-E, SRS	Hanford ORR

[a] For the purpose of the human health risk analysis, the ANL-W waste load is added to the INEL waste load.

D.3.4.6 Results Tables for the RH-TRUW Human Health Risk Analysis

This section contains the results tables for the RH-TRUW human health risk analysis. A discussion of the results is presented in Section D.3.4.7. The fatality and cancer incidence numbers in the tables are displayed in the standard exponential notation used in risk assessment; directions on reading this notation and a more complete description of the types of information in the tables are given in Section D.2.

- Table D.3.4–23 presents an overview, by alternative, of the *total*, programwide risks of cancer fatalities and cancer incidence for the offsite and noninvolved worker populations; and the risks of cancer fatalities, cancer incidence, and construction and operational fatalities for waste management workers. These tables provide the estimated *total number* of people in the three populations who will develop or die of cancers caused by exposure to RH-TRUW if a particular alternative is implemented nationwide. In addition, it shows the estimated total number of workers who will be killed in construction and operational activities.
- Table D.3.4–24 shows the sizes of the total affected populations for each alternative.
- Table D.3.4–25 summarizes the risks to the noninvolved worker MEI and offsite MEI for each RH-TRUW alternative. The numbers in this table are the estimated *probabilities* that the noninvolved worker and offsite MEIs will die of or develop cancer from radionuclide or chemical exposure, or indicators of the likelihood of suffering adverse health effects from exposure to noncarcinogenic, hazardous constituents.
- Tables D.3.4–26 through D.3.4–29 show the programwide risks for all receptors and health effect endpoints, by alternative.
- Tables D.3.4–30 through D.3.4–33 present offsite and worker population risks for each installation, by alternative.
- Table D.3.4–34 lists the radionuclides that contribute most of the risk to the offsite population, by installation and alternative.

Table D.3.4-23. Summary of Programwide Risks Associated With Routine Management of RH-TRUW: Risks to Total Populations, by Alternative

Alternative	Offsite Population		Noninvolved Worker Population		WM Workers		
	CF	CI	CF	CI	CF	CI	C&OF
No Action	2.8E-06	9.6E-06	1.3E-07	4.3E-07	6.2E-02	2.2E-01	7.1E-02
Decentralized	7.4E-06	2.5E-05	3.3E-07	1.1E-06	4.3E-03	1.5E-02	3.0E-01
Regionalized 1	1.3E-05	4.3E-05	5.7E-07	1.9E-06	6.2E-03	2.2E-02	3.3E-01
Regionalized 2, 3, and Centralized	4.6E-02	1.6E-01	1.6E-03	5.4E-03	9.6E-02	3.4E-01	4.6E-01

Notes: CF = cancer fatality associated with radionuclide exposure; CI = cancer incidence associated with exposure to radionuclides and carcinogenic chemicals; C&OF = fatalities due to the physical hazards of constructing and operating waste management facilities.

Table D.3.4-24. Size of Total Offsite, Noninvolved Worker, and Worker Populations Affected by Risks From Routine Management of RH-TRUW, by Alternative

Alternative	Offsite	Noninvolved Worker	WM Worker
No Action	10,131,913	38,057	59
Decentralized	10,131,913	38,057	1,109
Regionalized 1	10,131,913	38,057	1,469
Regionalized 2, 3, and Centralized	10,131,913	38,057	2,326

Table D.3.4-25. Summary of Programwide Risks Associated With Routine Management of RH-TRUW: Risks to the Maximally Exposed Offsite Individual and Maximally Exposed Noninvolved Worker, by Alternative

Alternative	Offsite MEI				Noninvolved Worker MEI			
	CF	Rad CI	Chem CI	HI	CF	Rad CI	Chem CI	HI
No Action	5.5E-11	1.9E-10	4.0E-13	3.5E-12	2.1E-10	7.2E-10	2.5E-12	2.8E-11
Decentralized	1.3E-10	4.5E-10	8.1E-12	1.3E-10	5.1E-10	1.7E-09	5.0E-11	8.0E-10
Regionalized 1	2.4E-10	8.3E-10	8.1E-12	1.3E-10	9.2E-10	3.1E-09	5.1E-11	7.7E-10
Regionalized 2, 3, and Centralized	1.3E-06	4.4E-06	5.7E-12	1.8E-09	1.1E-06	3.6E-06	3.5E-11	9.3E-09

Notes: CF = cancer fatality associated with exposure to radionuclides; Rad CI = cancer incidence associated with exposure to radionuclides; Chem CI = cancer incidence associated with exposure to carcinogenic chemicals; HI = hazard index associated with exposure to noncarcinogenic, toxic chemicals.

Table D.3.4–26. Programwide Risks Associated With Treatment of RH-TRUW Under the No Action Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	2.5E-04			
	Cancer fatalities	1.3E-07			
	Cancer incidence	4.3E-07	2.6E-09		
	Genetic effects	2.5E-08			
Noninvolved worker MEI	Dose (rem)	4.3E-07			
	Cancer fatalities	2.1E-10			
	Cancer incidence	7.2E-10	2.5E-12		
	Genetic effects	4.3E-11			
	Hazard index			2.8E-11	
Offsite population	Dose (person-rem)	5.7E-03			
	Cancer fatalities	2.8E-06			
	Cancer incidence	9.6E-06	8.1E-09		
	Genetic effects	5.7E-07			
Offsite MEI	Dose (rem)	1.1E-07			
	Cancer fatalities	5.5E-11			
	Cancer incidence	1.9E-10	4.0E-13		
	Genetic effects	1.1E-11			
	Hazard index			3.5E-12	
WM workers	Dose (FTE-rem)	1.5E+02			
	Cancer fatalities	6.2E-02			
	Cancer incidence	2.2E-01	9.0E-08		
	Genetic effects	9.3E-03			
	Exposure index			3.7E-06	
	Construction fatalities				3.5E-02
	Construction injuries				1.1E+01
	Operation fatalities				3.6E-02
	Operation injuries				1.8E-01

Table D.3.4-27. Programwide Risks Associated With Treatment of RH-TRUW Under the Decentralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	6.4E-04			
	Cancer fatalities	3.3E-07			
	Cancer incidence	1.1E-06	5.2E-08		
	Genetic effects	6.4E-08			
Noninvolved worker MEI	Dose (rem)	1.0E-06			
	Cancer fatalities	5.0E-10			
	Cancer incidence	1.7E-09	5.0E-11		
	Genetic effects	1.0E-10			
	Hazard index			8.0E-10	
Offsite population	Dose (person-rem)	1.5E-02			
	Cancer fatalities	7.4E-06			
	Cancer incidence	2.5E-05	1.6E-07		
	Genetic effects	1.5E-06			
Offsite MEI	Dose (rem)	2.7E-07			
	Cancer fatalities	1.3E-10			
	Cancer incidence	4.5E-10	8.1E-12		
	Genetic effects	2.7E-11			
	Hazard index			1.3E-10	
WM workers	Dose (FTE-rem)	1.1E+01			
	Cancer fatalities	4.3E-03			
	Cancer incidence	1.5E-02	3.0E-06		
	Genetic effects	6.3E-04			
	Exposure index			3.1E-05	
	Construction fatalities				2.0E-01
	Construction injuries				7.8E+01
	Operation fatalities				1.0E-01
	Operation injuries				6.7E+01

Table D.3.4-28. Programwide Risks Associated With Treatment of RH-TRUW Under Regionalized Alternative 1, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	1.1E-03			
	Cancer fatalities	5.7E-07			
	Cancer incidence	1.9E-06	5.2E-08		
	Genetic effects	1.1E-07			
Noninvolved worker MEI	Dose (rem)	1.9E-06			
	Cancer fatalities	9.3E-10			
	Cancer incidence	3.1E-09	5.0E-11		
	Genetic effects	1.9E-10			
	Hazard index			8.0E-10	
Offsite population	Dose (person-rem)	2.6E-02			
	Cancer fatalities	1.3E-05			
	Cancer incidence	4.3E-05	1.6E-07		
	Genetic effects	2.6E-06			
Offsite MEI	Dose (rem)	4.9E-07			
	Cancer fatalities	2.4E-10			
	Cancer incidence	8.3E-10	8.1E-12		
	Genetic effects	4.9E-11			
	Hazard index			1.3E-10	
WM workers	Dose (FTE-rem)	1.6E+01			
	Cancer fatalities	6.2E-03			
	Cancer incidence	2.2E-02	3.4E-06		
	Genetic effects	9.3E-04			
	Exposure index			3.1E-05	
	Construction fatalities				2.3E-01
	Construction injuries				7.8E+01
	Operation fatalities				1.0E-01
	Operation injuries				5.8E+01

Table D.3.4-29. Programwide Risks Associated With Treatment of RH-TRUW Under Regionalized Alternatives 2 and 3 and the Centralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	3.2			
	Cancer fatalities	1.6E-03			
	Cancer incidence	5.4E-03	3.7E-08		
	Genetic effects	3.2E-04			
Noninvolved worker MEI	Dose (rem)	2.8E-03			
	Cancer fatalities	1.4E-06			
	Cancer incidence	4.8E-06	3.5E-11		
	Genetic effects	2.8E-07			
	Hazard index			1.2E-08	
Offsite population	Dose (person-rem)	8.9E+01			
	Cancer fatalities	4.6E-02			
	Cancer incidence	1.6E-01	1.1E-07		
	Genetic effects	8.9E-03			
Offsite MEI	Dose (rem)	2.8E-03			
	Cancer fatalities	1.4E-06			
	Cancer incidence	4.8E-06	5.7E-12		
	Genetic effects	2.8E-07			
	Hazard index			1.9E-09	
WM workers	Dose (FTE-rem)	2.4E+02			
	Cancer fatalities	9.6E-02			
	Cancer incidence	3.4E-01	5.2E-06		
	Genetic effects	1.4E-02			
	Exposure index			2.4E-05	
	Construction fatalities				3.1E-01
	Construction injuries				1.2E+02
	Operation fatalities				1.5E-01
	Operation injuries				9.4E+01

Table D.3.4-30. Risks Associated With Treatment of RH-TRUW Under the No Action Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 30	7.4E-08	4.1E-13	6.1E-03	2.5E-07	1.4E-12	1.0E-07
Hanford	377,645 442	2.7E-06	5.6E-11	1.0E-01	9.1E-06	1.9E-10	2.2E-01
INEL	153,061 77	4.1E-09	5.1E-13	1.6E-02	1.4E-08	1.7E-12	1.0E-05
LANL	159,152 5	6.7E-10	7.0E-14	1.1E-03	2.3E-09	2.4E-13	3.5E-09
ORR	881,652 41	6.6E-08	2.1E-12	8.4E-03	2.3E-07	7.4E-12	1.3E-06
SRS	620,618 4	5.1E-09	4.8E-14	3.2E-04	1.7E-08	1.6E-13	5.5E-06
Total		2.8E-06	5.6E-11	1.3E-01	9.6E-06	1.9E-10	2.2E-01

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.4-31. Risks Associated With Treatment of RH-TRUW Under the Decentralized Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 62	1.9E-07	1.1E-12	2.6E-02	6.5E-07	3.6E-12	5.8E-04
Hanford	377,645 552	6.4E-06	1.3E-10	1.0E-01	2.2E-05	4.5E-10	6.8E-04
INEL	153,061 168	1.2E-08	1.6E-12	5.9E-02	4.2E-08	5.3E-12	3.7E-03
LANL	159,152 51	2.0E-08	2.1E-12	2.3E-02	6.7E-08	7.1E-12	4.8E-04
ORR	881,652 270	8.0E-07	2.5E-11	9.3E-02	2.9E-06	9.2E-11	9.5E-03
SRS	620,618 6	1.3E-08	1.2E-13	5.8E-03	4.4E-08	4.1E-13	2.8E-07
Total		7.4E-06	1.3E-10	3.1E-01	2.6E-05	4.5E-10	1.5E-02

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with radiation exposure and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.4–32. Risks Associated With Treatment of RH-TRUW Under Regionalized Alternative 1, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 29	2.0E-07	1.1E-12	8.9E-03	6.9E-07	3.8E-12	5.2E-04
Hanford	377,645 982	1.2E-05	2.4E-10	1.7E-01	4.0E-05	8.3E-10	7.5E-03
INEL	153,061 105	1.6E-08	2.0E-12	3.3E-02	5.4E-08	6.7E-12	3.5E-03
LANL	159,152 35	2.5E-08	2.6E-12	1.1E-02	8.5E-08	9.0E-12	4.6E-04
ORR	881,652 314	8.3E-07	2.6E-11	1.1E-01	3.0E-06	9.5E-11	9.7E-03
SRS	620,618 4	5.7E-09	5.4E-14	6.9E-04	1.9E-08	1.8E-13	9.9E-06
Total		1.3E-05	2.4E-10	3.3E-01	4.4E-05	8.3E-10	2.2E-02

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with radiation exposure and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.4–33. Risks Associated With Treatment of RH-TRUW Under Regionalized Alternatives 2 and 3 and the Centralized Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
LANL	159,152 35	2.5E-08	2.6E-12	1.1E-02	8.5E-08	9.0E-12	4.6E-04
ORR	881,652 682	4.6E-02	1.4E-06	3.0E-01	1.6E-01	4.8E-06	3.2E-01
ANL-E	7,939,785 29	2.0E-07	1.1E-12	8.9E-03	6.9E-07	3.8E-12	5.2E-04
Hanford	377,645 1,471	6.4E-04	1.3E-08	2.1E-01	2.2E-03	4.5E-08	1.4E-02
INEL	153,061 105	1.6E-08	2.0E-12	3.3E-02	5.4E-08	6.7E-12	3.5E-03
SRS	620,618 4	5.7E-09	5.4E-14	6.9E-04	1.9E-08	1.8E-13	9.9E-06
Total		4.7E-02	1.4E-06	5.6E-01	1.6E-01	4.8E-06	3.4E-01

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with radiation exposure and physical hazards.
[c] Indicates cancer incidence associated with radiation exposure.

Table D.3.4–34. RH-TRUW Radionuclides Contributing the Highest Risk of Cancer Fatality to the Offsite Population at Each Site, by Alternative

Alternative	Site					
	ANL-E	**Hanford**	**INEL**	**LANL**	**ORR**	**SRS**
No Action	Pu-239[a] 3.13E–08[b]	Pu-239 9.0E–07	Pu-241 2.13E–09	Pu-239 3.53E–10	Cm-244 3.22E–08	Pu-238 3.0E–09
Decentralized	Pu-239 8.02E–08	Pu-239 2.1E–06	Pu-241 6.64E–09	Pu-239 1.04E–08	Cm-244 3.75E–07	Pu-238 8.0E–09
Regionalized 1	Pu-239 8.53E–08	Pu-239 3.9E–06	Pu-241 8.46E–09	Pu-239 1.31E–08	Cm-244 3.75E–07	Pu-238 3.0E–09
Regionalized 2, 3, and Centralized	Pu-239 8.53E–08	Pu-239 4.3E–04	Pu-241 8.46E–09	Pu-239 1.31E–08	Cm-244 2.11E–02	Pu-238 3.0E–09

[a] Radionuclide contributing most risk of cancer fatality.
[b] Associated risk of cancer fatality to the offsite population within 80 km (50 mi) of this site.

D.3.4.7 Results of the RH-TRUW Human Health Risk Analysis

D.3.4.7.1 *Programwide Trends in Human Health Risks Associated With RH-TRUW Management Alternatives*

In general, the overall risks associated with managing RH-TRUW are somewhat lower than the risks from managing CH-TRUW. No Action presents the lowest health risks for all public and noninvolved worker populations and for all health risk endpoints because there is no waste treatment other than packaging. For the offsite, noninvolved worker, and worker populations, the health risks associated with the remaining RH-TRUW alternatives generally increase as more extensive waste treatment is employed; the highest estimated health risks are for the RH-TRUW scenario associated with the Regionalized 2, 3, and Centralized Alternatives, which involves incinerating RH-TRUW to destroy organic chemicals to meet RCRA LDRs. For workers, health risks are similar among the alternatives that include waste treatment. Overall, the health risks from exposure to chemicals in RH-TRUW are lower than from exposure to radionuclides, and the probability of adverse effects from noncarcinogenic, hazardous chemicals is very low. Estimated impacts to each receptor population are summarized below.

Offsite Population. Radiological and chemical exposure risks to the offsite population are lowest for No Action in which RH-TRUW is stored, without treatment, at the six generator sites in existing or approved facilities. The programwide risk of cancer fatality for this alternative is 2.8E–06 distributed over a total affected offsite population of approximately 10 million (see Tables D.3.4–23 and D.3.4–24).

The exposure risks to offsite populations in Decentralized (in which wastes are treated to WIPP waste acceptance criteria and stored at six sites) and Regionalized 1 (in which wastes are treated to reduce gas generation and stored at two sites) are slightly higher than those for No Action and are distributed over a similar total population. Treatment of RH-TRUW to LDRs and storage at two sites (Regionalized 2, 3, and Centralized Alternatives) results in markedly higher risks to offsite populations than in the other alternatives, with 4.6E–02 estimated cancer fatalities over a total population of approximately 10 million people.

Table D.3.4–33 shows that the predominant portion of the estimated cancer risks when RH-TRUW is treated to meet LDRs and stored at Hanford and ORR (Regionalized 2, 3, and Centralized Alternatives) is

attributed to ORR, where 4.6E–02 cancer fatalities in a population of 881,652 are estimated to occur over the 10-year treatment period. The higher estimated cancer risks at this site are linked to its relatively large inventory of curium-244 (the larger the contaminant inventory with respect to other sites, the larger the amount of contaminant assumed to be released during treatment).

Estimated programwide risks of cancer incidence from exposure to carcinogenic chemicals remain fairly consistent across alternatives, in the E–07 order of magnitude in all alternatives except No Action, in which cancer incidence risk is 8.1E–09 for the offsite population.

Noninvolved Worker Population. The programwide health risks to noninvolved worker populations parallel the trends observed for offsite populations but are slightly lower and involve a smaller affected population of 38,057 (see Table D.3.4–24). Treatment of RH-TRUW to LDRs and storage at two sites (Regionalized 2, 3, and Centralized Alternatives) poses the highest programwide risk to noninvolved worker populations (1.6E–03 total estimated cancer fatalities). The risk of cancer incidence due to exposure to carcinogenic chemicals is in the E–08 order of magnitude in all except No Action, where it is lower by approximately 1 order of magnitude (see Tables D.3.4–26 through D.3.4–29).

Maximally Exposed Noninvolved Worker and Maximally Exposed Offsite Individual. As shown in Table D.3.4–25, radiological risks to the noninvolved worker and offsite MEIs are lowest in No Action, slightly higher in Decentralized and Regionalized 1, and highest by approximately 4 orders of magnitude in the other alternatives (where RH-TRUW is treated to LDRs and stored at ORR and Hanford). Risks from chemical exposure follow a similar pattern. These trends generally parallel that seen for the total noninvolved worker and offsite populations.

Tables D.3.4–30 through D.3.4–33 show that the highest risks of cancer fatality to the offsite MEI are at Hanford and ORR in the Regionalized 2, 3, and Centralized Alternatives. These elevated risks are due to increased exposure from emissions during treatment to LDRs.

On the program level, estimated risk of cancer incidence due to chemical exposure is similar among alternatives and does not exceed the E–11 order of magnitude. While both MEI hazard indices are 2–3 orders of magnitude higher in Regionalized 2, 3, and Centralized than in No Action, the hazard indices in all alternatives are well below 1.0, indicating a low probability of adverse health effects from noncarcinogenic, hazardous constituents.

Workers. All exposures to FTEs are below regulatory limits. As was the case for CH-TRUW, RH-TRUW worker exposure and physical hazard risks generally increase as treatment increases in extent. Estimated construction and operational fatalities are always higher than those associated with radiation exposure, regardless of alternative. No Action results in lower worker health risks from physical hazards because fewer person-hours are spent in construction and operation of facilities, therefore injuries and fatalities are less likely. The risks from physical hazards are highest for the alternatives involving treatment (all except No Action) and are similar among these alternatives. Programwide radiological risks to workers are among the lowest in No Action (6.2E–02 estimated cancer fatalities over a population of 59 FTEs), slightly lower in Decentralized and Regionalized 1 (4.3E–03 and 6.2E–03, respectively), and increase somewhat in the other alternatives.

Worker health risks associated with chemical exposure vary slightly among alternatives. The exposure index, or highest individual worker exposure to noncarcinogenic chemicals, is approximately 1 order of magnitude lower in No Action than for the alternatives that involve treatment. However, in all alternatives the exposure indices are well below 1.0, indicating a low probability of adverse health effects from noncarcinogenic, hazardous constituents. The risk of worker cancer incidence from chemical exposure rises gradually across alternatives (lowest in No Action and slightly higher in the Decentralized, Regionalized, and Centralized Alternatives). Chemical exposure contributes much less to worker health risk estimates than radiation exposure.

Discussion. As stated above, radiation exposure risks are greater than chemical exposure risks for RH-TRUW for all populations by several orders of magnitude. The risks of worker fatalities due to physical hazards are always greater than those due to exposure.

For the offsite population, Hanford poses the highest estimated cancer fatalities in all alternatives except Regionalized 2, 3, and Centralized, where the highest risk is at ORR. The radionuclides contributing the most risk to the offsite population are plutonium-239 at Hanford in No Action, Decentralized, and Regionalized 1–3, and Centralized; and curium-244 at ORR in Regionalized 2, 3, and Centralized (see Table D.3.4–34).

For workers, the highest estimated total fatalities (cancer fatalities plus construction and operational fatalities) in all alternatives are associated with Hanford, where the most FTEs are involved in RH-TRUW management. Total fatality risks (as well as numbers of FTEs) are second highest at INEL in No Action, and at ORR in all other alternatives. In No Action, the radionuclides contributing the most worker risk are plutonium-241 at INEL, through inhalation; and plutonium-238 at Hanford, through inhalation. The controlling radionuclides for worker risks in Decentralized are uranium-236 at Hanford, through inhalation; and europium-152 and its radioactive decay products at ORR, through external exposure. In Regionalized 1 at Hanford, and in Regionalized 2, 3, and Centralized at ORR and Hanford, the controlling radionuclide is uranium-233, through inhalation.

D.3.4.7.2 *Comparison of the Decentralized and Regionalized 1 Alternatives: Treatment to WIPP Waste Acceptance Criteria Versus Treatment to Reduce Gas Generation*

A comparison of Decentralized (in which RH-TRUW is treated to WIPP waste acceptance criteria and stored at six installations) and Regionalized 1 (in which RH-TRUW is treated to reduce gas generation and stored at two installations) shows few differences in the health risks associated with these two treatment and consolidation options. The major difference between treating to WIPP waste acceptance criteria and treating to reduce gas generation is the addition of a waste shredding step in Regionalized 1, therefore, treatment risks should not be substantially different. The number of installations at which waste is consolidated also does not greatly affect the overall health risks.

D.3.4.7.3 *Comparison of Regionalized Alternative 1 With Regionalized Alternatives 2 and 3 and the Centralized Alternative: Treatment to Reduce Gas Generation Versus Treatment to Meet Land Disposal Restrictions*

A more controlled comparison of treatment risks can be made between the Regionalized 1 and the Regionalized 2 and 3, and Centralized Alternatives since consolidation schemes are identical (wastes are treated and stored at the same two installations in all of these alternatives) but treatments differ (treatment to reduce gas generation in Regionalized 1 versus treatment to LDRs in the other three alternatives). As previously noted, the programwide risks of cancer fatalities, cancer incidence, and genetic effects from radiation exposure associated with treatment of RH-TRUW to LDRs (in the Regionalized 2, 3, and Centralized Alternatives) are approximately 3 orders of magnitude greater for the offsite and noninvolved worker populations and MEIs than the risks from treatment to minimize gas generation in Regionalized 1.

The offsite and noninvolved worker MEI hazard indices associated with treatment of RH-TRUW to LDRs are approximately 1 order of magnitude higher than in Regionalized 1. This trend reflects the potential for higher individual exposure to noncarcinogenic hazardous chemicals when RH-TRUW undergoes treatment to meet LDRs rather than to reduce gas generation. However, in all alternatives, exposures to noncarcinogenic, hazardous chemicals yield hazard indices well below 1.0, indicating a very low probability of adverse effects from these contaminants.

The programwide risks to workers from radionuclide exposure are more than 1 order of magnitude higher in the alternatives involving treatment to LDRs than in Regionalized 1. However, the risk of chemical-related cancer incidence is similar between alternatives.

D.3.4.7.4 *Summary*

In summary, the No Action Alternative presents the fewest health risk to all populations. Health risks generally increase for the public receptors as more extensive treatment of RH-TRUW is employed. Radionuclide- and construction/operational-related health risks to workers increase somewhat as more extensive treatment is employed. Chemical-related risks for all receptors are slightly higher in the alternatives that involve treatment (all except No Action) than in No Action, but are relatively independent of treatment type.

The primary risk drivers for the offsite and noninvolved worker populations are radiation exposure (as opposed to chemical exposure) and treatment option. For workers, the primary risk drivers are the size of the waste load and the person-hours necessary to process it.

D.3.4.8 Summary of Alternatives for Potential CH-TRUW Accidents

The following CH-TRUW alternatives were evaluated for potential treatment facility (incinerator) accidents: Regionalized 2, Regionalized 3, and Centralized. No storage accidents were analyzed. Health risks associated with accidental releases of radionuclides were analyzed, while health risks associated with accidental releases of chemicals were not analyzed. The types of accidents evaluated were (1) an incinerator explosion and resulting fire; (2) a baghouse area fire; and (3) an earthquake and resulting fire.

D.3.4.9 Special Assumptions and Considerations Used in the CH-TRUW Accident Analysis

All accidental releases from incinerator facilities to the outside (i.e., to the offsite and noninvolved worker populations) are assumed to be at ground level with dispersion starting at a lower level rather than from a facility stack. In the incinerator explosion accident scenario, it is assumed that the efficiency of the facility's high-efficiency particulate air filtration system drops only to 99.9%. In the assessment of worker risks from incineration accidents, it is assumed that the air in the work area is not ventilated or filtered; the intra-facility source term for this accident is, therefore, 1,000 times higher than the atmospheric source term used to calculate risks to the offsite and noninvolved worker populations.

Incineration accidents are assumed to cause releases into the operating gallery where the workers are located. Half of the operating gallery (e.g., an area 32 m long × 6 m wide × 6 m high) is assumed to fill with contaminated air. Exposure duration is 1 min, the time necessary for workers to avoid any obstructions and leave the scene. During all accidents, one shift of waste management workers is assumed to be inside the incinerator facility. Shift size varies from 2 to 14 workers.

Each accident type has an associated estimated annual frequency of occurrence as determined by Argonne National Laboratory (see Section D.2.7.1). However, the probability of occurrence is not directly taken into account in the risk calculations. Risk estimates associated with each accident should be interpreted as the consequences if the accident occurred. Estimated annual frequencies vary by accident type, installation location, and contaminant type. For radionuclide-related accidents, the incinerator explosion is considered to be "anticipated" (greater than 1E-02 per year); the baghouse area fire is considered "unlikely" (1E-4 to 1E-02 per year); and the earthquake with subsequent fire is considered "very unlikely" (1E-06 to 1E-04 per year).

D.3.4.10 Results Tables for the Risk Analysis of Potential CH-TRUW Accidents

Table D.3.4-35 presents a summary of the maximum reasonably foreseeable accident risks to the offsite and noninvolved worker populations, their respective MEIs, and waste management worker populations for treatment facility accidents, by installation and alternative. Table D.3.4-36 provides the sizes of the offsite, noninvolved worker, and worker populations at each installation. Tables D.3.4-37 through D.3.4-45 present more detailed results by health endpoint and installation.

Table D.3.4–35. Radionuclide-Related Risks from Potential Maximum Reasonably Foreseeable CH-TRUW Treatment Facility Accidents, by Alternative and Site

	Offsite Population		Offsite MEI		Noninvolved Worker Population		Noninvolved Worker MEI[a]		Worker Population	
Site	CF[b]	CI[c]	CF	CI	CF	CI	CF	CI	CF	CI
Regionalized 2										
HS	2.1E+00	7.0E+00	4.9E-05	1.7E-04	4.0E-01	1.4E+00	4.0E-03	1.4E-02	5.5E+00	1.9E+01
INEL	3.0E-01	1.0E+00	3.4E-05	1.2E-04	4.3E-01	1.5E+00	2.6E-04	8.7E-04	1.9E+01	6.7E+01
LANL	2.8E+00	9.6E+00	1.3E-03	4.5E-03	8.0E-01	2.7E+00	2.4E-03	8.1E-03	2.7E+01	9.4E+01
RFP	1.9E+00	6.3E+00	6.6E-05	2.2E-04	2.7E-01	9.3E-01	8.1E-04	2.8E-03	1.4E+00	4.8E+00
SRS	8.0E-03	2.7E-02	2.5E-07	8.4E-07	1.8E-03	6.1E-03	7.7E-06	2.6E-05	1.6E-02	5.6E-02
Regionalized 3										
HS	2.1E+00	7.0E+00	4.9E-05	1.7E-04	4.0E-01	1.4E+00	4.0E-03	1.4E-02	5.5E+00	1.9E+01
INEL	7.3E-01	2.5E+00	8.3E-05	2.8E-04	1.1E+00	3.7E+00	6.6E-04	2.2E-03	5.8E+01	2.0E+02
SRS	8.0E-03	2.7E-02	2.5E-07	8.4E-07	1.8E-03	6.1E-03	7.7E-06	2.6E-05	1.6E-02	5.6E-02
Centralized										
WIPP	7.4E+00	2.5E+01	6.2E-02	2.1E-01	1.9E+00	6.3E+00	5.7E-02	2.0E-01	7.1E+01	2.5E+02

[a]MEI--most-exposed individual; each value represents the highest single risk (not the sum of all risks) to the MEI from among all accidents at an installation.
[b]CF--risk of cancer fatality associated with exposure to radionuclides.
[c]CI--risk of cancer incidence associated with exposure to radionuclides.

Table D.3.4–36. Sizes of the Offsite, Noninvolved Worker, and Worker Populations Affected by Risks from Potential CH-TRUW Treatment Accidents, by Site

Site	Offsite Population	Noninvolved Worker Population	WM Worker Population		
			Regionalized 2	Regionalized 3	Centralized
Hanford	377,645	8,674	9	9	
INEL	153,106	8,451	11	13	
LANL	159,152	11,552	11		
RFP	2,171,877	6,993	5		
SRS	620,618	15,996	2	2	
WIPP	99,889	1060			14

Table D.3.4-37. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at Hanford Under the Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	2.1E+00	4.9E-05	3.0E-01	7.0E+00	1.7E-04	1.1E+00
Incineration, (U) Baghouse Area Fire	8.0E-03	1.9E-07	1.2E-03	2.7E-02	6.5E-07	4.1E-03
Incineration, (A) Incinerator Explosion	3.8E-02	8.9E-07	5.5E+00	1.3E-01	3.0E-06	9.0E+00
Maximum reasonably foreseeable accident	2.1E+00	4.9E-05	5.5E+00	7.0E+00	1.7E-04	9.0E+00

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (>1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (<1E-06).

Table D.3.4-38. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at INEL Under the Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	3.0E-01	3.4E-05	1.0E+00	1.0E+00	1.2E-04	3.7E+00
Incineration, (U) Baghouse Area Fire	1.2E-03	1.3E-07	4.1E-03	4.0E-03	4.6E-07	1.4E-02
Incineration, (A) Incinerator Explosion	5.5E-03	6.2E-07	1.1E+01	1.9E-02	2.1E-06	1.1E+01
Maximum reasonably foreseeable accident	3.0E-01	3.4E-05	1.1E+01	1.0E+00	1.2E-04	1.1E+01

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (>1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (<1E-06).

Table D.3.4-39. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at LANL Under the Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	2.8E+00	1.3E-03	1.5E+00	9.6E+00	4.5E-03	5.1E+00
Incineration, (U) Baghouse Area Fire	1.1E-02	5.2E-06	5.8E-03	3.8E-02	1.8E-05	2.0E-02
Incineration, (A) Incinerator Explosion	5.2E-02	2.4E-05	1.1E+01	1.8E-01	8.3E-05	1.1E+01
Maximum reasonably foreseeable accident	2.8E+00	1.3E-03	1.1E+01	9.6E+00	4.5E-03	1.1E+01

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (> 1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (< 1E-06).

Table D.3.4-40. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at RFETS Under the Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	1.9E+00	6.6E-05	7.5E-02	6.3E+00	2.2E-04	2.6E-01
Incineration, (U) Baghouse Area Fire	7.3E-03	2.6E-07	3.0E-04	2.5E-02	8.8E-07	1.0E-03
Incineration, (A) Incinerator Explosion	3.4E-02	1.2E-06	1.4E+00	1.2E-01	4.1E-06	4.8E+00
Maximum reasonably foreseeable accident	1.9E+00	6.6E-05	1.4E+00	6.3E+00	2.2E-04	4.8E+00

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (> 1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (< 1E-06).

Table D.3.4-41. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at SRS Under the Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	8.0E-03	2.5E-07	8.7E-04	2.7E-02	8.4E-07	3.1E-03
Incineration, (U) Baghouse Area Fire	3.2E-05	9.8E-10	3.4E-06	1.1E-04	3.3E-09	1.2E-05
Incineration, (A) Incinerator Explosion	1.5E-04	4.6E-09	1.6E-02	5.0E-04	1.6E-08	5.6E-02
Maximum reasonably foreseeable accident	8.0E-03	2.5E-07	1.6E-02	2.7E-02	8.4E-07	5.6E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (> 1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (< 1E-06).

Table D.3.4-42. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at Hanford Under the Regionalized Alternative 3, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	2.1E+00	4.9E-05	3.0E-01	7.0E+00	1.7E-04	1.1E+00
Incineration, (U) Baghouse Area Fire	8.1E-03	1.9E-07	1.2E-03	2.7E-02	6.5E-07	4.1E-03
Incineration, (A) Incinerator Explosion	3.8E-02	8.9E-07	5.5E+00	1.3E-01	3.0E-06	9.0E+00
Maximum reasonably foreseeable accident	2.1E+00	4.9E-05	5.5E+00	7.0E+00	1.7E-04	9.0E+00

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (> 1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (< 1E-06).

Table D.3.4-43. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at INEL Under Regionalized Alternative 3, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	7.3E-01	8.3E-05	3.2E+00	2.5E+00	2.8E-04	1.1E+01
Incineration, (U) Baghouse Area Fire	2.9E-03	3.3E-07	1.2E-02	9.8E-03	1.1E-06	4.3E-02
Incineration, (A) Incinerator Explosion	1.3E-02	1.5E-06	1.3E+01	4.6E-02	5.2E-06	1.3E+01
Maximum reasonably foreseeable accident	7.3E-01	8.3E-05	1.3E+01	2.5E+00	2.8E-04	1.3E+01

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (> 1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (< 1E-06).

Table D.3.4-44. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at SRS Under Regionalized Alternative 3, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	8.0E-03	2.5E-07	8.7E-04	2.7E-02	8.4E-07	3.1E-03
Incineration, (U) Baghouse Area Fire	3.2E-05	9.8E-10	3.4E-06	1.1E-04	3.3E-09	1.2E-05
Incineration, (A) Incinerator Explosion	1.5E-04	4.6E-09	1.6E-02	5.0E-04	1.6E-08	5.6E-02
Maximum reasonably foreseeable accident	8.0E-03	2.5E-07	1.6E-02	2.7E-02	8.4E-07	5.6E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (> 1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (< 1E-06).

Table D.3.4-45. Radionuclide-Related Accident Risks Associated With CH-TRUW Treatment at WIPP Under the Centralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	7.4E+00	6.2E-02	3.9E+00	2.5E+01	2.1E-01	1.4E+01
Incineration, (U) Baghouse Area Fire	2.9E-02	2.5E-04	1.5E-02	9.8E-02	8.3E-04	5.3E-02
Incineration, (A) Incinerator Explosion	1.4E-01	1.1E-03	1.4E+01	4.6E-01	3.9E-03	1.4E+01
Maximum reasonably foreseeable accident	7.4E+00	6.2E-02	1.4E+01	2.5E+01	2.1E-01	1.4E+01

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (>1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (<1E-06).

D.3.4.11 Summary of the CH-TRUW Accident Analysis Results

For radionuclide-related incineration accidents in all alternatives, the dominant accident type for all receptors except the waste management worker is the earthquake with subsequent fire. For waste management workers, the dominant accident type is the incineration explosion.The highest installation-specific cancer fatality risks are associated with LANL and Hanford for all receptors in Regionalized 2 and Regionalized 3. For Centralized alternative, the highest installation-specific cancer fatality risks are associated with WIPP. Cancer fatality risks associated with operational incineration accidents such as the incineration explosion and baghouse area fire in alpha facilities are generally lower than those associated with similar accidents caused by an earthquake by 1 to 3 orders of magnitude for all receptors except waste management workers in all alternatives. Note that for workers, the risk of death from latent cancers due to exposure to radioactive materials released in such accidents may be smaller than the risk of fatality due to nonradiological impacts.

D.3.4.11.1 *Risks to the Offsite Population from CH-TRUW Accidents*

For incineration accidents involving releases of radionuclides due to an earthquake, cancer fatality risks to the offsite population range from 8.0E-03 to 7.4 in population sizes ranging from 99,889 to 620,618. Cancer fatality risks from operational accidents range from 3.2E-05 to 1.4E-01 in population sizes ranging from 99,889 to 620,618. Incineration accident risks at a given installation do not differ greatly among alternatives. Risks associated with a particular accident either remain the same at an installation across alternatives or increase only slightly with waste consolidation.

The incineration accident type resulting in the highest risks to offsite populations is the earthquake with subsequent fire. In each alternative, the risks of cancer fatalities for other incinerator accidents (incinerator explosion and baghouse area fire) are approximately 2 to 3 orders of magnitude lower than those associated with the earthquake scenario at a given installation. However, the estimated annual frequency of the earthquake scenario affecting the incinerator facility is "very unlikely" (1E-06 to 1E-04 per year) for all installations and alternatives, while the baghouse area fire and incinerator explosion are considered "unlikely" (1E-04 to 1E-02 per year) and "anticipated" (greater than 1E-02 per year), respectively.

LANL and Hanford have the highest cancer fatality risks to the offsite population from contact-handled alpha facility incineration accidents in Regionalized 2 because of relatively high releases of plutonium-238. For Regionalized 3, Hanford again has the highest cancer fatality risks, while WIPP is the highest cancer risk installation for Centralized. The highest cancer fatality risk at WIPP is 7.4 (distributed over a population of 99,889) for the earthquake scenario in the Centralized Alternative. LANL and Hanford have the next highest cancer fatality risks to the offsite population from incineration accidents caused by an earthquake (2.8 distributed over a population of 159,152 and 2.1 distributed over a population of 377,645, respectively). The controlling contaminant at WIPP, LANL, and Hanford is plutonium-238. Internal exposure is the primary route for all three installations. For the incinerator explosion accident, cancer fatality risks are again highest at LANL for Regionalized 2, at Hanford for Regionalized 3, and at WIPP for the Centralized Alternative. The controlling contaminant at all three installations is plutonium-238; the primary exposure route is internal. The risks for radionuclide-related cancer incidence and genetic effects follow the same general trend as for cancer fatalities.

D.3.4.11.2 *Risks to the Noninvolved Worker Population from CH-TRUW Accidents*

For radionuclide-related accidents, the trends in risk to the noninvolved worker population follow the trends for the offsite population, but vary slightly. For incineration accidents involving releases of radionuclides due to an earthquake, cancer fatality risks range from 1.8E-03 to 1.9 in population sizes ranging from 1,060 to 15,996. Cancer fatality risks from operational accidents range from 7.0E-06 to 3.4E-02 in population sizes ranging from 1,060 to 15,996. Incineration accident risks at a given installation do not differ greatly among alternatives. Risks associated with a particular accident either remain the same at an installation across alternatives or increase only slightly with waste consolidation.

The incineration accident type resulting in the highest risks to noninvolved worker populations is the earthquake with subsequent fire. For each alternative, the risks of cancer fatalities for other incinerator accidents (incinerator explosion and baghouse area fire) are generally 2 to 3 orders of magnitude lower than those associated with the earthquake scenario at a given installation. Recall, however, that the estimated annual frequency of the earthquake scenario affecting the incinerator facility is the lowest of the three accident types.

For the facility earthquake scenario, LANL produces the greatest risk of cancer fatalities in Regionalized 2, INEL produces the greatest risk of cancer fatalities in Regionalized 3, while WIPP is the highest-risk installation in the Centralized alternative. The maximum reasonably foreseeable accident risks occur at WIPP (1.9 cancer fatalities over a population of 1060), followed by INEL (1.1 cancer fatalities over a population of 8451) and LANL (0.8 cancer fatalities over a population of 11,552). The controlling contaminant at LANL and WIPP is plutonium-238. At INEL both americium-241 and plutonium-238 are the controlling radionuclides. For operational accidents, the highest-risk installations are LANL in Regionalized 2, INEL in Regionalized 3, and WIPP in the Centralized alternative. In these alternatives, cancer fatality risk associated with the worst-case incinerator accident (incinerator explosion) is 1.5E-02 for LANL in a population of 11,552, 2.0E-02 for INEL in a population of 8,451, and 3.4E-02 for WIPP in a population of 1060 . The controlling contaminants at INEL are americium-241 and plutonium-238. At both LANL and WIPP plutonium-238 is the controlling radionuclide.

D.3.4.11.3 *Risks to the Most-Exposed Noninvolved Worker and Most-Exposed Offsite Individual from CH-TRUW Accidents*

For radionuclide-related accidents, the trends in risk to the offsite MEI and noninvolved worker MEI generally follow those for their respective populations. Incineration accident risks at a given installation do not differ greatly among alternatives. Risks to the MEIs associated with a particular accident either remain the same at an installation across alternatives or increase only slightly with waste consolidation. Differences in cancer risks between earthquake accidents and internally-initiated accidents parallel those estimated for the offsite and noninvolved worker populations.

The highest-risk incineration accident type for both MEIs is the earthquake with subsequent fire by approximately two order of magnitude. The highest-risk installations for the offsite MEI differ somewhat from those observed for the offsite population. The highest installation-specific cancer fatality risk to the offsite MEI is from the earthquake scenario at LANL (1.3E-03) in Regionalized 2, INEL (8.3E-05) in Regionalized 3, and WIPP (6.2E-02) in the Centralized alternative. The next highest installation risks for the same earthquake scenario are at RFETS in Regionalized 2 (6.6E-05) and Hanford in Regionalized 3 (4.9E-05). In each alternative, the risks of cancer fatalities to the offsite MEI for other incinerator accidents are approximately 1 to 3 orders of magnitude lower than those for the earthquake scenario. For the

incinerator explosion accident, cancer risks to the offsite MEI are greatest at LANL (2.4E-05) in Regionalized 2, INEL (1.5E-06) in Regionalized 3, and WIPP (1.1E-03) in the Centralized Alternative.

The highest installation-specific cancer fatality risk to the noninvolved worker MEI is from the earthquake scenario at Hanford in Regionalized 2 and 3, and at WIPP in Centralized (ranging from 4.0E-03 to 5.7E-02). The next highest risk to the noninvolved worker MEI is from the same earthquake scenario at LANL in Regionalized 2 and INEL in Regionalized 3 (2.4E-03 and 6.6E-04 cancer fatalities, respectively). For the maximum reasonably foreseeable operational accident (incinerator explosion) the highest-risk installation for the noninvolved worker MEI is Hanford in Regionalized 2 and 3, and at WIPP in Centralized (ranging from 7.3E-05 to 1.1E-03).

D.3.4.11.4 *Risks to Waste Management Workers from CH-TRUW Accidents*

For incineration accidents involving releases of radionuclides, installation-specific worker risks are similar among alternatives, increasing only very slightly at installations where CH-TRUW is consolidated for treatment. Unlike all other receptors, the highest cancer-fatality risks to the waste management worker occur during the incinerator explosion accident. Estimated worker cancer fatalities associated with the incinerator explosion accident range from 1.6E-02 to 1.4E+01. For the earthquake accident, estimated worker cancer fatalities range from 8.7E-04 to 3.9. Shift size varies from 2 to 14 workers. In all alternatives, the incinerator explosion scenario produces the higher worker risks by about 1 to 2 orders of magnitude over the earthquake scenario and about 3 to 4 orders of magnitude over the baghouse area fire scenario.

The highest installation-specific cancer fatality risks associated with the incinerator accidents are for the incinerator explosion accident at LANL in Regionalized 2 (1.1E+01), at INEL in Regionalized 3 (1.3E+01), and at WIPP in Centralized (1.4E+01). For the earthquake facility incinerator accident, the highest installation cancer fatality risks are at LANL (1.5) in Regionalized 2, at INEL (3.2) in Regionalized 3, and WIPP in Centralized (3.9).

D.3.4.12 Summary of Alternatives for Potential RH-TRUW Accidents

The following RH-TRUW alternatives were evaluated for potential treatment facility (incinerator) accidents: Regionalized 2, Regionalized 3, and Centralized. All three of these alternatives treat to RCRA LDRs and store at 2 installations. Thus all accident scenarios remain the same across alternatives. No storage accidents were analyzed for RH-TRUW. Health risks associated with accidental releases of radionuclides were analyzed, while health risks associated with accidental releases of chemicals were not analyzed. The types of treatment facility accidents evaluated were (1) an incinerator explosion and resulting fire; (2) a baghouse area fire; and (3) an earthquake with subsequent fire.

D.3.4.13 Results Tables for the Risk Analysis of Potential RH-TRUW Accidents

Table D.3.4-46 presents a summary of the maximum reasonably foreseeable accident risks to the offsite and noninvolved worker populations, their respective MEIs, and waste management worker populations for treatment facility accidents, by installation and alternative. Table D.3.4-47 provides the sizes of the offsite, noninvolved worker, and worker populations at each installation. Tables D.3.4-48 through D.3.4-49 present more detailed results by health endpoint and installation.

Table D.3.4-46. Radionuclide-Related Risks from Potential Maximum Reasonably Foreseeable RH-TRUW Treatment Facility Accidents, by Alternative and Site

Site	Offsite Population		Offsite MEI		Noninvolved Worker Population		Noninvolved Worker MEI[a]		Worker Population	
	CF[b]	CI[c]	CF	CI	CF	CI	CF	CI	CF	CI
Regionalized 2, 3, and Centralized										
HS	9.7E-03	3.3E-02	2.3E-07	7.7E-07	1.5E-03	4.9E-03	1.5E-05	4.9E-05	2.2E-03	7.8E-03
ORNL	1.2E-01	4.1E-01	1.0E-05	3.5E-05	4.6E-02	1.6E-01	5.1E-05	1.8E-04	8.9E-02	3.1E-01

[a] MEI=most-exposed individual; each value represents the highest single risk (not the sum of all risks) to the MEI from among all accidents at an installation.
[b] CF=risk of cancer fatality associated with exposure to radionuclides.
[c] CI=risk of cancer incidence associated with exposure to radionuclides.

Table D.3.4–47. Sizes of the Offsite, Noninvolved Worker, and Worker Populations Affected by Risks from Potential RH-TRUW Treatment Accidents, by Site

Site	Offsite Population	Noninvolved Worker Population	WM Worker Population		
			Regionalized 2	Regionalized 3	Centralized
Hanford	377,645	8,674	1	1	1
ORR	881,652	3,809	7	7	7

Table D.3.4–48. Radionuclide-Related Accident Risks Associated With RH-TRUW Treatment at Hanford Under the Regionalized Alternative 2, 3, and Centralized Alternatives, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	9.7E-03	2.3E-07	1.2E-04	3.3E-02	7.7E-07	4.3E-04
Remote Incineration, (U) Baghouse Area Fire	3.8E-05	8.9E-10	4.8E-07	1.3E-04	3.0E-09	1.7E-06
Remote Incineration, (A) Incinerator Explosion	1.8E-04	4.2E-09	2.2E-03	6.1E-04	1.4E-08	7.8E-03
Maximum reasonably foreseeable accident	9.7E-03	2.3E-07	2.2E-03	3.3E-02	7.7E-07	7.8E-03

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (> 1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (< 1E-06).

Table D.3.4-49. Radionuclide-Related Accident Risks Associated With RH-TRUW Treatment at ORNL Under the Regionalized Alternative 2, 3, and Centralized Alternatives, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Population[c]	MEI	Workers	Population[c]	MEI	Workers
Incineration, (VU)[d] Earthquake	1.2E-01	1.0E-05	4.8E-03	4.1E-01	3.5E-05	1.7E-02
Remote Incineration, (U) Baghouse Area Fire	4.7E-04	4.0E-08	1.9E-05	1.6E-03	1.4E-07	6.6E-05
Remote Incineration, (A) Incinerator Explosion	2.2E-03	1.9E-07	8.9E-02	7.5E-03	6.4E-07	3.1E-01
Maximum reasonably foreseeable accident	1.2E-01	1.0E-05	8.9E-02	4.1E-01	3.5E-05	3.1E-01

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Offsite.
[d] Accident annual frequency codes are "A" for anticipated (> 1E-2), "U" for unlikely (1E-4 to 1E-2), "VU" for very unlikely (1E-6 to 1E-4), and "EU" for extremely unlikely (< 1E-06).

D.3.4.14 Summary of the RH-TRUW Accident Analysis Results

In general, the overall risks associated with managing RH-TRUW are somewhat lower than the risks from managing CH-TRUW. For radionuclide-related incineration accidents in all alternatives, the dominant accident type for all receptors except the waste management worker is the earthquake and resulting fire. For waste management workers, the dominant accident type is the incineration explosion.The highest installation-specific cancer fatality risks are associated with ORR for all receptors in all alternatives (Regionalized 2, 3 and Centralized). Cancer fatality risks associated with incineration accidents in remote facilities are generally lower than those associated with similar accidents caused by an earthquake by 2 to 3 orders of magnitude for all receptors (except waste management workers) in all alternatives. Note that for workers, the risk of death from latent cancers due to exposure to radioactive materials released in such accidents may be smaller than the risk of fatality due to nonradiological impacts.

D.3.4.14.1 *Risks to the Offsite Population from RH-TRUW Accidents*

For incineration accidents involving releases of radionuclides due to an earthquake, cancer fatality risks to the offsite population range from 9.7E-03 to 1.2E-01 in population sizes ranging from 377,645 to 881,652.

Cancer fatality risks from internally-initiated accidents range from 3.8E-05 to 2.2E-03 in population sizes ranging from 377,645 to 881,652. Incineration accident risks at a given site do not differ among alternatives. Risks associated with a particular accident remain the same at a site across all alternatives.

The incineration accident type resulting in the highest risks to offsite populations is the earthquake with subsequent fire. In each alternative, the risks of cancer fatalities for other incinerator accidents (incinerator explosion and baghouse area fire) are approximately 1 to 3 orders of magnitude lower than those associated with the earthquake scenario at a given site. However, the estimated annual frequency of the earthquake scenario affecting the incinerator facility is "very unlikely" (1E-06 to 1E-04 per year) for all sites and alternatives, while the baghouse fire and incinerator explosion are considered "unlikely" (1E-04 to 1E-02 per year) and "anticipated" (greater than 1E-02 per year), respectively.

ORR has the highest cancer fatality risks to the offsite population from remote-handled alpha facility incineration accidents in all alternatives (Regionalized 2, Regionalized 3, and Centralized) because of relatively high releases of curium-244. Cancer fatalities of 2.2E-03 over a population of 881,652 are estimated to occur at ORR for the incinerator explosion. For the earthquake scenario, ORR once again has the highest cancer fatality risks with 1.2E-01 over a population of 881,652. Hanford is always the second highest cancer fatality site in all three alternatives by one to two orders of magnitude.The controlling contaminant at ORR is curium-244. Internal exposure is the primary route. The controlling contaminant at Hanford is plutonium-239; the primary exposure route is internal. The risks of radionuclide-related cancer incidence and genetic effects follow the same general trend as for cancer fatalities.

D.3.4.14.2 *Risks to the Noninvolved Worker Population from RH-TRUW Accidents*

For radionuclide-related accidents, the trends in risk to the noninvolved worker population follow the trends for the offsite population. For incineration accidents involving releases of radionuclides due to an earthquake, cancer fatality risks range from 1.5E-03 to 4.6E-02 in population sizes ranging from 3,809 to 8,674. Cancer fatality risks from operational accidents range from 5.7E-06 to 8.5E-04 in population sizes ranging from 3,809 to 8,674. Incineration accident risks at a given installation do not differ among alternatives. Risks associated with a particular accident remain the same at a site across all alternatives.

The incineration accident type resulting in the highest risks to noninvolved worker populations is the earthquake with subsequent fire. For each alternative, the risks of cancer fatalities for other incinerator accidents (incinerator explosion and baghouse area fire) are approximately 2 to 3 orders of magnitude lower than those associated with the earthquake scenario at a given site. Recall, however, that the estimated annual frequency of the earthquake scenario affecting the incinerator facility is the lowest of the three accident types.

For the facility earthquake scenario, ORR produces the greatest risk of cancer fatalities in all alternatives (Regionalized 2, Regionalized 3, and Centralized). The worst-case accident risks occur during the facility earthquake scenario at ORR with 4.6E-02 cancer fatalities over a population of 3,809, followed by Hanford with 1.5E-03 cancer fatalities over a population of 8,674. For operational accidents, the highest-risk site is once again ORR for all alternatives, followed by Hanford. In these alternatives, cancer fatality risk associated with the worst-case incinerator accident (incinerator explosion) is 8.5E-04 for ORR in a population of 3,809, and 2.7E-05 for Hanford in a population of 8,674.

D.3.4.14.3 *Risks to the Most-Exposed Noninvolved Worker and Most-Exposed Offsite Individual from RH-TRUW Accidents*

For radionuclide-related accidents, the trends in risk to the offsite MEI and noninvolved worker MEI generally follow those for their respective populations. Incineration accident risks at a given site do not differ among alternatives. Risks to the MEIs associated with a particular accident remain the same at an installation across all alternatives. Differences in cancer risks between earthquake facility incineration accidents and internally-initiated facility incineration accidents parallel those estimated for the offsite and noninvolved worker populations.

The highest-risk incineration accident type for both MEIs is the earthquake with subsequent fire. The highest site-specific cancer fatality risk to the offsite MEI is from the facility earthquake scenario at ORR for all alternatives (Regionalized 2, Regionalized 3, and Centralized). Estimated cancer fatality risks to the offsite MEI at ORR are 1.0E-05. The next highest site risks are for the same facility earthquake scenarios at Hanford for all alternatives (2.3E-07). For the operational accidents of which the incinerator explosion is the worst-case accident, cancer fatality risks to the offsite MEI are once again greatest at ORR (1.9E-07)

for all alternatives. Hanford has the next highest risk with 4.2E-09 estimated cancer fatalities for all alternatives.

The risks to the noninvolved worker MEI follows the same trends in risk as those to the offsite MEI. The earthquake scenario at ORR is the worst-case accident for the noninvolved worker MEI for all alternatives. Estimated cancer fatality risks to the noninvolved worker MEI at ORR is 5.1E-05. Hanford has the next highest risk with 1.5E-05 estimated cancer fatalities for the same type of accident. For the operational accidents of which the incinerator explosion is the worst-case accident, ORR is once again the highest site-specific cancer fatality risk with 9.4E-07 estimated cancer fatalities. Hanford has the next highest risk with 2.7E-07 estimated cancer fatalities for the incinerator explosion.

D.3.4.14.4 *Risks to Waste Management Workers from RH-TRUW Accidents*

For incineration accidents involving releases of radionuclides, site-specific worker risks are the same among alternatives. Unlike all other receptors, the highest cancer-fatality risks to the waste management worker occur during the incinerator explosion accident. Estimated worker cancer fatalities associated with the earthquake facility incineration accident range from 1.2E-04 to 4.8E-03. For operational accident scenarios, estimated worker cancer fatalities range from 4.8E-07 to 8.9E-02. Shift size varies from 1 to 7 workers. In all alternatives, the incinerator explosion scenario produces the higher worker risks by about 1 order of magnitude over the earthquake scenario and about 3 to 4 orders of magnitude over the baghouse area fire scenario.

The highest site-specific cancer fatality risks associated with the incinerator accidents are for the incinerator explosion at ORR with 8.9E-02 estimated cancer fatalities. Hanford has 2.2E-03 estimated cancer fatalities for this same type of accident. For the earthquake scenario accident, ORR once again has the highest site cancer fatality risks followed by Hanford (4.8E-03 and 2.3E-07, respectively).

D.3.5 Low-Level Mixed Waste

Low-level mixed waste (LLMW) is waste that contains both low-level radioactivity and hazardous components regulated under the Resource Conservation and Recovery Act in sufficient quantities to render the waste hazardous per the guidelines of 40 CFR 261. Although asbestos-containing wastes are not considered hazardous under the Resource Conservation and Recovery Act, friable asbestos waste is considered a hazardous waste in several states. For the purposes of the PEIS, low-level radioactive waste contaminated with asbestos is considered LLMW. High-level waste, transuranic waste, or spent nuclear fuel that may be contaminated with hazardous components regulated by the Resource Conservation and Recovery Act are not classified as LLMW and are not evaluated for human health risks in this portion of the appendix (high-level waste is considered in Section D.3.1 and transuranic wastes containing hazardous constituents are addressed in Section D.3.4).

Like low-level waste, LLMW may contain a wide range of radionuclides at activities ranging from trace amounts to thousands of curies. Packaged LLMW with a surface dose rate of less than 200 mrem/h is categorized as contact-handled LLMW (CH-LLMW). Packaged LLMW with a surface dose rate greater than 200 mrem/h emits sufficient penetrating beta, gamma, or neutron radiation to require remote handling, and is classified as remote-handled LLMW (RH-LLMW). The handling category determines the level of protective shielding needed to store and process the waste safely. The distinction between CH-LLMW and RH-LLMW is maintained in the human health risk analyses for both routine operations and accidents. The risks associated with each category are estimated and discussed separately.

LLMW is also categorized according to its content of alpha-emitting radionuclides (e.g., alpha LLMW or nonalpha LLMW) and polychlorinated biphenyls (PCBs) (e.g., PCB LLMW or non-PCB LLMW).

About 50 sites within the DOE complex generate LLMW, including those listed below (note that the abbreviations given here are used in the tables in this appendix):

- Argonne National Laboratory–East (ANL-E), Argonne, Illinois
- Brookhaven National Laboratory (BNL), Brookhaven, New York
- Fernald Environmental Management Project (FEMP), Fernald, Ohio
- Hanford Site (Hanford), Richland, Washington
- Idaho National Engineering Laboratory (INEL), Idaho Falls, Idaho
- Inhalation Toxicology Research Institute (ITRI), Albuquerque, New Mexico

- Kansas City Plant (KCP), Kansas City, Missouri
- Knolls Atomic Power Laboratory–Kesselring (KAPL–K), Schenectady, New York
- Lawrence Berkeley Laboratory (LBL), Berkeley, California
- Lawrence Livermore National Laboratory (LLNL), Livermore, California
- Los Alamos National Laboratory (LANL), Los Alamos, New Mexico
- Mound Plant (Mound), Miamisburg, Ohio
- Nevada Test Site (NTS), Las Vegas, Nevada
- Oak Ridge Reservation (ORR), Oak Ridge, Tennessee
- Paducah Gaseous Diffusion Plant (PGDP), Paducah, Kentucky
- Pantex Plant (Pantex), Amarillo, Texas
- Portsmouth Gaseous Diffusion Plant (PORTS), Piketon, Ohio
- Rocky Flats Environmental Technology Site (RFETS), Golden, Colorado
- Sandia National Laboratories–New Mexico (SNL-NM), Albuquerque, New Mexico
- Savannah River Site (SRS), Aiken, South Carolina
- West Valley Demonstration Project (WVDP), West Valley, New York

This list includes the 16 major sites considered for LLMW management described in Section 1.6.1 and Chapter 6 of Volume I.

Treatment risks were also estimated separately later in this section in Tables D.3.5–15 through D.3.5–21 for several other sites in addition to the 16 major sites. These sites include KAPL-K, LBL, Mound, and KCP. Treatment risks at these sites are contained in the programwide risk tables presented in this section (Tables D.3.5–7 through D.3.5–14) and in the alternative summary risk tables presented in Section 6.4 of Volume I.

Depending on its chemical and physical properties, LLMW can be grouped into waste stream categories according to the type of treatment needed, such as aqueous wastes, organic liquids, inorganic or organic sludges, contaminated soil with or without debris, or special wastes.

Chapters 3 and 6 of the PEIS and the LLMW technical report (ANL, 1996e) provide more detailed information on this waste, including LLMW inventories at DOE sites, estimated release rates, treatment categories used in the PEIS, considerations regarding disposal, and the process for developing PEIS LLMW alternatives.

D.3.5.1 Summary of LLMW Alternatives

The PEIS waste management alternatives (No Action, Decentralized, Regionalized, and Centralized) and the rationale for developing the various LLMW analysis alternatives are discussed rigorously in the main body of the PEIS. A broad range of Decentralized, Regionalized, and Centralized Alternatives are analyzed for this waste stream:

- The No Action Alternative: In this alternative, all sites treat CH-LLMW and RH-LLMW using existing capabilities and store the treated waste onsite (there is no disposal scenario for this alternative).
- The Decentralized Alternative: In this alternative, 49 sites treat CH-LLMW and 15 sites dispose of it.
- The Regionalized Alternatives: Regionalized 1 involves treatment of CH-LLMW at 11 sites and disposal at 12. In Regionalized 2 and 3, CH-LLMW is treated at seven sites and disposed of at six and one site(s), respectively. Regionalized 4 entails treating CH-LLMW at four sites and disposing of it at six.
- The Centralized Alternative: Hanford treats and disposes of CH-LLMW in this alternative.
- The RH-LLMW management scenario (for all alternatives except No Action): four sites treat this waste and dispose of it onsite.

This series of alternatives makes it possible to compare the relative risks of consolidating CH-LLMW and treating it at varying numbers of sites, and the risks associated with a broad range of disposal configurations.

Table D.3.5-1 depicts the overall treatment and storage schemes for the LLMW alternatives; detailed information on waste consolidation scenarios can be found in the LLMW technical report (ANL, 1996e). Note that for the purposes of this risk analysis, the waste load from the ITRI has been added to the waste load for SNL-NM.

D.3.5.2 Special Assumptions and Considerations Used in the LLMW Risk Analysis

The following chemicals were used as representatives of generic classes of chemical contaminants in the risk evaluation for the offsite and noninvolved worker populations: 1,2-dichloroethane (to represent compounds containing two chlorine atoms), 1,1,1-trichloroethane (to represent compounds containing three chlorine atoms), carbon tetrachloride (to represent compounds containing four chlorine atoms),

Table D.3.5-1. PEIS Alternatives for LLMW

Alternative	Scenario	ANL-E	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	Pantex	PGDP	PORTS	RFETS	SNL-NM	SRS	WVDP	BNL	LBL	Mound	KCP	KAPL-K
No Action (CH and RH) All installations treat using existing capabilities and store onsite	Treat at all	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	Store at all	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Decentralized CH treatment	CH treatment at 49	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	Dispose at 15	D	D	D	D	D	D	D	D	D	D	D	D	D	D		D				
Regionalized 1 CH treatment	CH treatment at 11		T	T	T	T	T		T	T	T	T	T		T						
	Dispose at 12		D	D	D	D	D	D	D	D	D	D	D		D						
Regionalized 2 CH treatment	CH treatment at 7			T	T	T			T			T	T		T						
	Dispose at 6			D	D	D		D	D						D						
Regionalized 3 CH treatment	CH treatment at 7			T	T	T			T			T	T		T						
	Dispose at 1							D													
Regionalized 4 CH treatment	CH treatment at 4			T	T				T						T						
	Dispose at 6			D	D	D		D	D						D						
Centralized CH treatment	CH treatment at 1			T																	
	Dispose at 1			D																	
(All alternatives except No Action) RH treatment	RH treatment at 4			T	T				T						T						
	Dispose at 4			D	D				D						D						

Notes: T = treatment site; S = storage site; D = disposal site.

1,2,2-trichloro-1,1,2-trifluoroethane (to represent chlorofluorocarbons), benzene (to represent water-insoluble organic compounds), and acetone (to represent water-soluble organic compounds). It was also assumed that any chromium in the source term was the inhalation carcinogen, chromium (VI) (100%), due to lack of better information. This is a conservative assumption, and health risks associated with chromium (VI) may be overestimated.

For all disposal scenarios, it is assumed that shallow land burial will be used at sites west of the Mississippi River and tumulus (above-ground vault) disposal will be used at eastern sites. The exceptions are RFETS, which disposes in tumulus vaults, and SRS, which disposes in below-ground vaults.

It is assumed that, except in the No Action Alternative, LLMW disposal capacity at each site will be expanded as required to meet disposal demands.

The waste containers for CH-LLMW are assumed to be 55-gal drums; RH-LLMW is assumed to be packaged in concrete casks with 6-in. walls.

For the purposes of estimating the human health risks associated with treatment and disposal of LLMW, no distinction is made between PCB-contaminated LLMW and non-PCB LLMW. If a site is postulated to possess PCB-LLMW, the source term for that mixed waste is combined with all the other LLMW source terms for that site.

D.3.5.3 Results Tables for the LLMW Human Health Risk Analysis

This section contains the results tables for the LLMW human health risk analysis. A discussion of the results is presented in Section D.3.5.4. The risk numbers in the tables are displayed in the standard exponential notation used in risk assessment; directions on reading this notation and a more complete description of the types of information in the tables are given in Section D.2.

- Table D.3.5-2 presents an overview, by alternative, of the *total*, programwide risks associated with treatment of LLMW. Included are the risks of cancer fatalities and cancer incidence for the offsite and noninvolved worker populations; and the risks of cancer fatalities, cancer incidence, and construction and operational fatalities for waste management workers associated with waste treatment. This table provides the estimated *total number* of people in the three populations who will develop or die of

cancers caused by exposure to LLMW if a particular alternative is implemented nationwide. In addition, it shows the estimated total number of workers who will be killed during construction and operational activities. The results in this table are drawn from Tables D.3.5–7 through D.3.5–14 on the following pages.

- Table D.3.5–3 presents an overview, by alternative, of the programwide risks associated with disposal of LLMW. This table summarizes the risks of cancer fatalities and cancer incidence for the MEL of the hypothetical farm family; the likelihood of adverse health effects to the maximally exposed lifetime (MEL) from exposure to noncarcinogenic, hazardous chemicals; the total risks to members of all 143 lifetimes of the farm family; and the risks of cancer fatalities, cancer incidence, and construction and operational fatalities for waste management workers associated with waste disposal. The results in this table are drawn from Tables D.3.5–23 through D.3.5–29.
- Table D.3.5–4 shows the sizes of the total affected populations for each alternative.
- Table D.3.5–5 summarizes the risks to the noninvolved worker and offsite MEIs for each LLMW alternative. The numbers in this table are the estimated *probabilities* that the offsite and noninvolved worker MEIs will die of or develop cancer from radionuclide and chemical exposure and indicators of the likelihood of adverse health effects to the MEIs from exposure to noncarcinogenic, hazardous chemicals. These results are drawn from Tables D.3.5–7 through D.3.5–14 and Tables D.3.5–23 through D.3.5–29.
- Table D.3.5–6 lists the radionuclides that contribute most of the risk of cancer fatality to the offsite population for LLMW treatment, by site and alternative.

The following tables are located on the following pages:

- Tables D.3.5–7 through D.3.5–14 provide more detailed information on the programwide health risks to all receptors from treatment of LLMW, by alternative and health endpoint.
- Tables D.3.5–15 through D.3.5–22 present summaries of the health risks for the offsite and worker populations, by alternative and site.
- Tables D.3.5–23 through D.3.5–29 provide more detailed information on the programwide health risks to the MEL of the hypothetical farm family of four, all 143 lifetimes of the farm family, and waste disposal workers, by alternative and health endpoint.
- Tables D.3.5–30 through D.3.5–36 present summaries of the health risks to the farm family and workers and an indication of which farm family lifetime is maximally exposed, by installation.

Table D.3.5-2. Summary of Programwide Risks Associated With Treatment of LLMW: Risks to Total Populations, by Alternative

Alternative	Offsite Population		Noninvolved Worker Population		WM Workers		
	CF	CI	CF	CI	CF	CI	C&OF
No Action	2.8E-01	1.0	1.3E-02	4.4E-02	8.4E-01	2.9	1.7
Decentralized	1.7E-01	5.8E-01	2.4E-03	8.0E-03	5.2E-01	1.8	4.0
Regionalized 1	1.6E-01	5.5E-01	2.4E-03	8.0E-03	5.6E-01	2.0	3.7
Regionalized 2	1.8E-02	6.1E-02	3.6E-04	1.2E-03	5.7E-01	2.0	3.4
Regionalized 3	1.8E-02	6.1E-02	3.6E-04	1.2E-03	5.7E-01	2.0	3.4
Regionalized 4	1.8E-02	5.9E-02	3.6E-04	1.2E-03	6.2E-01	2.2	3.1
Centralized	2.5E-02	8.6E-02	3.3E-04	1.1E-03	6.3E-01	2.2	2.6
RH-LLMW	1.3E-03	4.5E-03	4.2E-05	1.4E-04	2.3E-02	8.1E-02	4.5E-01

Notes: CF = cancer fatality associated with radionuclide exposure; CI = cancer incidence associated with exposure to radionuclides and carcinogenic chemicals; C&OF = fatalities due to the physical hazards of constructing and operating waste management facilities.

Table D.3.5-3. Summary of Programwide Risks Associated With Disposal of LLMW: Risks to Hypothetical Farm Family and Waste Management Workers, by Alternative

Alternative	MEL of Farm Family				All (143) Lifetimes of Farm Family			WM Workers		
	CF	Rad CI	Chem CI	HI	CF	Rad CI	Chem CI	CF	CI	C&OF
Decentralized	1.5E-03	4.9E-03	9.8E-03	2.4	3.5E-02	1.2E-01	4.9E-01	5.5E-01	1.9	4.3E-01
Regionalized 1	1.2E-03	4.1E-03	9.8E-03	3.0	2.4E-02	8.0E-02	5.0E-01	5.5E-01	1.9	4.6E-01
Regionalized 2	1.4E-03	4.8E-03	1.3E-02	2.7	2.4E-02	8.0E-02	8.3E-01	5.2E-01	1.8	4.2E-01
Regionalized 3	0.00	0.00	7.2E-04	8.1E-01	0.00	0.00	3.0E-02	3.9E-01	1.4	8.4E-02
Regionalized 4	1.5E-03	5.1E-03	1.3E-02	2.7	2.5E-02	8.5E-02	8.2E-01	6.4E-01	2.2	4.1E-01
Centralized	1.9E-02	6.6E-02	9.5E-04	2.4	2.5E-01	8.6E-01	8.5E-03	3.6E-01	1.3	1.5E-01
RH-LLMW	8.5E-05	2.9E-04	1.4E-05	1.3E-02	1.3E-03	4.5E-03	5.8E-04	1.5E-03	5.2E-03	3.0E-02

Notes: CF = risk of cancer fatality associated with exposure to both radionuclides and carcinogenic chemicals; Rad CI = risk of cancer incidence associated with exposure to radionuclides; Chem CI = Risk of cancer incidence associated with exposure to chemical carcinogens; HI = hazard index; C&OF = estimated construction and operational fatalities from physical hazards.

Table D.3.5–4. Size of Total Offsite, Noninvolved Worker, and Worker Populations Affected by Risks From Routine Management of LLMW, by Alternative

Alternative	Offsite Population	Noninvolved Worker Population	WM Workers
No Action	53,223,046	113,878	10,261
Decentralized	53,223,046	113,878	13,070
Regionalized 1	53,223,046	113,878	12,867
Regionalized 2	53,223,046	113,878	12,467
Regionalized 3	53,223,046	113,878	12,467
Regionalized 4	53,223,046	113,878	11,261
Centralized	53,223,046	113,878	8,672
RH-LLMW	2,032,976	36,930	1,119

Table D.3.5–5. Summary of Programwide Risks Associated With Treatment of LLMW: Risks to the Offsite and Noninvolved Worker Maximally Exposed Individuals, by Alternative

	Offsite MEI				Noninvolved Worker MEI			
Alternative	CF	Rad CI	Chem CI	HI	CF	Rad CI	Chem CI	HI
No Action	3.5E-06	1.2E-05	2.0E-08	2.3E-05	8.7E-06	3.0E-05	2.1E-07	4.5E-05
Decentralized	2.5E-06	8.5E-06	1.2E-09	1.4E-06	7.3E-07	2.5E-06	7.1E-09	8.8E-06
Regionalized 1	2.6E-06	8.7E-06	1.0E-09	1.4E-06	7.4E-07	2.5E-06	6.2E-09	8.7E-06
Regionalized 2	2.7E-07	9.2E-07	1.0E-09	1.4E-06	3.1E-07	1.0E-06	6.2E-09	8.8E-06
Regionalized 3	2.7E-07	9.2E-07	1.0E-09	1.4E-06	3.1E-07	1.0E-06	6.2E-09	8.8E-06
Regionalized 4	2.7E-07	9.3E-07	1.5E-09	2.0E-06	3.1E-07	1.1E-06	9.3E-09	1.3E-05
Centralized	5.2E-07	1.8E-06	4.1E-10	4.5E-07	5.8E-07	2.0E-06	1.4E-08	1.6E-05
RH-LLMW	3.4E-08	1.2E-07	2.9E-12	4.8E-09	2.3E-08	7.8E-08	1.8E-11	3.8E-08

Notes: MEI = maximally exposed individual; CF = risk of cancer fatality associated with exposure to radionuclides; Rad CI = risk of cancer incidence associated with exposure to radionuclides; Chem CI = risk of cancer incidence associated with exposure to chemical carcinogens; HI = hazard index.

Table D.3.5–6. Radionuclide Contributing the Highest Risk of Cancer Fatality to the Offsite Population for LLMW Treatment, by Alternative and Site

Alt.	Site																		
	ANL-E	Hanford	INEL	KAPL-K	KCP	LANL	LBL	LLNL	NTS	ORR	Pantex	PORTS	PGDP	RFETS	SNL/NM	SRS	WVDP	FEMP	BNL	Mound
No Action	U-238[a] 1.24E-04[b]	Pu-238 1.11E-02	Pu-238 3.85E-04	Co-60 4.87E-04	Co-60 4.61E-06	Pu-238 8.81E-05	U-238 3.45E-05	Pu-238 7.55E-04	U-238 8.1E-06	U-238 1.09E-01	Pu-238 1.45E-06	U-238 5.92E-05	U-238 3.32E-03	Pu-238 1.63E-02	Pu-238 3.13E-05	H-3 2.60E-03	Pu-238 2.03E-04	U-238 5.90E-04	U-238 1.08E-04	Pu-238 1.38E-05
Dec.	U-238 7.1E-06	Pu-238 9.84E-04	H-3 3.50E-05	H-3 1.98E-04	H-3 2.30E-06	H-3 5.86E-04	H-3 1.02E-02	H-3 1.54E-01	U-238 1.1E-06	U-238 4.86E-04	H-3 3.41E-05	U-238 2.49E-06	U-238 1.10E-04	Pu-238 4.09E-05	H-3 1.30E-04	H-3 1.68E-03	Pu-238 1.08E-07	U-238 2.39E-05	U-238 5.32E-06	H-3 1.26E-04
Reg. 1	H-3 5.3E-07	Pu-238 9.03E-04	H-3 3.50E-05	Co-60 1.05E-07	Co-60 9.90E-10	H-3 6.02E-04	U-238 7.74E-09	H-3 1.57E-01	H-3 5.2E-09	U-238 4.19E-04	H-3 3.41E-05	H-3 3.03E-05	U-238 1.10E-04	Pu-238 4.08E-05	Pu-238 7.30E-09	H-3 1.68E-03	H-3 1.06E-07	U-238 3.30E-04	U-238 2.43E-08	Pu-238 3.22E-09
Reg. 2	H-3 5.3E-07	H-3 1.20E-02	H-3 6.10E-04	Co-60 1.05E-07	Co-60 9.90E-10	H-3 8.52E-04	U-238 7.74E-09	Pu-238 1.76E-07	H-3 5.2E-09	U-238 6.56E-04	H-3 2.34E-06	H-3 3.15E-05	U-238 7.48E-07	Pu-238 4.09E-05	Pu-238 7.30E-09	H-3 1.68E-03	H-3 1.06E-07	U-238 1.33E-07	U-238 2.43E-08	Pu-238 3.22E-09
Reg. 3	H-3 5.3E-07	H-3 1.20E-02	H-3 6.10E-04	Co-60 1.05E-07	Co-60 9.90E-10	H-3 8.52E-04	U-238 7.74E-09	Pu-238 1.76E-07	H-3 5.2E-09	U-238 6.56E-04	H-3 2.34E-06	H-3 3.15E-05	U-238 7.48E-07	Pu-238 4.09E-05	Pu-238 7.30E-09	H-3 1.68E-03	H-3 1.06E-07	U-238 1.33E-07	U-238 2.43E-08	Pu-238 3.22E-09
Reg. 4	H-3 5.3E-07	H-3 1.20E-02	H-3 6.51E-04	Co-60 1.05E-07	Co-60 9.90E-10	H-3 3.79E-05	U-238 7.74E-09	Pu-238 1.76E-07	H-3 5.2E-09	U-238 8.04E-04	H-3 2.34E-06	U-238 1.65E-08	U-238 7.48E-07	Pu-238 8.15E-07	Pu-238 7.30E-09	H-3 1.68E-03	H-3 1.06E-07	U-238 1.33E-07	U-238 2.43E-08	Pu-238 3.24E-09
Cen.	H-3 5.3E-07	H-3 2.30E-02	H-3 4.83E-06	Co-60 1.05E-07	Co-60 9.90E-10	H-3 3.79E-05	U-238 7.74E-09	Pu-238 1.76E-07	H-3 5.2E-09	U-238 2.18E-06	H-3 2.34E-06	U-238 1.65E-08	U-238 7.48E-07	Pu-238 8.15E-07	Pu-238 7.30E-09	H-3 9.81E-07	H-3 1.06E-07	U-238 1.33E-07	U-238 2.43E-08	Pu-238 3.24E-09
RH	H-3 5.3E-07	Pu-238 3.08E-07	H-3 1.95E-04							H-3 7.66E-04						H-3 2.80E-05				

Notes: Alt. = Alternative; Dec. = Decentralized; Reg. = Regionalized; Cen. = Centralized; RH = remote-handled low-level mixed waste.
[a] Radionuclide contributing most risk.
[b] Associated risk of cancer fatality to the offsite population within 80 km (50 mi) of this site.

Table D.3.5-7. Programwide Risks Associated With Treatment of LLMW Under the No Action Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	2.5E+01			
	Cancer fatalities	1.3E-02			
	Cancer incidence	4.3E-02	5.7E-04		
	Genetic effects	2.5E-03			
Noninvolved worker MEI	Dose (rem)	1.7E-02			
	Cancer fatalities	8.7E-06			
	Cancer incidence	3.0E-05	2.1E-07		
	Genetic effects	1.7E-06			
	Hazard index			4.5E-05	
Offsite population	Dose (person-rem)	5.7E+02			
	Cancer fatalities	2.8E-01			
	Cancer incidence	1.0	2.5E-03		
	Genetic effects	5.7E-02			
Offsite MEI	Dose (rem)	7.0E-03			
	Cancer fatalities	3.5E-06			
	Cancer incidence	1.2E-05	2.0E-08		
	Genetic effects	7.0E-07			
	Hazard index			2.3E-05	
WM workers	Dose (FTE-rem)	2.1E+03			
	Cancer fatalities	8.4E-01			
	Cancer incidence	2.9	1.1E-02		
	Genetic effects	1.3E-01			
	Exposure index			1.2E-02	
	Construction fatalities				6.0E-01
	Construction injuries				2.6E+02
	Operation fatalities				1.1
	Operation injuries				9.2E+02

Table D.3.5–8. Programwide Risks Associated With Treatment of LLMW Under the Decentralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	4.7			
	Cancer fatalities	2.4E–03			
	Cancer incidence	8.0E–03	1.4E–05		
	Genetic effects	4.7E–04			
Noninvolved worker MEI	Dose (rem)	1.5E–03			
	Cancer fatalities	7.3E–07			
	Cancer incidence	2.5E–06	7.1E–09		
	Genetic effects	1.5E–07			
	Hazard index			8.8E–06	
Offsite population	Dose (person-rem)	3.4E+02			
	Cancer fatalities	1.7E–01			
	Cancer incidence	5.8E–01	4.4E–05		
	Genetic effects	3.4E–02			
Offsite MEI	Dose (rem)	5.0E–03			
	Cancer fatalities	2.5E–06			
	Cancer incidence	8.5E–06	1.2E–09		
	Genetic effects	5.0E–07			
	Hazard index			1.4E–06	
WM workers	Dose (FTE-rem)	1.3E+03			
	Cancer fatalities	5.2E–01			
	Cancer incidence	1.8	9.7E–03		
	Genetic effects	7.7E–02			
	Exposure index			1.2E–02	
	Construction fatalities				2.2
	Construction injuries				9.2E+02
	Operation fatalities				1.8
	Operation injuries				1.5E+03

Table D.3.5-9. Programwide Risks Associated With Treatment of LLMW Under Regionalized Alternative 1, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	4.7			
	Cancer fatalities	2.4E-03			
	Cancer incidence	8.0E-03	1.3E-05		
	Genetic effects	4.7E-04			
Noninvolved worker MEI	Dose (rem)	1.5E-03			
	Cancer fatalities	7.4E-07			
	Cancer incidence	2.5E-06	6.2E-09		
	Genetic effects	1.5E-07			
	Hazard index			8.7E-06	
Offsite population	Dose (person-rem)	3.3E+02			
	Cancer fatalities	1.6E-01			
	Cancer incidence	5.5E-01	4.6E-05		
	Genetic effects	3.3E-02			
Offsite MEI	Dose (rem)	5.1E-03			
	Cancer fatalities	2.6E-06			
	Cancer incidence	8.7E-06	1.0E-09		
	Genetic effects	5.1E-07			
	Hazard index			1.4E-06	
WM workers	Dose (FTE-rem)	1.4E+03			
	Cancer fatalities	5.6E-01			
	Cancer incidence	2.0	9.2E-03		
	Genetic effects	8.4E-02			
	Exposure index			1.2E-02	
	Construction fatalities				2.0
	Construction injuries				8.6E+02
	Operation fatalities				1.7
	Operation injuries				1.5E+03

Table D.3.5-10. Programwide Risks Associated With Treatment of LLMW Under Regionalized Alternative 2, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	7.2E-01			
	Cancer fatalities	3.6E-04			
	Cancer incidence	1.2E-03	1.5E-05		
	Genetic effects	7.2E-05			
Noninvolved worker MEI	Dose (rem)	6.1E-04			
	Cancer fatalities	3.1E-07			
	Cancer incidence	1.0E-06	6.2E-09		
	Genetic effects	6.1E-08			
	Hazard index			8.8E-06	
Offsite population	Dose (person-rem)	3.6E+01			
	Cancer fatalities	1.8E-02			
	Cancer incidence	6.1E-02	3.8E-05		
	Genetic effects	3.6E-03			
Offsite MEI	Dose (rem)	5.4E-04			
	Cancer fatalities	2.7E-07			
	Cancer incidence	9.2E-07	1.0E-09		
	Genetic effects	5.4E-08			
	Hazard index			1.4E-06	
WM workers	Dose (FTE-rem)	1.4E+03			
	Cancer fatalities	5.7E-01			
	Cancer incidence	2.0	9.6E-03		
	Genetic effects	8.5E-02			
	Exposure index			1.3E-02	
	Construction fatalities				1.8
	Construction injuries				7.7E+02
	Operation fatalities				1.6
	Operation injuries				1.4E+03

Table D.3.5-11. Programwide Risks Associated With Treatment of LLMW Under Regionalized Alternative 3, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	7.2E-01			
	Cancer fatalities	3.6E-04			
	Cancer incidence	1.2E-03	1.1E-05		
	Genetic effects	9.2E-05			
Noninvolved worker MEI	Dose (rem)	6.1E-04			
	Cancer fatalities	3.1E-07			
	Cancer incidence	1.0E-06	6.2E-09		
	Genetic effects	6.1E-08			
	Hazard index			8.8E-06	
Offsite population	Dose (person-rem)	3.6E+01			
	Cancer fatalities	1.8E-02			
	Cancer incidence	6.1E-02	3.2E-05		
	Genetic effects	3.6E-03			
Offsite MEI	Dose (rem)	5.4E-04			
	Cancer fatalities	2.7E-07			
	Cancer incidence	9.2E-07	1.0E-09		
	Genetic effects	5.4E-08			
	Hazard index			1.4E-06	
WM workers	Dose (FTE-rem)	1.4E+03			
	Cancer fatalities	5.7E-01			
	Cancer incidence	2.0	9.6E-03		
	Genetic effects	8.5E-02			
	Exposure index			1.3E-02	
	Construction fatalities				1.8
	Construction injuries				7.7E+02
	Operation fatalities				1.6
	Operation injuries				1.4E+03

Table D.3.5-12. Programwide Risks Associated With Treatment of LLMW Under Regionalized Alternative 4, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	7.1E-01			
	Cancer fatalities	3.6E-04			
	Cancer incidence	1.2E-03	1.3E-05		
	Genetic effects	7.1E-05			
Noninvolved worker MEI	Dose (rem)	6.3E-04			
	Cancer fatalities	3.1E-07			
	Cancer incidence	1.1E-06	9.3E-09		
	Genetic effects	6.3E-08			
	Hazard index			1.3E-05	
Offsite population	Dose (person-rem)	3.5E+01			
	Cancer fatalities	1.8E-02			
	Cancer incidence	5.9E-02	3.4E-05		
	Genetic effects	3.5E-03			
Offsite MEI	Dose (rem)	5.5E-04			
	Cancer fatalities	2.7E-07			
	Cancer incidence	9.3E-07	1.5E-09		
	Genetic effects	5.5E-08			
	Hazard index			2.0E-06	
WM workers	Dose (FTE-rem)	1.6E+03			
	Cancer fatalities	6.2E-01			
	Cancer incidence	2.2	1.2E-02		
	Genetic effects	9.4E-02			
	Exposure index			1.6E-02	
	Construction fatalities				1.6
	Construction injuries				6.9E+02
	Operation fatalities				1.5
	Operation injuries				1.3E+03

Table D.3.5-13. Programwide Risks Associated With Treatment of LLMW Under the Centralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	6.6E-01			
	Cancer fatalities	3.3E-04			
	Cancer incidence	1.1E-03	7.9E-06		
	Genetic effects	6.6E-05			
Noninvolved worker MEI	Dose (rem)	1.2E-03			
	Cancer fatalities	5.8E-07			
	Cancer incidence	2.0E-06	1.4E-08		
	Genetic effects	1.2E-07			
	Hazard index			1.6E-05	
Offsite population	Dose (person-rem)	5.0E+01			
	Cancer fatalities	2.5E-02			
	Cancer incidence	8.6E-02	1.5E-05		
	Genetic effects	5.0E-03			
Offsite MEI	Dose (rem)	1.0E-03			
	Cancer fatalities	5.2E-07			
	Cancer incidence	1.8E-06	4.1E-10		
	Genetic effects	1.0E-07			
	Hazard index			4.5E-07	
WM workers	Dose (FTE-rem)	1.6E+03			
	Cancer fatalities	6.3E-01			
	Cancer incidence	2.2	1.8E-02		
	Genetic effects	9.5E-02			
	Exposure index			2.6E-02	
	Construction fatalities				1.4
	Construction injuries				6.0E+02
	Operation fatalities				1.2
	Operation injuries				9.8E+02

Table D.3.5-14. Programwide Risks Associated With Treatment of RH-LLMW Under Each Alternative Except No Action, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Noninvolved worker population	Dose (person-rem)	8.4E-02			
	Cancer fatalities	4.2E-05			
	Cancer incidence	1.4E-04	3.9E-08		
	Genetic effects	8.4E-06			
Noninvolved worker MEI	Dose (rem)	4.6E-05			
	Cancer fatalities	2.3E-08			
	Cancer incidence	7.8E-08	1.8E-11		
	Genetic effects	4.6E-09			
	Hazard index			3.8E-08	
Offsite population	Dose (person-rem)	2.7			
	Cancer fatalities	1.3E-03			
	Cancer incidence	4.5E-03	7.2E-08		
	Genetic effects	2.7E-04			
Offsite MEI	Dose (rem)	6.8E-05			
	Cancer fatalities	3.4E-08			
	Cancer incidence	1.2E-07	2.9E-12		
	Genetic effects	6.8E-09			
	Hazard index			4.8E-09	
WM workers	Dose (FTE-rem)	5.8E+01			
	Cancer fatalities	2.3E-02			
	Cancer incidence	8.1E-02	6.7E-05		
	Genetic effects	3.5E-03			
	Exposure index			4.6E-04	
	Construction fatalities				2.9E-01
	Construction injuries				1.3E+02
	Operation fatalities				1.6E-01
	Operation injuries				1.4E+02

Table D.3.5–15. Risks Associated With Treatment of LLMW Under the No Action Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
FEMP	2,764,589 165	3.2E-04	6.0E-09	1.4E-02	1.1E-03	2.1E-08	1.3E-03
KAPL-K	1,290,172 13	5.8E-04	1.3E-08	2.0E-03	2.0E-03	4.4E-08	3.2E-03
LBL	1,586,829 11	2.2E-05	3.3E-10	9.7E-04	7.7E-05	1.2E-09	9.2E-05
LANL	159,152 136	7.5E-05	8.0E-09	1.2E-02	2.6E-04	2.8E-08	2.9E-03
LLNL	6,324,234 220	9.5E-04	1.6E-08	1.9E-02	3.3E-03	5.5E-08	2.9E-03
Mound	3,032,983 7	1.3E-05	7.3E-10	5.8E-04	4.4E-05	2.5E-09	5.3E-05
NTS	14,266 330	5.8E-06	1.5E-09	3.9E-02	2.0E-05	5.1E-09	4.2E-02
Pantex	265,185 46	1.1E-06	9.2E-11	4.0E-03	3.8E-06	3.2E-10	6.1E-04
Ports	639,602 435	3.2E-05	4.0E-09	3.4E-02	1.7E-04	2.3E-08	4.5E-03
SNL-NM	610,714 8	3.8E-05	1.5E-09	6.6E-04	1.3E-04	5.2E-09	8.4E-05
Hanford	377,645 586	7.6E-03	1.6E-07	1.4E-01	2.6E-02	5.3E-07	3.7E-01
RFETS	2,171,877 2,407	1.3E-02	1.8E-07	2.4E-01	4.6E-02	6.1E-07	6.3E-01
WVDP	1,698,391 9	1.4E-04	2.1E-09	7.9E-04	4.7E-04	7.0E-09	1.1E-04
KCP	1,729,833 0	5.5E-06	2.5E-10	3.2E-05	1.9E-05	8.5E-10	3.8E-06
SRS	620,618 1,005	1.6E-03	1.5E-08	2.1E-01	5.3E-03	5.0E-08	4.8E-01
ORR	881,652 2,434	1.1E-01	3.5E-06	3.6E-01	3.9E-01	1.2E-05	7.0E-01
PGDP	500,502 55	1.8E-03	2.0E-07	4.8E-03	6.1E-03	6.8E-07	6.1E-04
INEL	153,061 782	5.6E-04	7.0E-08	1.8E-01	1.9E-03	2.4E-07	4.2E-01
BNL	5,738,554 24	1.1E-04	1.5E-09	2.1E-03	4.0E-04	5.3E-09	2.6E-04
ANL-E	7,939,785 22	2.6E-04	1.4E-09	1.9E-03	8.9E-04	4.9E-09	2.3E-04
Total		2.8E-01	3.5E-06	2.5E+0	1.0	1.2E-05	2.9

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5–16. Risks Associated With Treatment of LLMW Under the Decentralized Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
BNL	5,738,554 62	1.2E-05	1.6E-10	1.6E-02	4.1E-05	5.5E-10	4.3E-04
FEMP	2,764,589 533	2.6E-05	4.9E-10	1.6E-01	9.1E-05	1.7E-09	1.1E-03
KAPL-K	1,290,172 44	3.0E-04	6.7E-09	1.3E-02	1.0E-03	2.3E-08	6.2E-03
LBL	5,856,829 40	1.0E-02	1.6E-07	1.0E-02	3.5E-02	5.5E-07	1.3E-04
LANL	159,152 590	5.9E-04	6.2E-08	2.0E-01	2.0E-03	2.1E-07	5.5E-03
LLNL	6,324,234 831	1.5E-01	2.5E-06	2.7E-01	5.2E-01	8.5E-06	2.8E-02
ORR	881,652 2,530	1.1E-03	3.3E-08	7.7E-01	3.7E-03	1.2E-07	6.2E-01
Mound	3,032,983 7	1.3E-04	7.4E-09	2.1E-03	4.3E-04	2.5E-08	4.7E-05
NTS	14,266 785	7.9E-07	2.0E-10	1.1E-01	2.7E-06	6.9E-10	4.8E-02
Pantex	265,185 145	3.5E-05	2.9E-09	3.9E-02	1.2E-04	1.0E-08	1.2E-03
PORTS	639,602 1,853	2.7E-06	3.4E-10	4.8E-01	1.2E-05	1.5E-09	5.6E-03
SNL-NM	610,714 20	1.4E-04	5.4E-09	5.4E-03	4.7E-04	1.9E-08	1.2E-03
SRS	620,618 1,289	1.7E-03	1.7E-08	4.3E-01	5.9E-03	5.6E-08	3.7E-01
RFETS	2,171,877 2305	6.7E-05	9.1E-10	6.3E-01	2.3E-04	3.1E-09	4.1E-03
WVDP	1,698,391 11	2.5E-07	3.8E-12	6.8E-03	8.6E-07	1.3E-11	8.6E-03
KCP	1,729,833 1	3.9E-06	1.8E-10	2.6E-04	1.3E-05	6.0E-10	1.2E-04
INEL	153,061 1,588	5.2E-05	6.5E-09	5.3E-01	1.8E-04	2.2E-08	3.6E-01
Hanford	377,645 2,196	1.5E-03	3.0E-08	6.2E-01	5.0E-03	1.0E-07	3.6E-01
PGDP	500,502 144	1.2E-04	1.3E-08	4.7E-02	4.1E-04	4.5E-08	8.4E-04
ANL-E	7,939,785 50	1.7E-05	9.1E-11	6.4E-03	5.6E-05	3.1E-10	2.3E-04
Total		1.7E-01	2.5E-06	4.5	5.8E-01	8.5E-06	1.8

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-17. Risks Associated With Treatment of LLMW Under the Regionalized Alternative 1, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
BNL	5,738,554 16	5.2E-08	7.0E-13	4.0E-03	1.9E-07	2.5E-12	2.0E-04
FEMP	2,764,589 1,233	7.0E-04	1.3E-08	3.5E-01	2.4E-03	4.5E-08	9.5E-02
KAPL-K	1,290,172 9	2.6E-07	5.8E-12	2.8E-03	8.9E-07	2.0E-11	2.2E-03
LBL	5,856,829 8	9.8E-09	1.5E-13	1.9E-03	4.9E-08	8.3E-13	7.4E-05
LANL	159,152 597	6.1E-04	6.4E-08	2.0E-01	2.1E-03	2.2E-07	6.4E-03
LLNL	6,324,234 915	1.6E-01	2.6E-06	3.1E-01	5.3E-01	8.7E-06	8.1E-02
ORR	881,652 2,162	9.3E-04	2.9E-08	5.9E-01	3.2E-03	9.8E-08	3.9E-01
Mound	3,032,983 5	5.9E-09	3.4E-13	1.1E-03	7.3E-08	2.9E-12	4.3E-05
NTS	14,266 305	6.4E-09	1.6E-12	4.9E-02	2.2E-08	5.4E-12	1.0E-02
Pantex	265,185 145	3.5E-05	2.9E-09	3.9E-02	1.2E-04	1.0E-08	1.2E-03
PORTS	639,602 1,353	4.9E-05	6.0E-09	4.0E-01	1.7E-04	2.1E-08	2.1E-01
SNL-NM	610,714 5	1.8E-08	7.1E-13	1.2E-03	6.1E-08	2.4E-12	6.1E-05
SRS	620,618 1,290	1.8E-03	1.7E-08	4.4E-01	6.0E-03	5.7E-08	3.8E-01
RFETS	2,171,877 2,307	6.7E-05	9.0E-10	6.3E-01	2.3E-04	3.1E-09	4.1E-03
WVDP	1,698,391 10	1.7E-07	2.6E-12	3.2E-03	5.9E-07	8.9E-12	9.7E-05
KCP	1,729,833 0	2.5E-09	1.1E-13	5.9E-05	8.4E-09	3.8E-13	2.8E-06
Hanford	377,645 2,065	1.4E-03	2.8E-08	6.0E-01	4.7E-03	9.6E-08	4.2E-01
INEL	153,061 1,587	5.2E-05	6.5E-09	5.3E-01	1.8E-04	2.2E-08	3.6E-01
PGDP	500,502 144	1.2E-04	1.3E-08	4.7E-02	4.1E-04	4.5E-08	1.4E-03
ANL-E	7,939,785 23	5.9E-07	3.3E-12	3.8E-03	2.0E-06	1.1E-11	1.1E-04
Total		1.6E-01	2.6E-06	4.3	5.5E-01	8.7E-06	2.0

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-18. Risks Associated With Treatment of LLMW Under Regionalized Alternative 2, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 23	5.9E-07	3.3E-12	3.8E-03	2.0E-06	1.1E-11	1.1E-04
BNL	5,738,554 16	5.2E-08	7.0E-13	4.0E-03	1.9E-07	2.5E-12	2.0E-04
FEMP	2,764,589 269	1.4E-07	2.7E-12	8.8E-02	5.8E-07	1.2E-11	8.8E-04
KAPL-K	1,290,172 9	2.6E-07	5.8E-12	2.8E-03	8.9E-07	2.0E-11	2.2E-03
LBL	5,856,829 8	9.8E-09	1.5E-13	1.9E-03	4.9E-08	8.3E-13	7.4E-05
LANL	159,152 679	8.6E-04	9.1E-08	2.2E-01	2.9E-03	3.1E-07	8.2E-03
LLNL	6,324,234 136	4.4E-07	7.2E-12	3.3E-02	1.9E-06	3.5E-11	2.2E-03
ORR	881,652 2,177	1.2E-03	3.6E-08	6.0E-01	4.1E-03	1.3E-07	4.2E-01
Mound	3,032,983 5	5.9E-09	3.4E-13	1.1E-03	7.3E-08	2.9E-12	4.3E-05
NTS	14,266 305	6.4E-09	1.6E-12	4.9E-02	2.2E-08	5.4E-12	1.0E-02
Pantex	265,185 48	2.3E-06	2.0E-10	1.5E-02	8.0E-06	6.8E-10	5.8E-04
PORTS	639,602 1,951	1.1E-04	1.3E-08	5.4E-01	3.6E-04	4.5E-08	2.7E-01
SNL-NM	610,714 5	1.8E-08	7.1E-13	1.2E-03	6.1E-08	2.4E-12	6.1E-05
SRS	620,618 1,290	1.8E-03	1.7E-08	4.4E-01	6.0E-03	5.7E-08	3.8E-01
RFETS	2,171,877 2,307	6.8E-05	9.2E-10	6.3E-01	2.4E-04	3.2E-09	4.6E-03
WVDP	1,698,391 10	1.7E-07	2.6E-12	3.2E-03	5.8E-07	8.9E-12	9.7E-05
KCP	1,729,833 0	2.5E-09	1.1E-13	5.9E-05	8.4E-09	3.8E-13	2.8E-06
INEL	153,061 2,010	6.3E-04	7.8E-08	6.6E-01	2.1E-03	2.7E-07	3.9E-01
Hanford	377,645 2,132	1.3E-02	2.7E-07	6.4E-01	4.5E-02	9.2E-07	5.0E-01
PGDP	500,502 48	8.1E-07	9.0E-11	1.3E-02	2.8E-06	3.1E-10	5.2E-04
Total		1.8E-02	2.7E-07	4.0	6.1E-02	9.2E-07	2.0

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-19. Risks Associated With Treatment of LLMW Under Regionalized Alternative 3, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 23	5.9E-07	3.3E-12	3.8E-03	2.0E-06	1.1E-11	1.1E-04
BNL	5,738,554 16	5.2E-08	7.0E-13	4.0E-03	1.9E-07	2.5E-12	2.0E-04
FEMP	2,764,589 269	1.4E-07	2.7E-12	8.8E-02	5.8E-07	1.2E-11	8.8E-04
KAPL-K	1,290,172 9	2.6E-07	5.8E-12	2.8E-03	8.9E-07	2.0E-11	2.2E-03
LBL	5,856,829 8	9.8E-09	1.5E-13	1.9E-03	4.9E-08	8.3E-13	7.4E-05
LANL	159,152 679	8.6E-04	9.1E-08	2.2E-01	2.9E-03	3.1E-07	8.2E-03
LLNL	6,324,234 136	4.4E-07	7.2E-12	3.3E-02	1.9E-06	3.5E-11	2.2E-03
ORR	881,652 2,177	1.2E-03	3.6E-08	6.0E-01	4.1E-03	1.3E-07	4.2E-01
Mound	3,032,983 5	5.9E-09	3.4E-13	1.1E-03	7.3E-08	2.9E-12	4.3E-05
NTS	14,266 305	6.4E-09	1.6E-12	4.9E-02	2.2E-08	5.4E-12	1.0E-02
Pantex	265,185 48	2.3E-06	2.0E-10	1.5E-02	8.0E-06	6.8E-10	5.8E-04
PORTS	639,602 1,951	1.1E-04	1.3E-08	5.4E-01	3.6E-04	4.5E-08	2.7E-01
SNL-NM	610,714 5	1.8E-08	7.1E-13	1.2E-03	6.1E-08	2.4E-12	6.1E-05
SRS	620,618 1,290	1.8E-03	1.7E-08	4.4E-01	6.0E-03	5.7E-08	3.8E-01
RFETS	2,171,877 2,307	6.8E-05	9.2E-10	6.3E-01	2.4E-04	3.2E-09	4.6E-03
WVDP	1,698,391 10	1.7E-07	2.6E-12	3.2E-03	5.8E-07	8.9E-12	9.7E-05
KCP	1,729,833 0	2.5E-09	1.1E-13	5.9E-05	8.4E-09	3.8E-13	2.8E-06
Hanford	377,645 2,132	1.3E-02	2.7E-07	6.4E-01	4.5E-02	9.2E-07	5.0E-01
INEL	153,061 2,010	6.3E-04	7.8E-08	6.6E-01	2.1E-03	2.7E-07	3.9E-01
PGDP	500,502 48	8.1E-07	9.0E-11	1.3E-02	2.8E-06	3.1E-10	5.2E-04
Total		1.8E-02	2.7E-07	4.0	6.1E-02	9.2E-07	2.0

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-20. Risks Associated With Treatment of LLMW Under Regionalized Alternative 4, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 23	5.9E-07	3.3E-12	3.8E-03	2.0E-06	1.1E-11	1.1E-04
BNL	5,738,554 16	5.2E-08	7.0E-13	4.0E-03	1.9E-07	2.5E-12	2.0E-04
FEMP	2,764,589 269	1.4E-07	2.7E-12	8.8E-02	5.8E-07	1.2E-11	8.8E-04
KAPL-K	1,290,172 9	2.6E-07	5.8E-12	2.8E-03	8.9E-07	2.0E-11	2.2E-03
LBL	5,856,829 8	9.8E-09	1.5E-13	1.9E-03	4.9E-08	8.3E-13	7.4E-05
LANL	159,152 146	3.8E-05	4.0E-09	4.4E-02	1.3E-04	1.4E-08	2.4E-03
LLNL	6,324,234 136	4.4E-07	7.2E-12	3.3E-02	1.9E-06	3.5E-11	2.2E-03
ORR	881,652 3,116	1.6E-03	5.0E-08	9.5E-01	5.6E-03	1.7E-07	8.5E-01
Mound	3,032,983 5	6.0E-09	3.5E-13	1.2E-03	7.4E-08	2.9E-12	4.6E-05
NTS	14,266 305	6.4E-09	1.6E-12	4.9E-02	2.2E-08	5.4E-12	1.0E-02
Pantex	265,185 48	2.3E-06	2.0E-10	1.5E-02	8.0E-06	6.8E-10	5.8E-04
PORTS	639,602 405	1.8E-08	2.3E-12	1.2E-01	1.1E-07	1.6E-11	2.9E-03
SNL-NM	610,714 5	1.8E-08	7.1E-13	1.2E-03	6.1E-08	2.4E-12	6.1E-05
SRS	620,618 1,291	1.8E-03	1.7E-08	4.4E-01	6.0E-03	5.7E-08	3.8E-01
RFETS	2,171,877 769	1.3E-06	1.8E-11	2.1E-01	4.9E-06	6.4E-11	3.5E-03
WVDP	1,698,391 11	1.7E-07	2.6E-12	3.3E-03	6.0E-07	9.1E-12	1.0E-04
KCP	1,729,833 0	2.5E-09	1.1E-13	5.9E-05	8.4E-09	3.8E-13	2.8E-06
INEL	153,061 3,281	6.7E-04	8.4E-08	1.0	2.3E-03	2.8E-07	4.2E-01
Hanford	377,645 2,268	1.3E-02	2.7E-07	6.9E-01	4.5E-02	9.3E-07	5.2E-01
PGDP	500,502 48	8.1E-07	9.0E-11	1.3E-02	2.8E-06	3.1E-10	5.2E-04
Total		1.8E-02	2.7E-07	3.7	5.9E-02	9.3E-07	2.2

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-21. Risks Associated With Treatment of LLMW Under the Centralized Alternative, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
ANL-E	7,939,785 23	5.9E-07	3.3E-12	3.8E-03	2.0E-06	1.1E-11	1.1E-04
BNL	5,738,554 16	5.2E-08	7.0E-13	4.0E-03	1.9E-07	2.5E-12	2.0E-04
FEMP	2,764,589 269	1.4E-07	2.7E-12	8.8E-02	5.8E-07	1.2E-11	8.8E-04
KAPL-K	1,290,172 9	2.6E-07	5.8E-12	2.8E-03	8.9E-07	2.0E-11	2.2E-03
LBL	5,856,829 8	9.8E-09	1.5E-13	1.9E-03	4.9E-08	8.3E-13	7.4E-05
LANL	159,152 146	3.8E-05	4.0E-09	4.4E-02	1.3E-04	1.4E-08	2.4E-03
LLNL	6,324,234 136	4.4E-07	7.2E-12	3.3E-02	1.9E-06	3.5E-11	2.2E-03
ORR	881,652 490	6.8E-06	2.1E-10	1.6E-01	2.4E-05	7.7E-10	8.4E-02
Mound	3,032,983 5	6.0E-09	3.5E-13	1.2E-03	7.4E-08	2.9E-12	4.6E-05
NTS	14,266 305	6.4E-09	1.6E-12	4.9E-02	2.2E-08	5.4E-12	1.0E-02
Pantex	265,185 48	2.3E-06	2.0E-10	1.5E-02	8.0E-06	6.8E-10	5.8E-04
PORTS	639,602 405	1.8E-08	2.3E-12	1.2E-01	1.1E-07	1.6E-11	2.9E-03
SNL-NM	610,714 5	1.8E-08	7.1E-13	1.2E-03	6.1E-08	2.4E-12	6.1E-05
SRS	620,618 207	1.3E-06	1.3E-11	8.1E-02	4.6E-06	4.4E-11	1.1E-01
RFETS	2,171,877 769	1.3E-06	1.8E-11	2.1E-01	4.9E-06	6.4E-11	3.5E-03
WVDP	1,698,391 11	1.7E-07	2.6E-12	3.3E-03	5.9E-07	9.1E-12	1.0E-04
KCP	1,729,833 0	2.5E-09	1.1E-13	5.9E-05	8.4E-09	3.8E-13	2.8E-06
INEL	153,061 278	4.9E-06	6.1E-10	1.5E-01	1.7E-05	2.1E-09	2.5E-01
Hanford	377,645 6,706	2.5E-02	5.2E-07	2.2	8.5E-02	1.8E-06	1.8
PGDP	500,502 48	8.1E-07	9.0E-11	1.3E-02	2.8E-06	3.1E-10	5.2E-04
Total		2.5E-02	5.2E-07	3.2	8.6E-02	1.8E-06	2.3

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-22. Risks Associated With Treatment of RH-LLMW Under Each Alternative Except No Action, by Site

Site	Population[a]	Fatalities[b]			Cancer Incidence[c]		
		Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Hanford	377,645 1	4.4E-07	9.1E-12	1.7E-04	1.5E-06	3.1E-11	2.4E-09
ORR	881,652 725	1.1E-03	3.4E-08	3.0E-01	3.7E-03	1.2E-07	7.5E-02
INEL	153,061 569	2.1E-04	2.6E-08	1.7E-01	7.0E-04	8.7E-08	6.9E-03
SRS	620,618 17	3.0E-05	2.8E-10	5.1E-03	1.0E-04	9.6E-10	4.8E-06
Total		1.3E-03	3.4E-08	4.7E-01	4.5E-03	1.2E-07	8.1E-02

[a] Top number represents the offsite population within an 80-km radius of the site, while the bottom number represents the total FTEs for WM workers involved in both construction and operation activities.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-23. Programwide Risks Associated With Disposal of LLMW Under the Decentralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Maximally exposed farm family	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	2.9 1.5E-03 4.9E-03 2.9E-04	9.8E-03	2.4	
All lifetimes	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	7.0E+01 3.5E-02 1.2E-01 7.0E-03	4.9E-01	2.4	
WM workers	Dose (FTE-rem) Cancer fatalities Cancer incidence Genetic effects Exposure index Construction fatalities Construction injuries Operation fatalities Operation injuries	1.4E+03 5.5E-01 1.9 8.3E-02			1.1E-01 5.1E+01 3.2E-01 2.7E+02

Table D.3.5-24. Programwide Risks Associated With Disposal of LLMW Under Regionalized Alternative 1, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Maximally exposed farm family	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	2.4 1.2E-03 4.1E-03 2.4E-04	9.8E-03	3.0	
All lifetimes	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	4.7E+01 2.4E-02 8.0E-02 4.7E-03	5.0E-01	3.0	
WM workers	Dose (FTE-rem) Cancer fatalities Cancer incidence Genetic effects Exposure index Construction fatalities Construction injuries Operation fatalities Operation injuries	1.4E+03 5.5E-01 1.9 8.3E-02			1.2E-01 5.5E+01 3.4E-01 2.9E+02

Table D.3.5-25. Programwide Risks Associated With Disposal of LLMW Under Regionalized Alternative 2, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Maximally exposed farm family	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	2.8 1.4E-03 4.8E-03 2.8E-04	1.3E-02	2.7	
All lifetimes	Dose (person-rem) Cancer fatalities Cancer incidence Genetic effects Hazard index	4.7E+01 2.4E-02 8.0E-02 4.7E-03	8.3E-01	2.7	
WM workers	Dose (FTE-rem) Cancer fatalities Cancer incidence Genetic effects Exposure index Construction fatalities Construction injuries Operation fatalities Operation injuries	1.3E+03 5.2E-01 1.8 7.8E-02			1.1E-01 4.7E+01 3.1E-01 2.6E+02

Table D.3.5-26. Programwide Risks Associated With Disposal of LLMW Under Regionalized Alternative 3, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Maximally exposed farm family	Dose (person-rem)	0.00			
	Cancer fatalities	0.00			
	Cancer incidence	0.00	7.2E-04		
	Genetic effects	0.00			
	Hazard index			8.1E-01	
All lifetimes	Dose (person-rem)	0.00			
	Cancer fatalities	0.00			
	Cancer incidence	0.00	3.0E-02		
	Genetic effects	0.00			
	Hazard index			8.1E-01	
WM workers	Dose (FTE-rem)	9.8E+02			
	Cancer fatalities	3.9E-01			
	Cancer incidence	1.4			
	Genetic effects	5.9E-02			
	Exposure index				
	Construction fatalities				9.5E-03
	Construction injuries				2.6
	Operation fatalities				7.5E-02
	Operation injuries				2.0E+01

Table D.3.5-27. Programwide Risks Associated With Disposal of LLMW Under Regionalized Alternative 4, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Maximally exposed farm family	Dose (person-rem)	3.0			
	Cancer fatalities	1.5E-03			
	Cancer incidence	5.1E-03	1.3E-02		
	Genetic effects	3.0E-04			
	Hazard index			2.7	
All lifetimes	Dose (person-rem)	5.0E+01			
	Cancer fatalities	2.5E-02			
	Cancer incidence	8.5E-02	8.2E-01		
	Genetic effects	5.0E-03			
	Hazard index			2.7	
WM workers	Dose (FTE-rem)	1.6E+03			
	Cancer fatalities	6.4E-01			
	Cancer incidence	2.2			
	Genetic effects	9.5E-02			
	Exposure index				
	Construction fatalities				1.0E-01
	Construction injuries				4.4E+01
	Operation fatalities				3.1E-01
	Operation injuries				2.7E+02

Table D.3.5-28. Programwide Risks Associated With Disposal of LLMW Under the Centralized Alternative, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Maximally exposed farm family	Dose (person-rem)	3.9E+01			
	Cancer fatalities	1.9E-02			
	Cancer incidence	6.6E-02	9.5E-04		
	Genetic effects	3.9E-03			
	Hazard index			2.4	
All lifetimes	Dose (person-rem)	5.0E+02			
	Cancer fatalities	2.5E-01			
	Cancer incidence	8.6E-01	8.5E-03		
	Genetic effects	5.0E-02			
	Hazard index			2.4	
WM workers	Dose (FTE-rem)	9.1E+02			
	Cancer fatalities	3.6E-01			
	Cancer incidence	1.3			
	Genetic effects	5.4E-02			
	Exposure index				
	Construction fatalities				1.9E-02
	Construction injuries				8.1
	Operation fatalities				1.3E-01
	Operation injuries				1.1E+02

Table D.3.5-29. Programwide Risks Associated With Disposal of RH-LLMW Under Each Alternative Except No Action, by Health Endpoint

Receptor	Endpoint	Radionuclides	Hazardous Chemicals		Physical Hazards
			Carcinogens	Noncarcinogens	
Maximally exposed farm family	Dose (person-rem)	1.7E-01			
	Cancer fatalities	8.5E-05			
	Cancer incidence	2.9E-04	1.4E-05		
	Genetic effects	1.7E-05			
	Hazard index			1.3E-02	
All lifetimes	Dose (person-rem)	2.7			
	Cancer fatalities	1.3E-03			
	Cancer incidence	4.5E-03	5.8E-04		
	Genetic effects	2.7E-04			
	Hazard index			1.3E-02	
WM workers	Dose (FTE-rem)	3.7			
	Cancer fatalities	1.5E-03			
	Cancer incidence	5.2E-03			
	Genetic effects	2.2E-04			
	Exposure index				
	Construction fatalities				9.4E-03
	Construction injuries				4.1
	Operation fatalities				2.1E-02
	Operation injuries				1.8E+01

Table D.3.5-30. Risks Associated With Disposal of LLMW Under the Decentralized Alternative, by Site

Site (Lifetime)[a]	Fatalities[b]			Cancer Incidence[c]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	9.4E-04	1.8E-02	2.8E-01	3.7E-03	6.5E-02	7.1E-01
INEL (0)	0.00	0.00	1.9E-01	3.0E-05	4.1E-05	4.9E-01
LLNL (142)	1.3E-06	2.0E-05	6.3E-02	7.8E-06	2.6E-04	1.4E-01
LANL (0)	0.00	0.00	1.3E-02	3.1E-04	5.5E-03	5.5E-03
NTS (0)	0.00	0.00	2.7E-02	8.8E-06	4.3E-04	4.5E-02
ORR (22)	3.8E-06	5.9E-05	1.3E-01	6.4E-03	4.5E-01	2.8E-01
PGDP (146)	7.8E-06	6.6E-05	3.1E-03	2.8E-05	2.4E-04	4.8E-04
Pantex (96)	2.7E-06	8.6E-05	5.1E-03	1.4E-05	3.6E-04	1.1E-03
PORTS (145)	3.1E-05	1.1E-03	6.6E-02	5.4E-04	8.8E-03	1.3E-01
RFETS (38)	1.6E-06	3.1E-05	7.1E-02	1.1E-03	2.5E-02	8.2E-03
SNL-NM (92)	1.8E-04	9.3E-03	7.7E-04	6.2E-04	3.2E-02	1.2E-04
SRS (153)	9.7E-05	1.3E-03	1.4E-01	1.3E-03	7.2E-03	1.4E-01
ANL-E (64)	3.4E-06	1.5E-04	3.4E-04	1.7E-05	6.4E-04	9.2E-05
BNL (78)	4.2E-05	2.6E-03	1.6E-03	1.8E-04	9.0E-03	2.1E-04
FEMP (53)	1.5E-04	2.5E-03	9.3E-03	7.8E-06	2.6E-04	1.0E-03
Total	1.5E-03	3.5E-02	9.6E-01	1.5E-02	6.1E-01	1.9

[a] Number in parentheses indicates the most-exposed lifetime of the farm family for radionuclide exposure only.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-31. Risks Associated With Disposal of LLMW Under Regionalized Alternative 1, by Site

Site (Lifetime)[a]	Fatalities[b]			Cancer Incidence[c]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
FEMP (53)	1.5E-04	2.5E-03	9.3E-03	5.7E-04	8.7E-03	1.0E-03
INEL (0)	0.00	0.00	1.9E-01	3.0E-05	4.1E-05	4.9E-01
LLNL (142)	1.3E-06	2.0E-05	6.3E-02	7.8E-06	2.6E-04	1.4E-01
LANL (0)	0.00	0.00	1.3E-02	3.1E-04	5.5E-03	6.7E-03
NTS (0)	0.00	0.00	2.5E-04	8.1E-06	1.3E-04	2.7E-05
ORR (22)	3.0E-06	4.7E-05	1.2E-01	6.4E-03	4.5E-01	2.5E-01
PGDP (146)	7.8E-06	6.6E-05	3.1E-03	2.8E-05	2.4E-04	4.8E-04
Pantex (96)	2.7E-06	8.6E-05	5.1E-03	1.4E-05	3.6E-04	1.1E-03
PORTS (145)	8.5E-05	3.1E-03	1.1E-01	8.5E-04	1.7E-02	2.0E-01
RFETS (38)	1.6E-06	3.1E-05	7.1E-02	1.1E-03	2.5E-02	8.2E-03
SRS (153)	9.7E-05	1.3E-03	1.4E-01	1.3E-03	7.2E-03	1.4E-01
Hanford (18)	8.6E-04	1.7E-02	2.7E-01	3.4E-03	6.1E-02	7.0E-01
Total	1.2E-03	2.4E-02	9.9E-01	1.4E-02	5.8E-01	1.9

[a] Number in parentheses indicates the maximally exposed lifetime of the farm family for radionuclide exposure only.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-32. Risks Associated With Disposal of LLMW Under Regionalized Alternative 2, by Site

Site (Lifetime)[a]	Fatalities[b]			Cancer Incidence[c]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	1.3E-03	2.2E-02	2.9E-01	4.9E-03	8.0E-02	7.4E-01
INEL (0)	0.00	0.00	2.2E-01	3.0E-05	4.2E-05	5.8E-01
LANL (0)	0.00	0.00	1.4E-01	1.7E-04	3.2E-03	4.0E-02
NTS (0)	0.00	0.00	0.00	0.00	0.00	0.00
ORR (22)	3.6E-06	5.8E-05	1.5E-01	1.2E-02	8.1E-01	3.3E-01
SRS (153)	9.7E-05	1.3E-03	1.4E-01	1.3E-03	7.2E-03	1.4E-01
Total	1.4E-03	2.4E-02	9.4E-01	1.8E-02	9.1E-01	1.8

[a] Number in parentheses indicates the maximally exposed lifetime of the farm family for radionuclide exposure only.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-33. Risks Associated With Disposal of LLMW Under Regionalized Alternative 3, by Site

Site (Lifetime)[a]	Fatalities[b]			Cancer Incidence[c]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
NTS (0)	0.00	0.00	4.8E-01	7.2E-04	3.0E-02	1.4
Total	0.00	0.00	4.8E-01	7.2E-04	3.0E-02	1.4

[a] Number in parentheses indicates the maximally exposed lifetime of the farm family for radionuclide exposure only.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-34. Risks Associated With Disposal of LLMW Under Regionalized Alternative 4, by Site

Site (Lifetime)[a]	Fatalities[b]			Cancer Incidence[c]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
INEL (0)	0.00	0.00	4.0E-01	1.7E-05	2.2E-05	1.0
LANL (0)	0.00	0.00	7.6E-02	4.7E-07	8.4E-06	5.5E-03
NTS (0)	0.00	0.00	0.00	0.00	0.00	0.00
ORR (22)	4.3E-06	7.0E-05	1.5E-01	1.2E-02	8.2E-01	3.3E-01
SRS (153)	9.7E-05	1.3E-03	1.4E-01	1.3E-03	7.2E-03	1.4E-01
Hanford (18)	1.4E-03	2.4E-02	2.9E-01	5.2E-03	8.5E-02	7.4E-01
Total	1.5E-03	2.5E-02	1.1	1.8E-02	9.1E-01	2.2

[a] Number in parentheses indicates the maximally exposed lifetime of the farm family for radionuclide exposure only.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-35. Risks Associated With Disposal of LLMW Under the Centralized Alternative, by Site

Site (Lifetime)[a]	Fatalities[b]			Cancer Incidence[c]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
Hanford (18)	1.9E-02	2.5E-01	5.1E-01	6.7E-02	8.7E-01	1.3
Total	1.9E-02	2.5E-01	5.1E-01	6.7E-02	8.7E-01	1.3

[a] Number in parentheses indicates the maximally exposed lifetime of the farm family for radionuclide exposure only.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

Table D.3.5-36. Risks Associated With Disposal of RH-LLMW Under Each Alternative Except No Action, by Site

Site (Lifetime)[a]	Fatalities[b]			Cancer Incidence[c]		
	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers	Maximally Exposed Farm Family	All Farm Family Lifetimes	WM Workers
INEL (0)	0.00	0.00	2.1E-02	7.6E-07	1.2E-06	3.5E-03
Hanford (18)	2.4E-07	5.0E-06	2.5E-05	8.5E-07	1.7E-05	3.2E-11
ORR (22)	8.3E-05	1.3E-03	9.7E-03	2.9E-04	5.0E-03	1.8E-03
SRS (153)	2.1E-06	2.9E-05	1.2E-03	1.2E-05	1.1E-04	2.2E-06
Total	8.5E-05	1.3E-03	3.2E-02	3.0E-04	5.1E-03	5.2E-03

[a] Number in parentheses indicates the maximally exposed lifetime of the farm family for radionuclide exposure only.
[b] Includes worker fatalities associated with both radiation exposures and physical hazards.
[c] Indicates cancer incidence associated with both radiation and chemical carcinogen exposures.

D.3.5.4 Results of the LLMW Human Health Risk Analysis for Routine Operations

D.3.5.4.1 *Programwide Trends in Human Health Risks Associated With LLMW Management Alternatives*

For the offsite and noninvolved worker populations and their respective MEIs, the cancer fatality risks associated with CH-LLMW treatment under Regionalized Alternatives 2, 3, 4, and the Centralized Alternative are generally lower than for No Action, Decentralization, and Regionalized 1 Alternatives, due to reduction in the number of treatment installations and the transfer of wastes to installations where offsite populations are smaller and/or farther away from treatment facilities. However, for the off-site population and both MEIs, cancer fatality risks in the Centralized Alternative are slightly higher (less than a factor of 2) than those associated with the Regionalized 2, 3, and 4 Alternatives. In all alternatives, radiological risks to offsite and noninvolved worker receptors are higher than risks from chemical exposure.

Risks of cancer incidence from chemical exposure to offsite and noninvolved worker populations and offsite MEIs follows a similar trend, decreasing as fewer installations treat LLMW. However, for the noninvolved worker MEI, chemical-related cancer incidence risk increases slightly when all treatment is performed at only one installation. All hazard indices are all well below 1.0, indicating a low probability of adverse health effects due to noncarcinogenic, toxic chemicals.

For both involved and noninvolved workers, the No Action Alternative (which entails treatment of RH- and CH-LLMW) and all the other CH-LLMW treatment alternatives are very similar for all health risk endpoints. However, the cancer incidence risks due to potential chemical exposure are one to two orders of magnitude lower than the cancer incidence risks due to radionuclide exposure. All exposure indices are well below 1.0, indicating a low probability of adverse health effects due to noncarcinogenic, toxic chemicals.

For all receptors, cancer risks associated with RH-LLMW treatment (all alternatives except No Action) are greater at ORR and INEL than at other installations because these two installations treat substantially large waste loads.

Offsite Population. The No Action, Decentralized (49-installation treatment) and Regionalized 1 (11-installation treatment) Alternatives produce risks of cancer fatality to the offsite population approximately one order of magnitude higher than the Regionalized 2, 3, 4, and Centralized Alternatives (7-, 7-, 4- and 1-installation treatment, respectively). This is because CH-LLMW is being transferred for treatment from LLNL (which has a population of 6.3 million located relatively close to the facility) to Hanford (which has a population of 380,000 located farther from the facility). Total cancer fatality risks for No Action, Decentralized, and Regionalized 1 Alternatives are in the range of 1.6E–01 to 2.8E–01 over a total affected population of approximately 53.2 million, whereas the risks from Regionalized 2, 3, 4, and Centralized Alternatives range from 1.8E–02 to 2.5E–02 for the same affected population.

For the No Action Alternative and alternatives involving treatment of CH-LLMW, most of the estimated cancer fatality risk can be attributed to exposure to uranium-238 at ORR (No Action), tritium at LLNL (Decentralized and Regionalized 1), and tritium at Hanford (Regionalized 2, 3, 4, and Centralized). Reported by alternatives, installations posing the highest risks are the same. (As discussed in Chapter 6, the risks estimated in this section are based on the assumption that LLMW will be incinerated. The highest health risk to the offsite population is estimated to result from releases of tritium during incineration of wastes containing tritium. It should be noted that DOE is exploring alternative technologies for treating LLMW where incineration is determined to be unacceptable based on potential health risks.

Cancer incidence risk to offsite populations from exposure to carcinogenic chemicals follows the trends for radiological risks, generally decreasing from the No Action Alternative to the Centralized Alternative. The highest chemical-related cancer risk is from the No Action Alterative (2.5E–03). This is approximately one to two orders of magnitude higher than the other alternatives. The lowest estimated cancer incidence due to chemical exposure is from the Centralized Alternative (1.5E–05).

The treatment of RH-LLMW at four installations presents a programwide risk of cancer fatality to the offsite population of 1.3E–03 over a total affected population of approximately 2 million (in all alternatives except the No Action Alternative). The highest installation-specific cancer fatality risk is associated with RH-LLMW treatment from ORR, due to tritium emissions during management of a relatively large waste volume. The estimated programwide risk of cancer incidence from chemical exposure in the RH-LLMW treatment scenario is 7.2E–08.

Noninvolved Worker Population. The programwide health risks to noninvolved worker populations parallel the trends observed for the offsite populations. Cancer fatality risks in the No Action, Decentralized, and Regionalized 1 Alternatives are approximately one to two orders of magnitude higher than in the Regionalized 2, 3, 4, and Centralized Alternatives. The risk of cancer fatality to noninvolved worker populations for CH-LLMW ranges from 3.3E-04 (Centralized) to 1.3E-02 (No Action).

The No Action Alternative presents the highest risk of cancer fatality (1.3E-02) to the noninvolved worker populations and is approximately one order of magnitude higher than the next highest alternative. The Decentralized and Regionalized 1 Alternatives produce risks of cancer fatality (2.4E-03) to the noninvolved worker population, approximately one order of magnitude higher than the Regionalized 2, 3, 4, and Centralized Alternatives. This is explained by the fact that a larger population of noninvolved workers is located closer to LLNL than to Hanford (9,500 versus 160, respectively).

The risk of cancer incidence to noninvolved worker populations from exposure to carcinogenic chemicals in CH-LLMW follows the same general trend as for offsite populations and ranges from 7.9E-06 (Centralized) to 5.7E-04 (No Action).

The treatment of RH-LLMW at four installations (all alternatives except No Action) results in a risk to noninvolved worker populations from chemical exposure of 4.2E-05 for cancer fatality and 3.9E-08 for cancer incidence.

Maximally Exposed Noninvolved Worker Individuals and Maximally Exposed Offsite Population Individuals (MEIs). For CH-LLMW, the trends in cancer fatality risks to offsite MEIs are similar to those for the offsite and noninvolved worker populations in that Regionalized 2, 3, 4, and Centralized Alternatives generally presented lower risks than the No Action, Decentralized, and Regionalized 1 Alternatives. Risk of cancer incidence from chemical exposure to offsite and noninvolved worker populations and offsite MEIs follows a similar trend, decreasing as fewer installations treat LLMW. However, both cancer fatality risks and chemical-related cancer incidence risks to the noninvolved worker MEI increase slightly (less than a factor of 2) in the Centralized Alternative (as compared with the Regionalized 2, 3, and 4 Alternatives), reflecting increased exposure of the noninvolved worker MEI with consolidation of waste and treatment at one installation.

The No Action Alternative had the highest risk of cancer fatality for the offsite and noninvolved worker MEIs (6.9E-06 and 8.7E-06, respectively). The risk of cancer from chemical exposure is about two or more orders of magnitude less than from radionuclide exposure for both MEIs. The hazard index for the offsite MEI ranges from 4.8E-09 to 2.0E-05. The hazard index for the noninvolved worker MEI ranges from 3.8E-08 to 3.7E-05. The hazard and exposure indices for all MEIs are well below 1.0 in all alternatives, indicating a low probability of adverse health effects from noncarcinogenic chemicals.

Treatment of RH-LLMW at four installations results in cancer fatality risks to the offsite and noninvolved worker MEIs of 3.4E-08 and 2.3E-08, respectively. Risks of cancer incidence from chemical exposure to both MEIs ranges from 2.9E-12 and 1.8E-11, respectively.

Workers. Total estimated risks of cancer incidence and cancer fatality to workers potentially exposed to radionuclides are very similar among alternatives, differing by less than a factor of 2. Estimated cancer fatality risks for the No Action and the CH-LLMW treatment alternatives range from 5.2E-01 to 8.4E-01 (populations ranging from 8,700 to 13,100 FTEs). Risk of cancer incidence from potential radiation exposure ranges from 1.8 to 2.9 for the same alternatives. Risks of cancer fatality and incidence to workers potentially exposed to radionuclides in the RH treatment scenario are 2.3E-02 and 8.1E-02, respectively (total worker population of 1,119 FTEs).

Worker health risks due to potential chemical exposure are also similar among alternatives (No Action and CH-LLMW treatment). The highest cancer incidence (1.8E-02 out of a total population of 8,672 FTEs) and the highest exposure index (2.6E-02) from potential chemical exposure to workers is found in the Centralized Alternative, where all waste is treated at Hanford. In this alternative, chemical waste loads are substantially larger at Hanford and more workers are processing more waste at a time to complete treatment over the 10-year period. However, risk from potential chemical exposure to workers from the Centralized Alternative is higher only by a factor of 2 over the other alternatives. For RH-LLMW, cancer incidence risk of each alternative (excluding No Action) from potential chemical exposure to workers is 6.7E-05, and the exposure index is 4.6E-04.

All worker cancer incidence risks due to potential chemical exposure are one to two orders of magnitude lower than cancer incidence risk from potential radionuclide exposure. All exposure indices are well below 1.0, indicating a low possibility for adverse health effects from potential exposure to noncarcinogenic chemicals.

Estimated construction fatality risks for CH-LLMW treatment are also very similar among alternatives, ranging from 1.4 to 2.0 (Regionalized and Centralized Alternatives). Construction fatality risks are slightly lower for the No Action Alternative (6.0E–01). Construction fatality risk associated with the RH-LLMW treatment is 2.9E–01. Risk of operational fatality ranges from 1.1 to 1.8 for the No Action and CH-LLMW treatment alternatives, and is 1.6E–01 for the RH-LLMW treatment scenario. Estimated operational fatalities are one order of magnitude lower for the No Action Alternative (2.6E–01). This is due to the less worker person-hours associated with treatment in the No Action Alternative. Estimated construction and operations injuries follow the same pattern as fatalities.

Although worker risks associated with the CH-LLMW treatment are very similar across alternatives, some differences in risk reported by installation are notable. The estimated total fatality risk (cancer, construction, and operation combined) at KCP (E–05 to E–04 range) are lower by one or more orders of magnitude. The numbers are lower because this installation has a much smaller waste load to treat and fewer workers (one or less FTE in all alternatives) than other installations. The same trend is seen for total cancer incidence from potential radionuclide and chemical exposure at KCP (see Table D.3.5–15).

The highest total fatality and cancer incidence risks associated with potential exposure to radionuclides and chemicals from the CH-LLMW treatment alternatives are at Hanford in the Centralized Alternative (2.2 and 1.8 for radionuclides and chemicals, respectively). All risks at Hanford increase about one-half to one order of magnitude in the Centralized Alternative, where Hanford is the only treatment installation.

The highest total fatality and cancer incidence risks for the RH-LLMW treatment scenario are from ORR (3.0E–01 and 7.5E–02, respectively) and INEL (1.7E–01 and 6.9E–03, respectively). This is due to much larger RH-LLMW volumes and a much larger exposed work force at the two installations (725 at ORR and 569 at INEL compared with 1 at Hanford and 17 at SRS).

D.3.5.4.2 *Programwide Trends in Human Health Risks Associated With LLMW Disposal*

In general, Regionalized 3 (single-installation disposal of CH-LLMW at NTS) poses the lowest total health risks to all farm family lifetimes for cancer fatalities and cancer incidence. Estimated risk of cancer incidence (from radiological and chemical exposure) associated with all other CH-LLMW disposal alternatives is higher by approximately 1 order of magnitude. The estimated risk of cancer incidence to all

farm family lifetimes from radionuclides ranges from zero (Regionalized 3) to 8.6E–01 (Centralized); and the estimated cancer incidence risk from carcinogenic chemicals ranges from 8.5E–03 (Centralized) to 8.3E–01 (Regionalized 2). The hazard indices (for a member of the MEL of the farm family) range from 8.1E–01 in Regionalized 3 to 3.0 in Decentralized and Regionalized 1.

Only one scenario (all alternatives except No Action) was analyzed for RH-LLMW with four installations (Hanford, INEL, ORR, and SRS) treating and disposing of all waste onsite. The risks of cancer incidence to all farm family lifetimes from radionuclides range from zero (INEL) to 4.4E–03 (ORR). The risks of cancer incidence posed by chemicals range from 2.6E–07 (Hanford) to 5.7E–04 (ORR). The hazard indices (to a member of the MEL of the farm family) range from 7.2E–5 (Hanford) to 1.3E–02 (SRS).

Maximally Exposed Lifetime of the Hypothetical Farm Family. The lowest risks of cancer incidence due to radionuclide exposure to the MEL of the farm family are for Regionalized 3 in which all LLMW is disposed of at NTS. The risk of cancer incidence is zero for the farm family of four. This lack of risk is primarily due to the greater depth of the groundwater, the small amount of rainfall, and the lack of volatile radionuclides (such as carbon-14) in the waste at NTS. This results in retarded migration of contaminants into the groundwater (slow-moving, long-lived radionuclides have not yet reached the groundwater during the 10,000-year analysis period).

The highest risks of cancer incidence due to radionuclide exposure to the MEL of the farm family are for the Centralized Alternative in which all CH-LLMW is disposed of at Hanford. The risk of cancer incidence is 6.6E–02 (average individual risk of cancer incidence is 1.7E–02) during lifetime 18 with uranium-238 as the controlling radionuclide. The elevated risks are probably due to a higher level of contaminant migration into the groundwater.

The lowest disposal installation risks are at INEL, LANL, and NTS for Decentralized and Regionalized 1, 2, and 4 and at NTS for Regionalized 3. The estimated risk of cancer incidence due to radionuclide exposure to the MEL of the farm family for each of these alternatives is zero. This is due to the lack of volatile radionuclides in the waste at installations with a greater depth to groundwater and a small amount of rainfall.

The lowest estimated risks of cancer incidence due to chemical exposure to the MEL of the farm family are for the Centralized Alternative in which CH-LLMW is disposed of at Hanford. The programwide risk of

cancer incidence is 9.5E-04 for the MEL of the farm family (individual cancer incidence risk is 2.4E-04) during lifetime 18 where 1,2-dichloroethane is the controlling contaminant.

The highest risks of cancer incidence due to chemical exposure to the MEL of the farm family are for Decentralized (15-installation disposal), Regionalized 1 (12-installation disposal), and Regionalized 2 and 4 (both 6-installation disposal). The chemical-related cancer incidence risk for each of these alternatives is very similar, ranging from 9.8E-03 to 1.3E-02. For each of these alternatives, the risk of chemical-related cancer incidence at ORR ranges from 6.4E-03 to 1.2E-02 during lifetime 61, and the controlling contaminant is 1,2-dichloroethane. The higher risk at this installation is due to a much higher concentration of volatile, potentially carcinogenic contaminants in the groundwater.

The lowest hazard index for a member of the MEL of the farm family occurs at LLNL for Decentralized and Regionalized 1 (5.5E-04) during lifetime 22. The controlling contaminant is acetone, which accounts for more than 99% of the hazard index. The hazard index is well below 1.0, therefore, exposure to noncarcinogenic, hazardous chemicals presents very few health hazards to any of the farm family lifetimes at NTS in this alternative.

The highest hazard index occurs at RFETS for Regionalized 1 (3.0) during lifetime 26. The controlling contaminant is arsenic, which accounts for over 60% of the hazard index. As this hazard index is greater than 1.0, it indicates a risk of toxicity to the maximally exposed farm family.

For RH-LLMW disposal, the lowest estimated risks of cancer incidence due to radionuclides is at INEL where the risk to the MEL of the farm family is zero. As observed for NTS, the low amount of rainfall, the depth to groundwater, and a lack of volatile radionuclides in the waste lead to a greatly reduced risk due to retarded migration of contaminants. Estimated risk of radionuclide-related cancer incidence to the MEL of the farm family is highest at ORR with a risk of 2.8E-04 (individual cancer risk of 7.0E-05) during lifetime 22, and the driving radionuclide is neptunium-237.

The lowest risks of cancer incidence posed by chemicals in RH-LLMW is at Hanford (2.6E-08) where carbon tetrachloride is the controlling contaminant during lifetime 34. The highest estimated risk of cancer incidence due to chemicals is at ORR (8.1E-06) during lifetime 61; 1,2-dichloroethane is the controlling contaminant. All hazard indices are below 1.0, indicating that adverse health effects associated with noncarcinogenic chemicals are estimated to be unlikely for RH-LLMW disposal.

Workers Placing Wastes Into Disposal. The estimated worker cancer fatality and incidence risks due to radionuclide exposure during disposal are very similar among alternatives, ranging from 3.6E–01 to 6.4E–01 and from 1.3 and 2.2, respectively, for the CH-LLMW treatment alternatives. However, the estimated risk of fatality from construction is lower for the one-installation disposal alternatives (Regionalized 3 and Centralized) than for other alternatives. Hanford and NTS are the single disposal installations in these alternatives and both have a large amount of existing disposal capacity compared to other installations; therefore, these two installations would require less construction of disposal facilities. The construction risks for the other CH-LLMW alternatives (Decentralized and Regionalized 1, 2, 4) are very similar. Construction fatality risk for the RH-LLMW disposal scenario is 3.0E–02. Trends in risk of construction injury follow those seen for risk of construction fatality.

The estimated number of operational fatalities is within an order of magnitude among the CH disposal alternatives (ranging from 3.1E–01 to 1.6). The RH disposal scenario has an estimated operational fatality risk of 2.1E–02. In general, operational fatalities are slightly higher for alternatives where multiple installations dispose (Decentralized and Regionalized 1, 2, 4) and are slightly lower where only one installation disposes (Regionalized 3 and Centralized). This trend is due to fewer total worker person-hours associated with fewer disposal installations. Risk of operational injury to workers follows the same trend as operational fatalities.

Though overall risks to workers from disposal do not differ appreciably among CH treatment alternatives, some trends are apparent among installation risks associated with disposal. In the multiple-installation disposal alternatives (Decentralized and Regionalized 1, 2, 4), the same two installations, Hanford and INEL, have the highest cancer risks by about 0.5 to 2 orders of magnitude. These installations are consolidation installations for disposal of CH-LLMW in these alternatives. The controlling contaminants are cesium-137 at Hanford for Decentralized and cobalt-60 at Hanford and INEL for Regionalized 1, 2, and 4; external radiation is the predominant exposure route. In the one-installation disposal alternatives, the controlling contaminant at Hanford in Centralized and NTS in Regionalized 3 is cobalt-60; the primary exposure route is external radiation. Risks increase approximately 3 to 5 orders of magnitude at NTS where it is the only installation disposing in Regionalized 3; and risks go up only slightly at Hanford when it is the only disposal installation in the Centralized Alternative.

For RH-LLMW disposal, estimated risk of cancer fatality and cancer incidence from radionuclide exposure are 1.5E–03 and 5.2E–03, respectively. INEL and ORR have the greatest estimated risks to workers by 2

to 7 orders of magnitude with total estimated fatalities (exposure plus physical hazards) of 2.1E–02 and 9.7E–03 and cancer incidence (from radionuclides and chemicals) of 3.5E–03 and 1.8E–03, respectively, over Hanford and SRS. This difference in risk is attributed to the large amounts of remote-handled LLMW at INEL and ORR versus the comparatively small amounts at Hanford and SRS. The controlling radionuclide at INEL and ORR is cobalt-60 and external radiation is the primary exposure route.

D.3.5.4.3 *Comparison Among Treatment Options*

A comparison of CH-LLMW treatment options (No Action and 49-, 11-, 7-, 4-, and 1-installation treatment options) indicates that treatment risks (radiological and chemical) to offsite and noninvolved worker populations generally decrease as the number of treatment installations are reduced. This trend is due in part to transfer of waste to installations where offsite populations are smaller and/or farther away from treatment facilities. Worker risks associated with treatment are very similar for all alternatives. Radiological risks associated with treatment are consistently higher than chemical exposure risks associated with treatment for all receptors.

D.3.5.4.4 *Comparison Among Disposal Scenarios*

Direct comparisons can be made between the two CH-LLMW alternatives that involve disposal at a single installation. Regionalized 3 involves disposal at NTS, and Centralized involves disposal at Hanford. The estimated risk of cancer incidence due to radionuclide exposure is higher for Hanford (6.6E–02) than for NTS (zero). The risk of cancer incidence due to exposure to carcinogenic chemicals is slightly higher at NTS than at Hanford (7.2E–04 versus 9.5E–04, respectively). However, the hazard index at Hanford is higher by approximately one order of magnitude (8.1E–01 at NTS versus 2.4 at Hanford). Though both NTS and Hanford are in arid environments, the level of the groundwater at NTS is much deeper than at Hanford, and radionuclide contaminants migrate at a much slower rate.

Comparisons can also be made between Regionalized 2 (treat CH-LLMW at seven installations, dispose at six installations) and Regionalized 4 (treat CH-LLMW at four installations, dispose at six installations). There is no appreciable difference in the estimated risk of cancer incidence due to chemicals (8.2E+01)

or in the hazard indices (2.7). The risks of cancer incidence due to radionuclides show also little variation (8.0E-02 for Regionalized 2 and 8.5E-02 for Regionalized 4).

All worker risks associated with CH-LLMW disposal are similar among alternatives.

D.3.5.4.5 *Summary of Results for Routine Treatment and Disposal of LLMW*

In summary, the No Action Alternative presents the highest treatment health risks to the offsite and noninvolved worker populations. For treatment, radiological risks are consistently higher than chemical exposure risks for all receptors.

Since the types of treatment do not change for any of the LLMW alternatives, treatment is not a consideration for LLMW disposal. The risks are largely affected by the amount and type of waste load as well as the groundwater characteristics of the disposal installation. Geographical location of the disposal installation and the characteristics of the soil affecting the migration of contaminants into the groundwater affect the risks as well.

Worker risks are very similar across all CH-LLMW alternatives, regardless of number of treatment installations or disposal scenario. However, as might be expected, consolidation of CH-LLMW at fewer installations for treatment or disposal tends to elevate worker risks at those installations.

D.3.5.5 Summary of Alternatives for Potential LLMW Accidents

The following LLMW alternatives were evaluated for potential treatment facility (incinerator) accidents: No Action, Decentralized, Regionalized 1, Regionalized 2, Regionalized 4, and Centralized. Health risks associated with accidental releases of radionuclides and those associated with accidental releases of chemicals were analyzed separately from one another and are discussed separately in this section. In addition, the risks from accidents affecting facilities that manage alpha-emitting radionuclides were analyzed separately from the accident risks for facilities that manage nonalpha-emitting radionuclides (these two categories of radionuclides are referred to as "alpha" and "nonalpha" in the analysis). Note that incineration accident scenarios postulated for Regionalized 1 only include installations with alpha facilities.

The treatment facility accidents analyzed include (1) an incinerator explosion and resulting fire; (2) a baghouse area fire; and (3) an earthquake with subsequent fire. For accidents involving chemical releases during incineration, only the feedstock staging area fire scenario is evaluated.

D.3.5.6 Special Assumptions and Considerations Used in the LLMW Accident Analysis

All accidental releases from incinerator facilities to the outside (i.e., to the offsite and noninvolved worker populations) are assumed to be at ground level with dispersion starting at a lower level rather than from a facility stack. In the incinerator explosion accident scenario, it is assumed that the efficiency of the facility's high-efficiency particulate air filtration system drops only to 99.9%. In the assessment of worker risks from incineration accidents, it is assumed that the air in the work area is not ventilated or filtered; the intrafacility source term for this accident is, therefore, 1,000 times higher than the atmospheric source term used to calculate risks to the offsite and noninvolved worker populations.

Incineration accidents are assumed to cause releases into the operating gallery where the workers are located. Half of the operating gallery (e.g., an area 32 m long × 6 m wide × 6 m high) is assumed to fill with contaminated air. Exposure duration is 1 min, the time necessary for workers to avoid any obstructions and leave the scene. During all accidents, one shift of waste management workers is assumed to be inside the incinerator facility. Shift size varies from 1 to 14 workers.

Each accident type has an associated estimated annual frequency of occurrence as determined by Argonne National Laboratory (see Section D.2.7.1). However, the probability of occurrence is not taken into account in the risk calculations. Risk estimates associated with each accident should be interpreted as the consequences if the accident occurred. Estimated annual frequencies vary by accident type and contaminant type.

For radionuclide-related accidents, the incinerator explosion is considered to be "anticipated" (greater than 1.0E-02); the feedstock staging area fire is considered "unlikely" (1.0E-04 to 1.0E-02); and the earthquake resulting in an incinerator facility fire is considered "very unlikely" (1.0E-06 to 1.0E-04). For chemical-related accidents, the incinerator feedstock staging area fire is considered "anticipated" (greater than 1.0E-02) (see Appendix F).

All "chromium" listed in the source term was assumed to be 100% chromium (VI) due to lack of more specific information. This is a conservative assumption, and health risks associated with chromium (VI) may be overestimated.

D.3.5.7 Results Tables for the Risk Analysis of Potential LLMW Accidents

Because of the volume of results tables for potential LLMW accidents, the following results tables are presented on the following pages.

- Tables D.3.5-37 and D.3.5-38 present the maximum reasonably foreseeable radionuclide- and chemical-related accidents for the offsite and noninvolved worker populations, their respective MEIs, and waste management workers for treatment facility accidents, by installation and alternative.
- Tables D.3.5-39 through D.3.5-70 present the radionuclide-related risks associated with LLMW treatment for the offsite population, offsite MEI, and worker population by alternative, installation, and accident type.
- Tables D.3.5-71 through D.3.5-113 present the chemical-related risks associated with LLMW treatment for the offsite population, offsite MEI, and worker population by alternative, installation, and accident type.

While the risk analysis results for the noninvolved worker population and noninvolved worker MEI are discussed below, the risk results for these receptors are not included in Tables D.3.5-39 through D.3.5-113.

Table D.3.5-37. Radionuclide-Related Risks From Potential Maximum Reasonably Foreseeable LLMW Treatment Facility Accidents, by Alternative and Site

Site	Offsite Population		Offsite MEI		Noninvolved Worker Population		Noninvolved Worker MEI		Worker Population	
	CF	CI	CF	CI	CF	CI	CF	CI	CF	CI
No Action										
INEL	1.3E-03	4.4E-03	1.5E-07	5.0E-07	7.2E-04	2.4E-03	4.3E-07	1.5E-06	1.4E-04	5.0E-04
ORR	1.6E-01	5.5E-01	1.4E-05	4.7E-05	8.3E-02	2.8E-01	9.2E-05	3.1E-04	9.8E-03	3.4E-02
SRS	2.0E-02	6.7E-02	6.1E-07	2.1E-06	2.2E-03	7.3E-03	9.4E-06	3.2E-05	3.2E-03	1.1E-02
Decentralized										
ANL-E	9.4E-04	3.2E-03	2.8E-08	9.5E-08	1.2E-05	4.2E-05	9.1E-08	3.1E-07	2.1E-06	9.5E-06
BNL	1.0E-02	3.5E-02	9.2E-07	3.1E-06	8.1E-05	2.8E-04	7.5E-07	2.5E-06	9.3E-06	3.2E-05
FEMP	1.6E-05	5.4E-05	4.1E-09	1.4E-08	5.9E-07	2.0E-06	4.0E-09	1.3E-08	7.0E-08	2.5E-07
Hanford	2.7E-01	9.1E-01	6.3E-06	2.1E-05	2.2E-02	7.5E-02	2.2E-04	7.6E-04	1.1E-02	3.8E-02
INEL	2.1E-03	7.1E-03	2.4E-07	8.1E-07	2.0E-03	6.8E-03	1.2E-06	4.1E-06	3.1E-03	1.1E-02
KAPL-K	4.1E-03	1.4E-02	2.1E-07	7.0E-07	6.9E-05	2.4E-04	2.8E-07	9.5E-07	5.7E-06	2.0E-05
LANL	9.1E-04	3.1E-03	4.3E-07	1.5E-06	2.6E-04	8.8E-04	7.7E-07	2.6E-06	1.7E-04	6.0E-04
LLNL	1.1E-02	3.8E-02	1.6E-06	5.3E-06	9.5E-04	3.2E-03	1.7E-06	5.6E-06	1.3E-04	4.7E-04
ORR	1.6E-01	5.5E-01	1.4E-05	4.7E-05	8.3E-02	2.8E-01	9.2E-05	3.1E-04	1.1E-02	3.9E-02
PGDP	3.1E-02	1.1E-01	9.0E-06	3.1E-05	6.1E-03	2.1E-02	5.4E-05	1.8E-04	2.3E-03	8.2E-03
Pantex	5.1E-04	1.7E-03	5.6E-08	1.9E-07	1.1E-05	3.7E-05	1.9E-07	6.4E-07	5.2E-06	1.8E-05
RFETS	5.9E-03	2.0E-02	2.1E-07	7.1E-07	1.0E-03	3.5E-03	3.1E-06	1.0E-05	3.9E-04	1.4E-03
SRS	2.0E-02	6.7E-02	6.1E-07	2.1E-06	2.2E-03	7.3E-03	9.4E-06	3.2E-05	3.2E-03	1.1E-02
Regionalized 1										
INEL	2.1E-03	7.1E-03	2.4E-07	8.1E-07	2.0E-03	6.8E-03	1.2E-06	4.1E-06	3.1E-03	1.1E-02
LANL	9.1E-04	3.1E-03	4.3E-07	1.5E-06	2.6E-04	8.8E-04	7.7E-07	2.6E-06	1.7E-04	6.0E-04
LLNL	1.1E-02	3.8E-02	1.6E-06	5.3E-06	9.5E-04	3.2E-03	1.7E-06	5.6E-06	1.3E-04	4.7E-04
RFETS	5.9E-03	2.0E-02	2.1E-07	7.1E-07	1.0E-03	3.5E-03	3.1E-06	1.0E-05	3.9E-04	1.4E-03
SRS	1.7E-03	5.9E-03	5.3E-08	1.8E-07	1.9E-04	6.5E-04	8.2E-07	2.8E-06	1.4E-04	4.9E-04
Regionalized 2										
Hanford	2.7E-01	9.1E-01	6.3E-06	2.1E-05	2.2E-02	7.5E-02	2.2E-04	7.6E-04	1.1E-02	3.8E-02
INEL	2.1E-03	7.1E-03	2.4E-07	8.1E-07	2.0E-03	6.9E-03	1.2E-06	4.1E-06	3.1E-03	1.1E-02
LANL	9.1E-04	3.1E-03	4.3E-07	1.5E-06	2.6E-04	8.8E-04	7.7E-07	2.6E-06	1.7E-04	6.0E-04
ORR	1.8E-01	6.1E-01	1.5E-05	5.1E-05	1.2E-01	4.2E-01	1.4E-04	4.6E-04	1.6E-02	5.7E-02
RFETS	5.9E-03	2.0E-02	2.1E-07	7.1E-07	1.0E-03	3.5E-03	3.1E-06	1.0E-05	3.9E-04	1.4E-03
SRS	2.0E-02	6.7E-02	6.1E-07	2.1E-06	2.2E-03	7.4E-03	9.4E-06	3.2E-05	3.2E-03	1.1E-02

Table D.3.5-37. Radionuclide-Related Risks From Potential Maximum Reasonably Foreseeable LLMW Treatment Facility Accidents, by Alternative and Site—Continued

Site	Offsite Population		Offsite MEI		Noninvolved Worker Population		Noninvolved Worker MEI		Worker Population	
	CF	CI	CF	CI	CF	CI	CF	CI	CF	CI
Regionalized 4										
Hanford	2.7E-01	9.1E-01	6.3E-06	2.1E-05	2.2E-02	7.5E-02	2.2E-04	7.6E-04	1.1E-02	3.8E-02
INEL	2.1E-03	7.1E-03	2.4E-07	8.1E-07	2.0E-03	6.9E-03	1.2E-06	4.1E-06	3.5E-03	1.2E-02
ORR	1.8E-01	6.2E-01	1.6E-05	5.3E-05	9.6E-02	3.3E-01	1.1E-04	3.6E-04	1.4E-02	5.0E-02
SRS	2.0E-02	6.7E-02	6.1E-07	2.1E-06	2.2E-03	7.4E-03	9.4E-06	3.2E-05	3.2E-03	1.1E-02
Centralized										
Hanford	4.0E-01	1.4	9.4E-06	3.2E-05	3.8E-02	1.3E-01	3.9E-04	1.3E-03	4.4E-02	1.6E-01

Notes: ME = Maximally exposed individual; each value represents the highest *single* risk (not the sum of all risks) to the MEI from among all accidents at a site; CF = risk of cancer fatality associated with exposure to radionuclides; CI = risk of cancer incidence associated with exposure to radionuclides.

Table D.3.5-38. Chemical-Related Risks From Potential Maximum Reasonably Foreseeable LLMW Treatment Facility Accidents, by Alternative and Site

Site	Offsite Population	Offsite MEI		Noninvolved Worker Population	Noninvolved Worker MEI		Workers	
	CI	CI	HI	CI	CI	HI	CI	IDLH
No Action								
INEL	8.9E-07	2.1E-10	3.5E-03	2.0E-06	1.2E-09	1.9E-02	7.5E-08	1.1
ORR	7.3E-03	4.7E-07	7.8	6.3E-04	5.0E-07	8.1	1.9E-04	3.0E+01
SRS	1.5E-05	4.9E-09	8.1E-02	6.9E-05	2.7E-07	4.4	6.0E-05	1.4E+01
Decentralized								
ANL-E	5.4E-05	1.5E-11	2.8E-04	8.0E-09	4.4E-11	8.2E-04	4.3E-09	1.0
BNL	3.2E-05	5.8E-10	9.5E-03	2.4E-08	1.9E-10	3.1E-03	1.8E-08	1.0
FEMP	2.3E-04	1.0E-08	1.6E-01	1.5E-06	9.6E-09	1.6E-01	2.1E-06	1.9
Hanford	6.5E-05	1.7E-09	2.8E-02	3.4E-07	9.1E-09	1.5E-01	2.1E-05	5.3
INEL	3.5E-05	8.2E-09	1.3E-01	7.9E-05	4.5E-08	7.4E-01	1.9E-05	4.7
KCP	2.7E-07	1.2E-11	2.0E-04	3.4E-09	1.2E-11	2.0E-04	7.7E-12	1.0
KAPL-K	3.6E-06	6.1E-10	1.0E-02	1.5E-07	6.1E-10	1.0E-02	9.3E-09	1.0
LANL	2.2E-05	7.5E-09	1.2E-01	4.3E-06	5.8E-08	9.4E-01	4.5E-06	2.6
LBL	5.6E-06	5.1E-10	8.4E-03	1.4E-07	5.3E-10	8.7E-03	3.9E-09	1.0
LLNL	8.8E-05	2.4E-08	4.0E-01	2.0E-05	3.4E-08	5.6E-01	6.0E-06	3.2
ORR	8.7E-03	5.6E-07	9.2	7.5E-04	5.9E-07	9.6	2.5E-04	3.6E+01
PGDP	1.3E-04	1.9E-08	3.2E-01	1.4E-06	1.2E-08	1.9E-01	9.9E-07	1.8
Pantex	6.5E-06	4.5E-10	7.4E-03	7.8E-07	8.6E-09	1.4E-01	7.0E-07	1.9

Table D.3.5-38. Chemical-Related Risks From Potential Maximum Reasonably Foreseeable LLMW Treatment Facility Accidents, by Alternative and Site—Continued

Site	Offsite Population	Offsite MEI		Noninvolved Worker Population	Noninvolved Worker MEI		Workers	
	CI	CI	HI	CI	CI	HI	CI	IDLH
Decentralized (Cont.)								
PORTS	1.1E-04	7.9E-08	1.3	4.6E-05	1.3E-07	2.1	3.4E-05	9.5
RFETS	4.7E-04	9.5E-09	1.6E-01	4.6E-06	1.2E-08	1.9E-01	4.5E-06	1.8
SNL-NM	3.5E-06	1.0E-09	1.7E-02	3.6E-07	1.0E-09	1.7E-02	4.6E-08	1.1
SRS	1.6E-05	5.2E-09	8.5E-02	7.3E-05	2.8E-07	4.7	5.9E-05	1.4E+01
Regionalized 1								
FEMP	2.5E-04	1.1E-08	1.8E-01	1.6E-06	1.1E-08	1.7E-01	3.8E-06	2.0
Hanford	6.6E-05	1.7E-09	2.8E-02	3.5E-07	9.3E-09	1.5E-01	2.2E-05	5.4
INEL	3.5E-05	8.2E-09	1.3E-01	7.9E-05	4.5E-08	7.4E-01	1.9E-05	4.7
LANL	2.2E-05	7.5E-09	1.2E-01	4.3E-06	5.8E-08	9.4E-01	4.5E-06	2.6
LLNL	9.1E-05	2.5E-08	4.1E-01	2.1E-05	3.6E-08	5.8E-01	6.4E-06	3.3
ORR	8.7E-03	5.6E-07	9.2	7.6E-04	5.9E-07	9.6	2.5E-04	3.6E+01
PGDP	1.3E-04	1.9E-08	3.2E-01	1.4E-06	1.2E-08	1.9E-01	9.9E-07	1.8
Pantex	6.5E-06	4.5E-10	7.4E-03	7.8E-07	8.6E-09	1.4E-01	7.0E-07	1.9
PORTS	1.1E-04	8.1E-08	1.3	4.7E-05	1.3E-07	2.2	3.5E-05	9.8
RFETS	4.7E-04	9.5E-09	1.6E-01	4.6E-06	1.2E-08	1.9E-01	4.5E-06	1.8
SRS	1.6E-05	5.2E-09	8.6E-02	7.3E-05	2.9E-07	4.7	5.9E-05	1.4E+01
Regionalized 2								
Hanford	1.0E-04	2.6E-09	4.3E-02	5.3E-07	1.4E-08	2.3E-01	3.4E-05	7.7
INEL	5.0E-05	1.2E-08	1.9E-01	1.1E-04	6.6E-08	1.1	3.1E-05	6.3
LANL	2.2E-05	7.5E-09	1.2E-01	4.3E-06	5.8E-08	9.4E-01	4.5E-06	2.6
ORR	8.9E-03	5.7E-07	9.4	7.6E-04	6.0E-07	9.8	2.5E-04	3.6E+01
PORTS	1.2E-04	9.0E-08	1.5	5.2E-05	1.5E-07	2.4	4.7E-05	1.1E+01
RFETS	4.7E-04	9.5E-09	1.6E-01	4.6E-06	1.2E-08	1.9E-01	4.5E-06	1.8
SRS	1.6E-05	5.2E-09	8.6E-02	7.3E-05	2.9E-07	4.7	5.9E-05	1.4E+01
Regionalized 4								
Hanford	1.0E-04	2.6E-09	4.3E-02	5.3E-07	1.4E-08	2.3E-01	3.2E-05	7.7
INEL	7.2E-05	1.7E-08	2.8E-01	1.7E-04	9.5E-08	1.6	4.9E-05	8.7
ORR	1.1E-02	7.3E-07	1.2E+01	9.7E-04	7.7E-07	1.3E+01	3.6E-04	4.6E+01
SRS	1.6E-05	5.2E-09	8.6E-02	7.3E-05	2.9E-07	4.7	6.4E-05	1.4E+01
Centralized								
Hanford	1.0E-03	2.6E-08	4.3E-01	5.2E-06	1.4E-07	2.3	7.5E-04	6.8E+01

Notes: MEI = Maximally exposed individual; each value represents the highest *single* risk (not the sum of all risks) to the MEI from among all accidents at a site; CI = risk of cancer incidence associated with exposure to carcinogenic chemicals; HI = hazard index; IDLH = worker IDLH index.

Table D.3.5-39. Radionuclide-Related Accident Risks Associated With LLMW Treatment at INEL Under the No Action Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (A)[c] incinerator explosion	7.8E-07	8.9E-11	8.6E-05	2.7E-06	3.0E-10	3.0E-04
Non-alpha incineration, (U) baghouse area fire	2.0E-05	2.2E-09	2.1E-06	6.6E-05	7.6E-09	7.5E-06
Non-alpha incineration, (VU) earthquake	1.3E-03	1.5E-07	1.4E-04	4.4E-03	5.0E-07	5.0E-04
Maximum reasonably foreseeable accident	1.3E-03	1.5E-07	1.4E-04	4.4E-03	5.0E-07	5.0E-04

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-40. Radionuclide-Related Accident Risks Associated With LLMW Treatment at ORR Under the No Action Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (A)[c] incinerator explosion	1.6E-01	1.4E-05	9.8E-03	5.5E-01	4.7E-05	3.4E-02
Non-alpha incineration, (U) baghouse area fire	9.7E-05	8.2E-09	5.9E-03	3.3E-04	2.8E-08	2.1E-02
Non-alpha incineration, (VU) earthquake	2.4E-03	2.1E-07	1.5E-04	8.2E-03	7.0E-07	5.1E-04
Maximum reasonably foreseeable accident	1.6E-01	1.4E-05	9.8E-03	5.5E-01	4.7E-05	3.4E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–41. Radionuclide-Related Accident Risks Associated With LLMW Treatment at SRS Under the No Action Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (A)[c] incinerator explosion	2.0E-02	6.1E-07	3.2E-03	6.7E-02	2.1E-06	1.1E-02
Non-alpha incineration, (U) baghouse area fire	1.2E-05	3.6E-10	1.9E-03	4.0E-05	1.2E-09	6.7E-03
Non-alpha incineration, (VU) earthquake	3.0E-04	9.1E-09	4.8E-05	1.0E-03	3.1E-08	1.7E-04
Maximum reasonably foreseeable accident	2.0E-02	6.1E-07	3.2E-03	6.7E-02	2.1E-06	1.1E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5–42. Radionuclide-Related Accident Risks Associated With LLMW Treatment at ANL-E Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (A)[c] incinerator explosion	5.6E-07	1.7E-11	1.6E-06	1.9E-06	5.7E-11	5.7E-06
Non-alpha incineration, (U) baghouse area fire	1.2E-07	3.6E-12	3.5E-10	4.1E-07	1.2E-11	1.2E-09
Non-alpha incineration, (VU) earthquake	9.4E-04	2.8E-08	2.7E-06	3.2E-03	9.5E-08	9.5E-06
Maximum reasonably foreseeable accident	9.4E-04	2.8E-08	2.7E-06	3.2E-03	9.5E-08	9.5E-06

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-43. Radionuclide-Related Accident Risks Associated With LLMW Treatment at BNL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (A)[c] incinerator explosion	6.1E-06	5.5E-10	5.6E-06	2.1E-05	1.9E-09	1.9E-05
Non-alpha incineration, (U) baghouse area fire	1.5E-04	1.4E-08	1.4E-07	5.2E-04	4.7E-08	4.9E-07
Non-alpha incineration, (VU) earthquake	1.0E-02	9.2E-07	9.3E-06	3.5E-02	3.1E-06	3.2E-05
Maximum reasonably foreseeable accident	1.0E-02	9.2E-07	9.3E-06	3.5E-02	3.1E-06	3.2E-05

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-44. Radionuclide-Related Accident Risks Associated With LLMW Treatment at FEMP Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (A)[c] incinerator explosion	1.6E-05	4.1E-09	7.0E-08	5.4E-05	1.4E-08	2.5E-07
Non-alpha incineration, (U) baghouse area fire	9.5E-09	2.5E-12	4.2E-08	3.2E-08	8.4E-12	1.5E-07
Non-alpha incineration, (VU) earthquake	2.4E-07	6.2E-11	1.1E-09	8.1E-07	2.1E-10	3.7E-09
Maximum reasonably foreseeable accident	1.6E-05	4.1E-09	7.0E-08	5.4E-05	1.4E-08	2.5E-07

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-45. Radionuclide-Related Accident Risks Associated With LLMW Treatment at Hanford Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, incinerator explosion (A)[c]	2.7E-01	6.3E-06	1.1E-02	9.1E-01	2.1E-05	3.8E-02
Non-alpha incineration, baghouse area fire (U)	1.6E-04	3.8E-09	6.5E-03	5.5E-04	1.3E-08	2.3E-02
Non-alpha incineration, earthquake (VU)	4.0E-03	9.5E-08	1.6E-04	1.4E-02	3.2E-07	5.7E-04
Maximum reasonably foreseeable accident	2.7E-01	6.3E-06	1.1E-02	9.1E-01	2.1E-05	3.8E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-46. Radionuclide-Related Accident Risks Associated With LLMW Treatment at INEL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, earthquake (VU)[c]	2.1E-03	2.4E-07	3.1E-03	7.1E-03	8.1E-07	1.1E-02
Alpha incineration, incinerator explosion (A)	1.3E-06	1.4E-10	1.8E-03	4.3E-06	4.9E-10	6.4E-03
Alpha incineration, baghouse area fire (U)	3.1E-05	3.6E-09	4.6E-05	1.1E-04	1.2E-08	1.6E-04
Non-alpha incineration, earthquake (VU)	1.3E-03	1.5E-07	1.4E-04	4.5E-03	5.1E-07	5.1E-04
Non-alpha incineration incinerator explosion (A)	7.9E-07	9.0E-11	8.7E-05	2.7E-06	3.1E-10	3.0E-04
Non-alpha incineration, baghouse area fire (U)	2.0E-05	2.3E-09	2.2E-06	6.7E-05	7.7E-09	7.6E-06
Maximum reasonably foreseeable accident	2.1E-03	2.4E-07	3.1E-03	7.1E-03	8.1E-07	1.1E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-47. Radionuclide-Related Accident Risks Associated With LLMW Treatment at KAPL-K Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (VU)[c] earthquake	4.1E-03	2.1E-07	5.7E-06	1.4E-02	7.0E-07	2.0E-05
Non-alpha incineration, (A) incinerator explosion	2.5E-06	1.2E-10	3.4E-06	8.4E-06	4.2E-10	1.2E-05
Non-alpha incineration, (U) baghouse area fire	6.2E-05	3.1E-09	8.6E-08	2.1E-04	1.1E-08	3.0E-07
Maximum reasonably foreseeable accident	4.1E-03	2.1E-07	5.7E-06	1.4E-02	7.0E-07	2.0E-05

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-48. Radionuclide-Related Accident Risks Associated With LLMW Treatment at LLNL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	1.1E-02	1.6E-06	1.3E-04	3.8E-02	5.3E-06	4.7E-04
Alpha incineration, (A) incinerator explosion	6.8E-06	9.3E-10	8.0E-05	2.3E-05	3.2E-09	2.8E-04
Alpha incineration, (U) baghouse area fire	1.7E-04	2.3E-08	2.0E-06	5.8E-04	7.9E-08	7.0E-06
Maximum reasonably foreseeable accident	1.1E-02	1.6E-06	1.3E-04	3.8E-02	5.3E-06	4.7E-04

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-49. Radionuclide-Related Accident Risks Associated With LLMW Treatment at LANL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, earthquake (VU)[c]	9.1E-04	4.3E-07	1.7E-04	3.1E-03	1.5E-06	6.0E-04
Alpha incineration, incinerator explosion (A)	5.4E-07	2.6E-10	1.0E-04	1.9E-06	8.8E-10	3.6E-04
Alpha incineration, baghouse area fire (U)	1.4E-05	6.5E-09	2.6E-06	4.6E-05	2.2E-08	9.0E-06
Maximum reasonably foreseeable accident	9.1E-04	4.3E-07	1.7E-04	3.1E-03	1.5E-06	6.0E-04

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-50. Radionuclide-Related Accident Risks Associated With LLMW Treatment at ORR Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, earthquake (VU)[c]	1.6E-01	1.4E-05	1.1E-02	5.5E-01	4.7E-05	3.9E-02
Alpha incineration, incinerator explosion (A)	9.7E-05	8.2E-09	6.6E-03	3.3E-04	2.8E-08	2.3E-02
Alpha incineration, baghouse area fire (U)	2.4E-03	2.1E-07	1.7E-04	8.2E-03	7.0E-07	5.8E-04
Maximum reasonably foreseeable accident	1.6E-01	1.4E-05	1.1E-02	5.5E-01	4.7E-05	3.9E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–51. Radionuclide-Related Accident Risks Associated With LLMW Treatment at PGDP Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	3.1E-02	9.0E-06	2.3E-03	1.1E-01	3.1E-05	8.2E-03
Alpha incineration, (A) incinerator explosion	1.9E-05	5.4E-09	1.4E-03	6.3E-05	1.8E-08	4.9E-03
Alpha incineration, (U) baghouse area fire	4.6E-04	1.4E-07	3.5E-05	1.6E-03	4.6E-07	1.2E-04
Maximum reasonably foreseeable accident	3.1E-02	9.0E-06	2.3E-03	1.1E-01	3.1E-05	8.2E-03

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5–52. Radionuclide-Related Accident Risks Associated With LLMW Treatment at Pantex Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	5.1E-04	5.6E-08	5.2E-06	1.7E-03	1.9E-07	1.8E-05
Alpha incineration, (A) incinerator explosion	3.1E-07	3.3E-11	3.1E-06	1.0E-06	1.1E-10	1.1E-05
Alpha incineration, (U) baghouse area fire	7.7E-06	8.3E-10	7.8E-08	2.6E-05	2.8E-09	2.7E-07
Maximum reasonably foreseeable accident	5.1E-04	5.6E-08	5.2E-06	1.7E-03	1.9E-07	1.8E-05

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5–53. Radionuclide-Related Accident Risks Associated With LLMW Treatment at RFETS Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	5.9E-03	2.1E-07	3.9E-04	2.0E-02	7.1E-07	1.4E-03
Alpha incineration, (A) incinerator explosion	3.5E-06	1.3E-10	2.4E-04	1.2E-05	4.3E-10	8.3E-04
Alpha incineration, (U) baghouse area fire	8.8E-05	3.1E-09	5.9E-06	3.0E-04	1.1E-08	2.1E-05
Maximum reasonably foreseeable accident	5.9E-03	2.1E-07	3.9E-04	2.0E-02	7.1E-07	1.4E-03

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–54. Radionuclide-Related Accident Risks Associated With LLMW Treatment at SRS Under the Decentralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	1.7E-03	5.3E-08	1.4E-04	5.9E-03	1.8E-07	4.9E-04
Alpha incineration, (A) incinerator explosion	1.0E-06	3.2E-11	8.4E-05	3.5E-06	1.1E-10	2.9E-04
Alpha incineration, (U) baghouse area fire	2.6E-05	8.0E-10	2.1E-06	8.8E-05	2.7E-09	7.3E-06
Non-alpha incineration, (VU) earthquake	2.0E-02	6.1E-07	3.2E-03	6.7E-02	2.1E-06	1.1E-02
Non-alpha incineration, (A) incinerator explosion	1.2E-05	3.6E-10	1.9E-03	4.0E-05	1.2E-09	6.7E-03
Non-alpha incineration, (U) baghouse area fire	3.0E-04	9.1E-09	4.8E-05	1.0E-03	3.1E-08	1.7E-04
Maximum reasonably foreseeable accident	2.0E-02	6.1E-07	3.2E-03	6.7E-02	2.1E-06	1.1E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-55. Radionuclide-Related Accident Risks Associated With LLMW Treatment at INEL Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, incinerator explosion (A)	1.3E-06	1.4E-10	1.8E-03	4.3E-06	4.9E-10	6.4E-03
Alpha incineration, baghouse area fire (U)	3.1E-05	3.6E-09	4.6E-05	1.1E-04	1.2E-08	1.6E-04
Alpha incineration, earthquake (VU)	2.1E-03	2.4E-07	3.1E-03	7.1E-03	8.1E-07	1.1E-02
Maximum reasonably foreseeable accident	2.1E-03	2.4E-07	3.1E-03	7.1E-03	8.1E-07	1.1E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-56. Radionuclide-Related Accident Risks Associated With LLMW Treatment at LLNL Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, earthquake (VU)[c]	1.1E-02	1.6E-06	1.3E-04	3.8E-02	5.3E-06	4.7E-04
Alpha incineration incinerator explosion (A)	6.8E-06	9.3E-10	8.0E-05	2.3E-05	3.2E-09	2.8E-04
Alpha incineration, baghouse area fire (U)	1.7E-04	2.3E-08	2.0E-06	5.8E-04	7.9E-08	7.0E-06
Maximum reasonably foreseeable accident	1.1E-02	1.6E-06	1.3E-04	3.8E-02	5.3E-06	4.7E-04

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-57. Radionuclide-Related Accident Risks Associated With LLMW Treatment at LANL Under the Regionalized Alternative 1, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	9.1E-04	4.3E-07	1.7E-04	3.1E-03	1.5E-06	6.0E-04
Alpha incineration, (A) incinerator explosion	5.4E-07	2.6E-10	1.0E-04	1.9E-06	8.8E-10	3.6E-04
Alpha incineration, (U) baghouse area fire	1.4E-05	6.5E-09	2.6E-06	4.6E-05	2.2E-08	9.0E-06
Maximum reasonably foreseeable accident	9.1E-04	4.3E-07	1.7E-04	3.1E-03	1.5E-06	6.0E-04

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-58. Radionuclide-Related Accident Risks Associated With LLMW Treatment at RFETS Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	5.9E-03	2.1E-07	3.9E-04	2.0E-02	7.1E-07	1.4E-03
Alpha incineration, (A) incinerator explosion	3.5E-06	1.3E-10	2.4E-04	1.2E-05	4.3E-10	8.3E-04
Alpha incineration, (U) baghouse area fire	8.8E-05	3.1E-09	5.9E-06	3.0E-04	1.1E-08	2.1E-05
Maximum reasonably foreseeable accident	5.9E-03	2.1E-07	3.9E-04	2.0E-02	7.1E-07	1.4E-03

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-59. Radionuclide-Related Accident Risks Associated With LLMW Treatment at SRS Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	1.7E-03	5.3E-08	1.4E-04	5.9E-03	1.8E-07	4.9E-04
Alpha incineration, (A) incinerator explosion	1.0E-06	3.2E-11	8.4E-05	3.5E-06	1.1E-10	2.9E-04
Alpha incineration, (U) baghouse area fire	2.6E-05	8.0E-10	2.1E-06	8.8E-05	2.7E-09	7.3E-06
Maximum reasonably foreseeable accident	1.7E-03	5.3E-08	1.4E-04	5.9E-03	1.8E-07	4.9E-04

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-60. Radionuclide-Related Accident Risks Associated With LLMW Treatment at Hanford Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (VU)[c] earthquake	2.7E-01	6.3E-06	1.1E-02	9.1E-01	2.1E-05	3.8E-02
Non-alpha incineration, (A) incinerator explosion	1.6E-04	3.8E-09	6.5E-03	5.5E-04	1.3E-08	2.3E-02
Non-alpha incineration, (U) baghouse area fire	4.0E-03	9.5E-08	1.6E-04	1.4E-02	3.2E-07	5.7E-04
Maximum reasonably foreseeable accident	2.7E-01	6.3E-06	1.1E-02	9.1E-01	2.1E-05	3.8E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-61. Radionuclide-Related Accident Risks Associated With LLMW Treatment at INEL Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (A)[c] incinerator explosion	1.3E-06	1.4E-10	1.8E-03	4.3E-06	4.9E-10	6.4E-03
Alpha incineration, (U) baghouse area fire	3.1E-05	3.6E-09	4.6E-05	1.1E-04	1.2E-08	1.6E-04
Non-alpha incineration, (A) incinerator explosion	7.9E-07	9.0E-11	1.7E-04	2.7E-06	3.1E-10	6.1E-04
Non-alpha incineration, (U) baghouse area fire	2.0E-05	2.3E-09	4.3E-06	6.7E-05	7.7E-09	1.5E-05
Alpha incineration, (VU) earthquake	2.1E-03	2.4E-07	3.1E-03	7.1E-03	8.1E-07	1.1E-02
Non-alpha incineration, (VU) earthquake	1.3E-03	1.5E-07	2.9E-04	4.5E-03	5.1E-07	1.0E-03
Maximum reasonably foreseeable accident	2.1E-03	2.4E-07	3.1E-03	7.1E-03	8.1E-07	1.1E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-62. Radionuclide-Related Accident Risks Associated With LLMW Treatment at LANL Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, incinerator explosion (A)[c]	5.4E-07	2.6E-10	1.0E-04	1.9E-06	8.8E-10	3.6E-04
Alpha incineration, baghouse area fire (U)	1.4E-05	6.5E-09	2.6E-06	4.6E-05	2.2E-08	9.0E-06
Non-alpha incineration, incinerator explosion (A)	4.8E-04	2.3E-07	9.3E-06	1.7E-03	7.8E-07	3.3E-05
Non-alpha incineration, baghouse area fire (U)	2.9E-07	1.4E-10	5.6E-06	9.9E-07	4.7E-10	2.0E-05
Alpha incineration, earthquake (VU)	7.3E-06	3.5E-09	1.4E-07	2.5E-05	1.2E-08	4.9E-07
Non-alpha incineration, earthquake (VU)	9.1E-04	4.3E-07	1.7E-04	3.1E-03	1.5E-06	6.0E-04
Maximum reasonably foreseeable accident	9.1E-04	4.3E-07	1.7E-04	3.1E-03	1.5E-06	6.0E-04

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-63. Radionuclide-Related Accident Risks Associated With LLMW Treatment at ORR Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, earthquake (VU)[c]	1.8E-01	1.5E-05	1.6E-02	6.1E-01	5.1E-05	5.7E-02
Non-alpha incineration, incinerator explosion (A)	1.1E-04	9.0E-09	9.8E-03	3.6E-04	3.1E-08	3.4E-02
Non-alpha incineration, baghouse area fire (U)	2.7E-03	2.3E-07	2.4E-04	9.1E-03	7.6E-07	8.5E-04
Maximum reasonably foreseeable accident	1.8E-01	1.5E-05	1.6E-02	6.1E-01	5.1E-05	5.7E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-64. Radionuclide-Related Accident Risks Associated With LLMW Treatment at RFETS Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-Alpha incineration, (VU)[c] earthquake	1.5E-04	5.5E-09	4.0E-07	5.3E-04	1.9E-08	1.4E-06
Alpha incineration, (A) incinerator explosion	3.5E-06	1.3E-10	2.4E-04	1.2E-05	4.3E-10	8.3E-04
Alpha incineration, (U) baghouse area fire	8.8E-05	3.1E-09	5.9E-06	3.0E-04	1.1E-08	2.1E-05
Alpha incineration, (VU) earthquake	5.9E-03	2.1E-07	3.9E-04	2.0E-02	7.1E-07	1.4E-03
Non-alpha incineration, (A) incinerator explosion	9.3E-08	3.3E-12	2.4E-07	3.2E-07	1.1E-11	8.5E-07
Non-alpha incineration, (U) baghouse area fire	2.3E-06	8.3E-11	6.0E-09	7.9E-06	2.8E-10	2.1E-08
Maximum reasonably foreseeable accident	5.9E-03	2.1E-07	3.9E-04	2.0E-02	7.1E-07	1.4E-03

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-65. Radionuclide-Related Accident Risks Associated With LLMW Treatment at SRS Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	1.7E-03	5.3E-08	1.4E-04	5.9E-03	1.8E-07	4.9E-04
Alpha incineration, (A) incinerator explosion	1.0E-06	3.2E-11	8.4E-05	3.5E-06	1.1E-10	2.9E-04
Alpha incineration, (U) baghouse area fire	2.6E-05	8.0E-10	2.1E-06	8.8E-05	2.7E-09	7.3E-06
Non-alpha incineration, (VU) earthquake	2.0E-02	6.1E-07	3.2E-03	6.7E-02	2.1E-06	1.1E-02
Non-alpha incineration, (A) incinerator explosion	1.2E-05	3.7E-10	1.9E-03	4.0E-05	1.3E-09	6.7E-03
Non-alpha incineration, (U) baghouse area fire	3.0E-04	9.2E-09	4.8E-05	1.0E-03	3.1E-08	1.7E-04
Maximum reasonably foreseeable accident	2.0E-02	6.1E-07	3.2E-03	6.7E-02	2.1E-06	1.1E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-66. Radionuclide-Related Accident Risks Associated With LLMW Treatment at Hanford Under Regionalized Alternative 4, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (VU)[c] earthquake	2.7E-01	6.3E-06	1.1E-02	9.1E-01	2.1E-05	3.8E-02
Non-alpha incineration, (A) incinerator explosion	1.6E-04	3.8E-09	6.5E-03	5.5E-04	1.3E-08	2.3E-02
Non-alpha incineration, (U) baghouse area fire	4.0E-03	9.5E-08	1.6E-04	1.4E-02	3.2E-07	5.7E-04
Maximum reasonably foreseeable accident	2.7E-01	6.3E-06	1.1E-02	9.1E-01	2.1E-05	3.8E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-67. Radionuclide-Related Accident Risks Associated With LLMW Treatment at INEL Under Regionalized Alternative 4, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	2.1E-03	2.4E-07	3.5E-03	7.1E-03	8.1E-07	1.2E-02
Alpha incineration, (A) incinerator explosion	1.3E-06	1.4E-10	2.1E-03	4.3E-06	4.9E-10	7.4E-03
Alpha incineration, (U) baghouse area fire	3.1E-05	3.6E-09	5.3E-05	1.1E-04	1.2E-08	1.9E-04
Non-alpha incineration, (VU) earthquake	1.3E-03	1.5E-07	4.4E-04	4.5E-03	5.1E-07	1.5E-03
Non-alpha incineration, (A) incinerator explosion	7.9E-07	9.0E-11	2.6E-04	2.7E-06	3.1E-10	9.1E-04
Non-alpha incineration, (U) baghouse area fire	2.0E-05	2.3E-09	6.5E-06	6.7E-05	7.7E-09	2.3E-05
Maximum reasonably foreseeable accident	2.1E-03	2.4E-07	3.5E-03	7.1E-03	8.1E-07	1.2E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-68. Radionuclide-Related Accident Risks Associated With LLMW Treatment at ORR Under Regionalized Alternative 4, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Non-alpha incineration, (VU)[c] earthquake	1.8E-01	1.6E-05	1.4E-02	6.2E-01	5.3E-05	5.0E-02
Non-alpha incineration, (A) incinerator explosion	1.1E-04	9.4E-09	8.5E-03	3.7E-04	3.2E-08	3.0E-02
Non-alpha incineration, (U) baghouse area fire	2.8E-03	2.3E-07	2.1E-04	9.3E-03	8.0E-07	7.4E-04
Maximum reasonably foreseeable accident	1.8E-01	1.6E-05	1.4E-02	6.2E-01	5.3E-05	5.0E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-69. Radionuclide-Related Accident Risks Associated With LLMW Treatment at SRS Under Regionalized Alternative 4, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, (VU)[c] earthquake	1.7E-03	5.3E-08	1.4E-04	5.9E-03	1.8E-07	4.9E-04
Alpha incineration, (A) incinerator explosion	1.0E-06	3.2E-11	8.4E-05	3.5E-06	1.1E-10	2.9E-04
Alpha incineration, (U) baghouse area fire	2.6E-05	8.0E-10	2.1E-06	8.8E-05	2.7E-09	7.3E-06
Non-alpha incineration, (VU) earthquake	2.0E-02	6.1E-07	3.2E-03	6.7E-02	2.1E-06	1.1E-02
Non-alpha incineration, (A) incinerator explosion	1.2E-05	3.7E-10	1.9E-03	4.0E-05	1.3E-09	6.7E-03
Non-alpha incineration, (U) baghouse area fire	3.0E-04	9.2E-09	4.8E-05	1.0E-03	3.1E-08	1.7E-04
Maximum reasonably foreseeable accident	2.0E-02	6.1E-07	3.2E-03	6.7E-02	2.1E-06	1.1E-02

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-70. Radionuclide-Related Accident Risks Associated With LLMW Treatment at Hanford Under the Centralized Alternative, by Accident Type

Accident	Cancer Fatalities[a]			Cancer Incidence[b]		
	Offsite Population	Offsite MEI	Workers	Offsite Population	Offsite MEI	Workers
Alpha incineration, earthquake (VU)[c]	3.4E-03	8.0E-08	4.5E-04	1.2E-02	2.7E-07	1.6E-03
Non-alpha incineration, earthquake (VU)	4.0E-01	9.4E-06	4.4E-02	1.4	3.2E-05	1.6E-01
Non-alpha incineration, incinerator explosion (A)	2.4E-04	5.7E-09	2.7E-02	8.2E-04	1.9E-08	9.3E-02
Non-alpha incineration, baghouse area fire (U)	6.0E-03	1.4E-07	6.7E-04	2.1E-02	4.8E-07	2.3E-03
Alpha incineration, incinerator explosion (A)	2.0E-06	4.8E-11	2.7E-04	6.9E-06	1.6E-10	9.4E-04
Alpha incineration, baghouse area fire (U)	5.1E-05	1.2E-09	6.7E-06	1.7E-04	4.1E-09	2.4E-05
Maximum reasonably foreseeable accident	4.0E-01	9.4E-06	4.4E-02	1.4	3.2E-05	1.6E-01

[a] Indicates cancer fatalities associated with radiation exposure.
[b] Indicates cancer incidence associated with radiation exposure.
[c] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-71. Chemical-Related Accident Risks Associated With LLMW Treatment at INEL Under the No Action Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, baghouse area fire (A)[b]	8.9E-07	2.1E-10	7.5E-08	3.5E-03	1.1
Maximum reasonably foreseeable accident	8.9E-07	2.1E-10	7.5E-08	3.5E-03	1.1

[a] Indicates cancer incidence associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-72. Chemical-Related Accident Risks Associated With LLMW Treatment at ORR Under the No Action Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-Alpha incineration, (A)[b] baghouse area fire	7.3E-03	4.7E-07	1.9E-04	7.8	3.0E+01
Maximum reasonably foreseeable accident	7.3E-03	4.7E-07	1.9E-04	7.8	3.0E+01

[a] Indicates cancer incidence associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-73. Chemical-Related Accident Risks Associated With LLMW Treatment at SRS Under the No Action Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, (A)[b] baghouse area fire	1.5E-05	4.9E-09	6.0E-05	8.1E-02	1.4E+01
Maximum reasonably foreseeable accident	1.5E-05	4.9E-09	6.0E-05	8.1E-02	1.4E+01

[a] Indicates cancer incidence associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-74. Chemical-Related Accident Risks Associated With LLMW Treatment at ANL-E Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, (A)[b] baghouse area fire	5.4E-07	1.5E-11	4.3E-09	2.8E-04	1.0
Maximum reasonably foreseeable accident	5.4E-07	1.5E-11	4.3E-09	2.8E-04	1.0

[a] Indicates cancer incidence associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–75. Chemical-Related Accident Risks Associated With LLMW Treatment at BNL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, baghouse area fire (A)[b]	3.2E-05	5.8E-10	1.8E-08	9.5E-03	1.0
Maximum reasonably foreseeable accident	3.2E-05	5.8E-10	1.8E-08	9.5E-03	1.0

[a] Indicates cancer incidence associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5–76. Chemical-Related Accident Risks Associated With LLMW Treatment at FEMP Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, baghouse area fire (A)[b]	2.3E-04	1.0E-08	2.1E-06	1.6E-01	1.9
Maximum reasonably foreseeable accident	2.3E-04	1.0E-08	2.1E-06	1.6E-01	1.9

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5–77. Chemical-Related Accident Risks Associated With LLMW Treatment at Hanford Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, baghouse area fire (A)[b]	6.5E-05	1.7E-09	2.1E-05	2.8E-02	5.3
Maximum reasonably foreseeable accident	6.5E-05	1.7E-09	2.1E-05	2.8E-02	5.3

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-78. Chemical-Related Accident Risks Associated With LLMW Treatment at INEL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	2.8E-06	6.8E-10	3.1E-07	1.1E-02	1.3
Alpha incineration, (A) baghouse area fire	3.5E-05	8.2E-09	1.9E-05	1.3E-01	4.7
Maximum reasonably foreseeable accident	3.5E-05	8.2E-09	1.9E-05	1.3E-01	4.7

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
b Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-79. Chemical-Related Accident Risks Associated With LLMW Treatment at KCP Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, (A)[b] baghouse area fire	2.7E-07	1.2E-11	7.7E-12	2.0E-04	1.0
Maximum reasonably foreseeable accident	2.7E-07	1.2E-11	7.7E-12	2.0E-04	1.0

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-80. Chemical-Related Accident Risks Associated With LLMW Treatment at KAPL-K Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, baghouse area fire (A)[b]	3.6E-06	6.1E-10	9.3E-09	1.0E-02	1.0
Maximum reasonably foreseeable accident	3.6E-06	6.1E-10	9.3E-09	1.0E-02	1.0

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-81. Chemical-Related Accident Risks Associated With LLMW Treatment at LANL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, baghouse area fire (A)[b]	2.6E-06	8.7E-10	7.9E-08	1.4E-02	1.2
Alpha incineration, baghouse area fire (A)	2.2E-05	7.5E-09	4.5E-06	1.2E-01	2.6
Maximum reasonably foreseeable accident	2.2E-05	7.5E-09	4.5E-06	1.2E-01	2.6

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-82. Chemical-Related Accident Risks Associated With LLMW Treatment at LBL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, (A)[b] baghouse area fire	5.6E-06	5.1E-10	3.9E-09	8.4E-03	1.0
Maximum reasonably foreseeable accident	5.6E-06	5.1E-10	3.9E-09	8.4E-03	1.0

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-83. Chemical-Related Accident Risks Associated With LLMW Treatment at LLNL Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, (A)[b] baghouse area fire	8.8E-05	2.4E-08	6.0E-06	4.0E-01	3.2
Alpha incineration, (A) baghouse area fire	6.4E-05	1.8E-08	4.7E-06	2.9E-01	2.6
Maximum reasonably foreseeable accident	8.8E-05	2.4E-08	6.0E-06	4.0E-01	3.2

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–84. Chemical-Related Accident Risks Associated With LLMW Treatment at ORR Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, (A)[b] baghouse area fire	8.7E-03	5.6E-07	2.5E-04	9.2	3.6E+01
Maximum reasonably foreseeable accident	8.7E-03	5.6E-07	2.5E-04	9.2	3.6E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–85. Chemical-Related Accident Risks Associated With LLMW Treatment at PGDP Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, (A)[b] baghouse area fire	1.3E-04	1.9E-08	9.9E-07	3.2E-01	1.8
Maximum reasonably foreseeable accident	1.3E-04	1.9E-08	9.9E-07	3.2E-01	1.8

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–86. Chemical-Related Accident Risks Associated With LLMW Treatment at Pantex Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, (A)[b] baghouse area fire	6.5E-06	4.5E-10	7.0E-07	7.4E-03	1.9
Maximum reasonably foreseeable accident	6.5E-06	4.5E-10	7.0E-07	7.4E-03	1.9

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-87. Chemical-Related Accident Risks Associated With LLMW Treatment at PORTS Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Worker
Non-alpha incineration, baghouse area fire (A)[b]	1.1E-04	7.9E-08	3.4E-05	1.3	9.5
Maximum reasonably foreseeable accident	1.1E-04	7.9E-08	3.4E-05	1.3	9.5

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-88. Chemical-Related Accident Risks Associated With LLMW Treatment at RFETS Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Alpha incineration, baghouse area fire (A)[b]	4.7E-04	9.5E-09	4.5E-06	1.6E-01	1.8
Maximum reasonably foreseeable accident	4.7E-04	9.5E-09	4.5E-06	1.6E-01	1.8

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-89. Chemical-Related Accident Risks Associated With LLMW Treatment at SNL-NM Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	3.5E-06	1.0E-09	4.6E-08	1.7E-02	1.1
Maximum reasonably foreseeable accident	3.5E-06	1.0E-09	4.6E-08	1.7E-02	1.1

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-90. Chemical-Related Accident Risks Associated With LLMW Treatment at SRS Under the Decentralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	1.6E-05	5.2E-09	5.9E-05	8.5E-02	1.4E+01
Alpha incineration, (A) baghouse area fire	1.5E-06	4.7E-10	3.2E-06	7.6E-03	2.2
Maximum reasonably foreseeable accident	1.6E-05	5.2E-09	5.9E-05	8.5E-02	1.4E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-91. Chemical-Related Accident Risks Associated With LLMW Treatment at FEMP Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	2.5E-04	1.1E-08	3.8E-06	1.8E-01	2.0
Maximum reasonably foreseeable accident	2.5E-04	1.1E-08	3.8E-06	1.8E-01	2.0

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-92. Chemical-Related Accident Risks Associated With LLMW Treatment at Hanford Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	6.6E-05	1.7E-09	2.2E-05	2.8E-02	5.4
Maximum reasonably foreseeable accident	6.6E-05	1.7E-09	2.2E-05	2.8E-02	5.4

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-93. Chemical-Related Accident Risks Associated With LLMW Treatment at INEL Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	2.8E-06	6.8E-10	3.1E-07	1.1E-02	1.3
Alpha incineration, (A) baghouse area fire	3.5E-05	8.2E-09	1.9E-05	1.3E-01	4.7
Maximum reasonably foreseeable accident	3.5E-05	8.2E-09	1.9E-05	1.3E-01	4.7

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-94. Chemical-Related Accident Risks Associated With LLMW Treatment at LANL Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	3.4E-06	1.2E-09	1.1E-07	1.9E-02	1.3
Alpha incineration, (A) baghouse area fire	2.2E-05	7.5E-09	4.5E-06	1.2E-01	2.6
Maximum reasonably foreseeable accident	2.2E-05	7.5E-09	4.5E-06	1.2E-01	2.6

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-95. Chemical-Related Accident Risks Associated With LLMW Treatment at LLNL Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	9.1E-05	2.5E-08	6.4E-06	4.1E-01	3.3
Alpha incineration, (A) baghouse area fire	6.4E-05	1.8E-08	4.7E-06	2.9E-01	2.6
Maximum reasonably foreseeable accident	9.1E-05	2.5E-08	6.4E-06	4.1E-01	3.3

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (> 1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (< 1.0E-06).

Table D.3.5-96. Chemical-Related Accident Risks Associated With LLMW Treatment at ORR Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	8.7E-03	5.6E-07	2.5E-04	9.2	3.6E+01
Maximum reasonably foreseeable accident	8.7E-03	5.6E-07	2.5E-04	9.2	3.6E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-97. Chemical-Related Accident Risks Associated With LLMW Treatment at Pantex Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	6.5E-06	4.5E-10	7.0E-07	7.4E-03	1.9
Maximum reasonably foreseeable accident	6.5E-06	4.5E-10	7.0E-07	7.4E-03	1.9

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-98. Chemical-Related Accident Risks Associated With LLMW Treatment at PGDP Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	1.3E-04	1.9E-08	9.9E-07	3.2E-01	1.8
Maximum reasonably foreseeable accident	1.3E-04	1.9E-08	9.9E-07	3.2E-01	1.8

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-99. Chemical-Related Accident Risks Associated With LLMW Treatment at PORTS Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	1.1E-04	8.1E-08	3.5E-05	1.3	9.8
Maximum reasonably foreseeable accident	1.1E-04	8.1E-08	3.5E-05	1.3	9.8

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-100. Chemical-Related Accident Risks Associated With LLMW Treatment at RFETS Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	2.1E-07	4.2E-12	2.7E-12	6.9E-05	1.0
Alpha incineration, baghouse area fire (A)	4.7E-04	9.5E-09	4.5E-06	1.6E-01	1.8
Maximum reasonably foreseeable accident	4.7E-04	9.5E-09	4.5E-06	1.6E-01	1.8

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-101. Chemical-Related Accident Risks Associated With LLMW Treatment at SRS Under Regionalized Alternative 1, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	1.6E-05	5.2E-09	5.9E-05	8.6E-02	1.4E+01
Alpha incineration, baghouse area facility fire (A)	1.5E-06	4.7E-10	3.2E-06	7.6E-03	2.2
Maximum reasonably foreseeable accident	1.6E-05	5.2E-09	5.9E-05	8.6E-02	1.4E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-102. Chemical-Related Accident Risks Associated With LLMW Treatment at Hanford Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	1.0E-04	2.6E-09	3.4E-05	4.3E-02	7.7
Maximum reasonably foreseeable accident	1.0E-04	2.6E-09	3.4E-05	4.3E-02	7.7

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-103. Chemical-Related Accident Risks Associated With LLMW Treatment at INEL Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	2.9E-06	7.0E-10	5.2E-07	1.1E-02	1.3
Alpha incineration, (A) baghouse area fire	5.0E-05	1.2E-08	3.1E-05	1.9E-01	6.3
Maximum reasonably foreseeable accident	5.0E-05	1.2E-08	3.1E-05	1.9E-01	6.3

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-104. Chemical-Related Accident Risks Associated With LLMW Treatment at LANL Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	1.6E-05	5.5E-09	1.2E-06	9.0E-02	2.2
Alpha incineration, (A) baghouse area fire	2.2E-05	7.5E-09	4.5E-06	1.2E-01	2.6
Maximum reasonably foreseeable accident	2.2E-05	7.5E-09	4.5E-06	1.2E-01	2.6

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-105. Chemical-Related Accident Risks Associated With LLMW Treatment at ORR Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration (A)[b] baghouse area fire	8.9E-03	5.7E-07	2.5E-04	9.4	3.6E+01
Maximum reasonably foreseeable accident	8.9E-03	5.7E-07	2.5E-04	9.4	3.6E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-106. Chemical-Related Accident Risks Associated With LLMW Treatment at PORTS Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	1.2E-04	9.0E-08	4.7E-05	1.5	1.1E+01
Maximum reasonably foreseeable accident	1.2E-04	9.0E-08	4.7E-05	1.5	1.1E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-107. Chemical-Related Accident Risks Associated With LLMW Treatment at RFETS Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	8.0E-07	1.6E-11	2.1E-11	2.6E-04	1.0
Alpha incineration, baghouse area fire (A)	4.7E-04	9.5E-09	4.5E-06	1.6E-01	1.8
Maximum reasonably foreseeable accident	4.7E-04	9.5E-09	4.5E-06	1.6E-01	1.8

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-108. Chemical-Related Accident Risks Associated With LLMW Treatment at SRS Under Regionalized Alternative 2, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	1.6E-05	5.2E-09	5.9E-05	8.6E-02	1.4E+01
Alpha incineration, (A) baghouse area fire	1.5E-06	4.7E-10	3.2E-6	7.6E-03	2.2
Maximum reasonably foreseeable accident	1.6E-05	5.2E-09	5.9E-05	8.6E-02	1.4E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-109. Chemical-Related Accident Risks Associated With LLMW Treatment at Hanford Under Regionalized Alternative 4, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, (A)[b] baghouse area fire	1.0E-04	2.6E-09	3.2E-05	4.3E-02	7.7
Maximum reasonably foreseeable accident	1.0E-04	2.6E-09	3.2E-05	4.3E-02	7.7

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-110. Chemical-Related Accident Risks Associated With LLMW Treatment at INEL Under Regionalized Alternative 4, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	1.4E-05	3.4E-09	3.6E-06	5.5E-02	2.5
Alpha incineration, baghouse area fire (A)	7.2E-05	1.7E-08	4.9E-05	2.8E-01	8.7
Maximum reasonably foreseeable accident	7.2E-05	1.7E-08	4.9E-05	2.8E-01	8.7

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5-111. Chemical-Related Accident Risks Associated With LLMW Treatment at ORR Under Regionalized Alternative 4, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	1.1E-02	7.3E-07	3.6E-04	1.2E+01	4.6E+01
Maximum reasonably foreseeable accident	1.1E-02	7.3E-07	3.6E-04	1.2E+01	4.6E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–112. Chemical-Related Accident Risks Associated With LLMW Treatment at SRS Under Regionalized Alternative 4, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	1.6E-05	5.2E-09	6.4E-05	8.6E-02	1.4E+01
Alpha incineration, baghouse area fire (A)	1.5E-06	4.7E-10	3.8E-06	7.6E-03	2.2
Maximum reasonably foreseeable accident	1.6E-05	5.2E-09	6.4E-05	8.6E-02	1.4E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

Table D.3.5–113. Chemical-Related Accident Risks Associated With LLMW Treatment at Hanford Under the Centralized Alternative, by Accident Type

Accident	Cancer Incidence[a]			Hazard Index	IDLH Index
	Offsite Population	Offsite MEI	Workers	Offsite MEI	Workers
Non-alpha incineration, baghouse area fire (A)[b]	1.0E-03	2.6E-08	7.5E-04	4.3E-01	6.8E+01
Alpha incineration, baghouse area fire (A)	1.3E-04	3.5E-09	5.7E-05	5.7E-02	9.8
Maximum reasonably foreseeable accident	1.0E-03	2.6E-08	7.5E-04	4.3E-01	6.8E+01

[a] Indicates cancer fatalities associated with chemical carcinogen exposure.
[b] Accident annual frequency codes are "A" for anticipated (>1.0E-02), "U" for unlikely (1.0E-04 to 1.0E-02), "VU" for very unlikely (1.0E-06 to 1.0E-04), and "EU" for extremely unlikely (<1.0E-06).

D.3.5.8 Summary of the LLMW Accident Analysis Results

Accidents Involving Releases of Radiological Contaminants. For radionuclide-related incineration accidents in all alternatives, the dominant accident type for all receptors is the earthquake resulting in a fire. The highest site-specific cancer fatality risks are consistently associated with Hanford and/or ORR for all receptors. Cancer fatality risks associated with incineration accidents in alpha facilities are usually higher than those associated with similar accidents in non-alpha facilities by 2 times to 3 orders of magnitude (for all receptors at INEL, LANL, and RFETS in Decentralized, Regionalized 2, and Regionalized 4). However, at SRS (in all alternatives where SRS is evaluated) and at Hanford (in the Centralized Alternative), alpha facility accident risks are lower than those from similar accidents in non-alpha facilities by 1 to 2 orders of magnitude. Note that for workers, the risk of death from latent cancers due to exposure to radioactive materials released in such accidents may be smaller than the risk of fatality due to nonradiological impacts.

Accidents Involving Releases of Chemical Contaminants. For chemical-related incineration accidents in all alternatives except Centralized (where Hanford treats all LLMW), ORR is consistently the highest-risk site for all receptors. In the Centralized Alternative, however, Hanford has the highest worker cancer incidence risk and IDLH index of all alternatives due to a greater number of exposed workers. At sites where both alpha and non-alpha LLMW are incinerated, the accident risks vary depending on contaminant inventories. At a given site, the estimated cancer incidence risks and hazard/IDLH indices for accidents occurring in alpha incineration facilities are usually higher (in some instances by more than 2 orders of magnitude) than those estimated for similar non-alpha facility accidents. The exceptions to this are: SRS (Decentralized and Regionalized 1, 2, and 4) and Hanford (Centralized), where the risks from non-alpha incineration accidents are approximately one order of magnitude higher than those from alpha facility accidents; and LLNL (Decentralized and Regionalized 1), where non-alpha incineration accident risks are only slightly higher (less than a factor of two) than similar alpha facility accident risks.

D.3.5.8.1 *Risks to the Offsite Population From LLMW Accidents*

Accidents Involving Releases of Radiological Contaminants. For incineration accidents involving releases of radionuclides from non-alpha facilities, cancer fatality risks to the offsite population range from 9.5E–09 to 4.0E–01 in population sizes ranging from 153,061 to 10,453,402. Cancer fatality risks from alpha

facility incinerator accidents range from 5.4E-07 to 1.1E-02 in population sizes ranging from 153,061 to 6,324,234. Incineration accident risks at a given site do not differ greatly among alternatives. Risks associated with a particular accident either remain the same at a site across alternatives or increase only slightly with waste consolidation.

The incineration accident type resulting in the highest risks to offsite populations is the earthquake resulting in a fire. In each alternative, the risks of cancer fatalities for other incinerator accidents (incinerator explosion and aircraft impact) are approximately 2 to 3 orders of magnitude lower than those associated with the earthquake scenario at a given site. However, the estimated annual frequency of the earthquake scenario affecting the incinerator facility is "very unlikely" (1.0E-06 to 1.0E-04) for all sites and alternatives, while the baghouse area fire and incinerator explosion are considered "unlikely" (1.0E-04 to 1.0E-02) and "anticipated" (greater than 1.0E-02), respectively. Hanford has the highest cancer fatality risks to the offsite population from incineration accidents in all alternatives (where Hanford is evaluated) because of relatively high releases of plutonium-238 and/or uranium-238. The highest cancer fatality risk at Hanford is 4.0E-1 (distributed over a population of 377,645) for the non-alpha earthquake scenario in the Centralized Alternative. ORR has the next highest cancer fatality risks to the offsite population from non-alpha incineration accidents. The controlling contaminant at ORR is uranium-238. Internal exposure is the primary route for both sites. The highest alpha facility accident risks are at LLNL in Decentralized and Regionalized 1 and at RFETS in Decentralized and Regionalized 1 and 2. The controlling contaminant at both sites is plutonium-238; the primary exposure route is internal.

Accidents Involving Releases of Chemical Contaminants. For incineration accidents that involve chemical releases from non-alpha facilities (baghouse area fire), the estimated risks of cancer incidence range from 2.1E-07 to 1.1E-02 in population sizes ranging from 153,061 to 10,453,402. Estimated risks of cancer incidence from alpha incinerator facility baghouse area fire accidents range from 1.5E-06 to 4.7E-04 in population sizes ranging from 153,061 to 6,324,234. All chemical-related baghouse area fire scenarios are considered "anticipated" (estimated annual frequency greater than 1.0E-02).

The highest estimated risk of cancer incidence from an accidental chemical release associated with incineration at a site is at ORR in Regionalized 4 (1.1E-02 in a population of 881,652). In all alternatives except Centralized (in which all treatment is performed at Hanford), ORR poses the greatest risks of cancer incidence from incineration accidents, ranging from 7.3E-03 to 1.1E-02 in a population of 881,652. This is approximately 1 to 5 orders of magnitude higher than the risks at all other sites. The higher estimated

cancer risk at ORR is due to a relatively large release of chromium (VI) during an incinerator accident. The alpha incineration accident with the highest risk of cancer incidence to the offsite population is the baghouse area fire at RFETS; the risk of cancer incidence is 4.7E-04 in a population of 2,171,877 for Decentralized and Regionalized 1 and 2. The controlling contaminant at RFETS is also chromium (VI).

Maximum reasonably foreseeable incineration accident risks do not differ much among alternatives at most sites (remain approximately equal or increase slightly with greater waste consolidation). However, cancer incidence risk to the offsite population from the maximum reasonably foreseeable accident in Decentralized and Regionalized 1, 2, and 4 is higher than for No Action at INEL by 1 to 2 orders of magnitude. In addition, cancer incidence risk from the worst-case accident at Hanford in the Centralized Alternative is higher than for Hanford in other alternatives by an order of magnitude or more due to centralized consolidation of waste loads.

D.3.5.8.2 *Risks to the Noninvolved Worker Population From LLMW Accidents*

Accidents Involving Releases of Radiological Contaminants. For radionuclide-related accidents, the trends in risk to the noninvolved worker population follow the trends for the offsite population. For incineration accidents involving releases of radionuclides from non-alpha facilities, cancer fatality risks range from 3.5E-10 to 1.2E-01 in population sizes ranging from 128 to 15,996. Cancer fatality risks from alpha facility incinerator accidents range from 1.1E-07 to 2.0E-03 in population sizes ranging from 6,993 to 15,996. Incineration accident risks at a given site do not differ greatly among alternatives. Risks associated with a particular accident either remain the same at a site across alternatives or increase only slightly with waste consolidation.

The incineration accident type resulting in the highest risks to noninvolved worker populations is the earthquake resulting in a fire. For each alternative, the risks of cancer fatalities for other incinerator accidents (incinerator explosion and aircraft impact) are approximately 1 to 3 orders of magnitude lower than those associated with the earthquake scenario at a given site. Recall, however, that the estimated annual frequency of the earthquake scenario affecting the incinerator facility is the lowest of the three accident types.

For the non-alpha facility earthquake scenario, ORR produces the greatest risk of cancer fatalities, with the maximum reasonably foreseeable accident risks ranging from 8.3E-02 to 1.2E-01 in Decentralized and Regionalized 2 and 4, distributed over a population of 3,809. The next highest non-alpha accident risks are at Hanford in all alternatives (where Hanford is evaluated), with cancer fatality risks ranging from 2.2E-02 to 3.8E-02 in a population of 8,674. The controlling contaminants at ORR and Hanford are uranium-238 and plutonium-238, respectively. For alpha facility incinerator accidents, the highest-risk sites are INEL and RFETS in Decentralized and Regionalized 1 and 2 and INEL in Regionalized 4. In these alternatives, cancer fatality risk associated with the incinerator accident (earthquake) is 2.0E-03 for INEL in a population of 8,451 and 1.0E-03 for RFETS in a population of 6,993; the controlling contaminant is plutonium-238 at both sites.

Accidents Involving Releases of Chemical Contaminants. For chemical-related incineration accidents occurring in non-alpha facilities, the estimated risks of cancer incidence range from 5.1E-10 to 9.7E-04 in population sizes ranging from 128 to 15,996. Estimated risks of cancer incidence from alpha facility incinerator accidents range from 4.3E-06 to 1.7E-04 in population sizes ranging from 6,993 to 15,996. The incinerator accident resulting in the highest estimated risk of cancer incidence is the non-alpha baghouse area fire at ORR in Regionalized 4 (9.7E-04 in a population of 3,809). In all alternatives except Centralized (all sites treat at Hanford), ORR poses the greatest risks of cancer incidence. Incineration accident risks to noninvolved worker populations at other sites are 1 to 6 orders of magnitude lower. The controlling contaminant at ORR is chromium (VI). The alpha incineration accident with the highest risk of cancer incidence to the noninvolved worker population is the baghouse area fire at INEL in Regionalized 4 (1.7E-04 in a population of 8,451). The controlling contaminant at INEL is also chromium (VI).

Maximum reasonably foreseeable accident risks of cancer incidence do not differ much among alternatives at most sites (remain approximately equal or increase slightly with greater waste consolidation). However, cancer incidence risk to the noninvolved worker population from the worst-case accident in Decentralized and Regionalized 1, 2, and 4 is higher than for No Action at INEL by 1 to 2 orders of magnitude. In addition, cancer incidence risk from the maximum reasonably foreseeable accident at Hanford in the Centralized Alternative is higher than for Hanford in other alternatives by about an order of magnitude due to centralized consolidation of waste loads.

D.3.5.8.3 *Risks to the Maximally Exposed Noninvolved Worker and Maximally Exposed Offsite Individual From LLMW Accidents*

Accidents Involving Releases of Radiological Contaminants. For radionuclide-related accidents, the trends in risk to the offsite MEI and noninvolved worker MEI generally follow those for their respective populations. Incineration accident risks at a given site do not differ greatly among alternatives. Risks to the MEIs associated with a particular accident either remain the same at a site across alternatives or increase only slightly with waste consolidation. Differences in cancer risks between non-alpha facility accidents and alpha facility accidents parallel those estimated for the offsite and noninvolved worker populations.

The highest-risk incineration accident type for both MEIs is the earthquake resulting in a fire. The highest-risk sites for the offsite MEI differ somewhat from those observed for the offsite population. The highest site-specific cancer fatality risk to the offsite MEI is from the non-alpha facility earthquake scenario at ORR in No Action, Decentralized, and Regionalized 2 and 4 (ranging from 1.4E–05 to 1.6E–05). The controlling contaminant at ORR is uranium-238; the primary exposure route is internal. The next highest site risks are for the non-alpha facility earthquake scenarios at Hanford in Centralized (9.4E–06) and PGDP in Decentralized (9.0E–06). The controlling contaminants at Hanford and PGDP are plutonium-238 and uranium-238, respectively; exposure is primarily internal.

The highest cancer fatality risk to the noninvolved worker MEI from an earthquake scenario is at Hanford (for non-alpha facilities) in Decentralized, Regionalized 2 and 4, and Centralized (ranging from 2.2E–04 to 3.9E–04). The contaminant contributing the most to risk at Hanford is plutonium-238 by internal exposure. The next highest risk to the noninvolved worker MEI is from the non-alpha earthquake scenario at ORR in Regionalized 2 and 4 (1.4E–04 and 1.1E–04 cancer fatalities, respectively). The controlling contaminant at ORR is uranium-238; exposure is primarily internal.

Accidents Involving Releases of Chemical Contaminants. For chemical-related accidents, the trends in risks to the offsite MEI and the noninvolved worker MEI tend to generally follow those for their respective populations. As observed for the offsite and noninvolved worker populations, risks and hazard indices do not differ greatly among alternatives at a site with the exception of INEL (lower in No Action than other alternatives by about 2 orders of magnitude) and Hanford (greater in the Centralized Alternative with centralized consolidation by an order of magnitude or more). For incineration accidents (i.e., baghouse area fire), the highest risks of cancer incidence to the offsite MEI (7.3E–07) and the noninvolved worker MEI

(7.7E-07) occur at ORR in Regionalized 4. The cancer incidence risks to both MEIs are higher at ORR than those at other sites by 2 times to 4 orders of magnitude. The controlling carcinogenic contaminant at ORR is chromium (VI).

The highest hazard indices associated with incineration accidents are also at ORR in all alternatives (ranging from 7.8 to 1.2E+01 for the offsite MEI and from 8.1 to 1.3E+01 for the noninvolved worker MEI). For both MEIs, the hazard index is greater than 1.0 at PORTS in Decentralized and Regionalized 1 and 2 (ranging from 1.3 to 1.5 for the offsite MEI and from 2.1 to 2.4 for the noninvolved worker MEI). In addition, for the noninvolved worker MEI, hazard indices are greater than 1.0 at SRS in all alternatives where SRS treats LLMW (ranging from 4.4 to 4.7) and at INEL in Regionalized 2 and 4 (ranging from 1.1 to 1.6). The controlling noncarcinogenic chemical is hydrogen chloride at ORR, PORTS, SRS, and INEL. All other hazard indices are below 1.0, indicating less likelihood of harmful effects from exposure to noncarcinogens.

D.3.5.8.4 *Risks to Waste Management Workers From LLMW Accidents*

Accidents Involving Releases of Radiological Contaminants. For incineration accidents involving releases of radionuclides, site-specific worker risks are similar among alternatives, increasing only very slightly at sites where LLMW is consolidated for treatment, most notably in the Centralized Alternative, in which estimated cancer fatalities at Hanford from all incineration accidents increase approximately half an order of magnitude. Estimated worker cancer fatalities associated with accident scenarios in non-alpha facilities range from 7.9E-08 to 1.6E-02. For alpha facility accident scenarios, estimated worker cancer fatalities range from 1.3E-04 to 3.5E-03. Shift size varies from 1 to 14 workers. In all alternatives, the earthquake and incinerator explosion scenarios produce the higher worker risks by about 1 to 2 orders of magnitude over the baghouse area fire scenario.

The highest site-specific cancer fatality risks associated with non-alpha incinerator accidents are for the earthquake scenarios at ORR in No Action (9.8E-03), at ORR and Hanford in Decentralized (1.1E-02 at both sites), at ORR and Hanford in Regionalized 2 (1.6E-02 and 1.1E-02, respectively), at ORR and Hanford in Regionalized 4 (1.4E-02 and 1.1E-02, respectively), and at Hanford in the Centralized Alternative (4.4E-02). The controlling contaminants are uranium-238 at ORR and plutonium-238 at Hanford; the primary exposure route is inhalation. For alpha incinerator accidents, the highest site cancer

fatality risks are for the earthquake scenario at INEL in Decentralized and Regionalized 1, 2, and 4 (ranging from 3.1E-03 to 3.5E-03). The controlling contaminant at this site is plutonium-238, and the primary exposure route is inhalation. Recall that the radionuclide-related earthquake scenario affecting the incinerator is considered to be "very unlikely."

Accidents Involving Releases of Chemical Contaminants. Estimated risks of cancer incidence to workers from non-alpha incineration accidents (baghouse area fires) range from 2.7E-12 to 7.5E-04 across alternatives. Alpha facility accident risks range from 3.2E-06 to 5.7E-05. Worker population size (shift size) varies from 1 to 14 workers. Chemical emissions from an incinerator baghouse area fire in a non-alpha facility are assumed to be identical regardless of site or alternative; the same assumption was made for alpha facility accidents. Because of this, cancer incidence risk estimates for workers only vary by facility type and in direct proportion to the number of workers assumed to be present during the accident at each site (which depends on the waste volume being incinerated at each site).

The highest cancer incidence risk to workers from a non-alpha incinerator baghouse area fire is at Hanford in the Centralized Alternative (7.5E-04) due to the consolidated waste load and a greater number of workers necessary to operate the incinerator. The next highest cancer incidence risks to workers from non-alpha baghouse area fires are at ORR in all alternatives where ORR treats LLMW (ranging from 1.9E-04 to 3.6E-04). The highest alpha facility risks are also associated with Hanford in the Centralized Alternative (5.7E-05). The IDLH index is equal to or greater than 1.0 for all sites and alternatives, indicating a danger of irreversible health effects due to exposure to toxic chemicals. The controlling contaminants are the same at each site, chromium (VI) and carbon monoxide.

As observed for the offsite and noninvolved worker populations and their respective MEIs, risks and IDLH indices do not differ greatly among alternatives at a site with the exception of INEL (lower in No Action than other alternatives by about 2 orders of magnitude) and Hanford (greater in the Centralized Alternative with waste consolidation by an order of magnitude or more).

D.3.5.9 Risks to the Hypothetical Intruder From LLMW Disposal

The health risks to the hypothetical intruder who drills a well through an LLMW disposal facility were evaluated for the Decentralized, Regionalized 2, and Centralized Alternatives, and for remote-handled LLMW (RH-LLMW) disposal (disposal at four sites in the Decentralized, Regionalized, and Centralized

Alternatives). Intrusion was evaluated 100 years and 300 years after the cessation of disposal activities at each site.

Tables D.3.5-114 and D.3.5-115 present summaries of the risk evaluations at 100 and 300 years, respectively. Tables D.3.5-116 through D.3.5-123 contain the health risks by health endpoint and site for each alternative in both time frames.

Table D.3.5-114. Summary Table for the Intruder Scenario for LLMW (100 years)

Alternative	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
Decentralized	34	1.7E-02	5.8E-02	3.4E-03	1.8E-13	1.1E-07
Regionalized 2	33	1.6E-02	5.5E-02	3.3E-03	1.8E-13	1.4E-07
Centralized	7.1	3.6E-03	1.2E-02	7.1E-04	5.1E-14	9.6E-08
RH-LLMW	68	3.3E-02	1.2E-01	6.8E-03	1.2E-14	8.8E-09

Table D.3.5-115. Summary Table for the Intruder Scenario for LLMW (300 years)

Alternative	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
Decentralized	7.2E-01	3.5E-04	1.2E-03	7.2E-05	1.8E-13	1.1E-07
Regionalized 2	6.1E-01	3.0E-04	1.0E-03	6.1E-05	1.8E-13	1.4E-07
Centralized	1.5E-01	7.3E-05	2.5E-04	1.5E-05	5.1E-14	9.6E-08
RH-LLMW	2.2	1.1E-03	3.7E-03	2.2E-04	1.2E-14	8.8E-09

Table D.3.5-116. Intruder Scenario Risk Results for the Decentralized Alternative (100 years)

Site	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
ANL-E	6.6E-01	3.3E-04	1.1E-03	6.6E-05	1.4E-14	1.6E-08
BNL	1.5E-02	7.4E-06	2.5E-05	1.5E-06	0.0	1.3E-09
FEMP	1.4E-03	6.8E-07	2.3E-06	1.4E-07	0.0	6.8E-09
Hanford	19	9.4E-03	3.2E-02	1.9E-03	3.1E-14	4.0E-08
INEL	7.5	3.8E-03	1.3E-02	7.5E-04	2.2E-14	6.2E-08
LANL	5.2E-02	2.6E-05	8.8E-05	5.2E-06	0.0	1.0E-08
LLNL	3.2E-01	1.6E-04	5.4E-04	3.2E-05	0.0	1.6E-08
NTS	4.9E-02	2.4E-05	8.3E-05	4.9E-06	0.0	6.7E-09
ORR	2.6	1.3E-03	4.4E-03	2.6E-04	4.8E-14	1.1E-07
PGDP	1.3E-01	6.4E-05	2.2E-04	1.3E-05	0.0	2.5E-09
Pantex	1.9E-02	9.4E-06	3.2E-05	1.9E-06	0.0	8.6E-10
PORTS	4.8E-01	2.4E-04	8.2E-04	4.8E-05	2.7E-14	2.9E-08
RFETS	1.6E-02	7.8E-06	2.6E-05	1.6E-06	1.3E-14	5.4E-09
SNL-NM	1.1E-02	5.6E-06	1.9E-05	1.1E-06	0.0	4.9E-11
SRS	3.1	1.6E-03	5.4E-03	3.1E-04	2.8E-14	1.0E-07
Total	34	1.7E-02	5.8E-02	3.4E-03	1.8E-13	1.1E-07

Table D.3.5–117. Intruder Scenario Risk Results for the Decentralized Alternative (300 years)

Site	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
ANL-E	2.3E-02	1.1E-05	3.9E-05	2.3E-06	1.4E-14	1.6E-08
BNL	5.0E-04	2.5E-07	8.6E-07	5.0E-08	0.0	1.3E-09
FEMP	1.4E-03	6.8E-07	2.3E-06	1.4E-07	0.0	6.8E-09
Hanford	1.5E-01	7.7E-05	2.6E-04	1.5E-05	3.1E-14	4.0E-08
INEL	2.5E-01	1.2E-04	4.2E-04	2.5E-05	2.2E-14	6.2E-08
LANL	1.9E-03	9.3E-07	3.2E-06	1.9E-07	0.0	1.0E-08
LLNL	9.3E-03	4.6E-06	1.6E-05	9.3E-07	0.0	1.6E-08
NTS	3.1E-03	1.6E-06	5.3E-06	3.1E-07	0.0	6.7E-09
ORR	8.5E-02	4.2E-05	1.4E-04	8.5E-06	4.8E-14	1.1E-07
PGDP	1.3E-01	6.4E-05	2.2E-04	1.3E-05	0.0	2.5E-09
Pantex	1.9E-04	9.3E-08	3.2E-07	1.9E-08	0.0	8.6E-10
PORTS	6.0E-03	3.0E-06	1.0E-05	6.0E-07	2.7E-14	2.9E-08
RFETS	1.1E-02	5.7E-06	1.9E-05	1.1E-06	1.3E-14	5.4E-09
SNL-NM	1.6E-04	8.2E-08	2.8E-07	1.6E-08	0.0	4.9E-11
SRS	4.6E-02	2.3E-05	7.9E-05	4.6E-06	2.8E-14	1.0E-07
Total	7.2E-01	3.5E-04	1.2E-03	7.2E-05	1.8E-13	1.1E-07

Table D.3.5–118. Intruder Scenario Risk Results for Regionalized Alternative 2 (100 years)

Site	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
Hanford	19	9.4E-03	3.2E-02	1.9E-03	3.4E-14	4.7E-08
INEL	7.9	3.9E-03	1.3E-02	7.9E-04	2.7E-14	6.9E-08
LANL	4.6E-02	2.3E-05	7.9E-05	4.6E-06	1.7E-14	1.1E-08
NTS	1.4E-04	7.1E-08	2.4E-07	1.4E-08	0.0	2.8E-12
ORR	2.5	1.2E-03	4.2E-03	2.5E-04	7.1E-14	1.4E-07
SRS	3.1	1.6E-03	5.4E-03	3.1E-04	2.7E-14	1.0E-07
Total	33	1.6E-02	5.5E-02	3.3E-03	1.8E-13	1.4E-07

Table D.3.5-119. Intruder Scenario Risk Results for Regionalized Alternative 2 (300 years)

Site	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
Hanford	1.4E-01	7.1E-05	2.4E-04	1.4E-05	3.4E-14	4.7E-08
INEL	2.6E-01	1.3E-04	4.4E-04	2.6E-05	2.7E-14	6.9E-08
LANL	1.4E-02	6.8E-06	2.3E-05	1.4E-06	1.7E-14	1.1E-08
NTS	3.4E-04	1.7E-08	5.8E-08	3.4E-09	0.0	2.8E-12
ORR	1.5E-01	7.4E-05	2.5E-04	1.5E-05	7.1E-14	1.4E-07
SRS	4.6E-02	2.3E-05	7.9E-05	4.6E-06	2.7E-14	1.0E-07
Total	6.1E-01	3.0E-04	1.0E-03	6.1E-05	1.8E-13	1.4E-07

Table D.3.5-120. Intruder Scenario Risk Results for the Centralized Alternative (100 years)

Site	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
Hanford	7.1	3.6E-03	1.2E-02	7.1E-04	5.1E-14	9.6E-08
Total	7.1	3.6E-03	1.2E-02	7.1E-04	5.1E-14	9.6E-08

Table D.3.5-121. Intruder Scenario Risk Results for the Centralized Alternative (300 years)

Site	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
Hanford	1.5E-01	7.3E-05	2.5E-04	1.5E-05	5.1E-14	9.6E-08
Total	1.5E-01	7.3E-05	2.5E-04	1.5E-05	5.1E-14	9.6E-08

Table D.3.5-122. Intruder Scenario Risk Results for RH-LLMW (100 years)

Site	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
Hanford	6.2E-03	3.1E-06	1.0E-05	6.2E-07	0.0	5.9E-13
INEL	13	6.4E-03	2.2E-02	1.3E-03	1.2E-14	8.8E-09
ORR	55	2.7E-02	9.3E-02	5.5E-03	0.0	2.3E-10
SRS	7.0E-02	3.5E-05	1.2E-04	7.0E-06	0.0	6.8E-11
Total	68	3.3E-02	1.2E-01	6.8E-03	1.2E-14	8.8E-09

Table D.3.5-123. Intruder Scenario Risk Results for RH-LLMW (300 years)

Site	Radionuclides				Chemicals	
	Dose (rem)	Cancer Fatality	Cancer Incidence	Genetic Effects	Cancer Incidence	Hazard Index
Hanford	4.7E-05	2.4E-08	8.1E-08	4.7E-09	0.0	5.9E-13
INEL	2.8E-01	1.4E-04	4.8E-04	2.8E-05	1.2E-14	8.8E-09
ORR	1.9	9.5E-04	3.2E-03	1.9E-04	0.0	2.3E-10
SRS	1.0E-03	5.2E-07	1.8E-06	1.0E-07	0.0	6.8E-11
Total	2.2	1.1E-03	3.7E-03	2.2E-04	1.2E-14	8.8E-09

D.3.5.9.1 *Results of the Human Health Risk Analysis for the Intruder*

For the Decentralized Alternative (which entails disposal at 15 sites), 100 years after the end of disposal operations, the site with the highest intruder cancer fatality risk is Hanford (9.4E-03) and the lowest cancer fatality risk is at FEMP (6.8E-07). The high dose at Hanford is due to large inventories of strontium-90 and cesium-137. Three hundred years after waste disposal is completed, the highest intruder cancer fatality risk is at INEL (1.2E-04), due primarily to a large inventory of nickel-63, and the lowest risk is at SNL-NM (8.2E-08).

For Regionalized Alternative 2 (involving disposal at six sites), 100 years following the end of disposal, the highest intruder cancer fatality risk is at Hanford (9.4E-03) due to strontium-90 and cesium-137; the lowest intruder risk is at NTS (7.1E-08). Three hundred years after disposal, the highest intruder cancer

fatality risk is at INEL (1.3E–04), where nickel-63 is the driving radionuclide; the lowest risk is at NTS (1.7E–08).

The Centralized Alternative (in which all waste is disposed at Hanford) poses an intruder cancer fatality risk of 3.6E–03 at 100 years, following the end of disposal activities. The controlling radionuclide is strontium-90. Three hundred years after disposal, the cancer fatality risk to the intruder decreases to 7.3E–05. The risks at Hanford under this single-site consolidation alternative are nearly three times lower than the risks at Hanford under the 15- or 6-site disposal options. While this may seem counterintuitive at first, it derives from the reduction in *average* waste concentration at Hanford that results when the waste volumes of low-activity wastes from other sites are added to the relatively higher-activity Hanford wastes.

For the RH-LLMW disposal scenario, 100 years after disposal operations cease, the highest cancer fatality risk is at ORR (2.7E–02) due to the presence of strontium-90 in the inventory. The lowest cancer fatality risk occurs at Hanford (3.1E–06). Three hundred years after the end of disposal operations, the highest intruder cancer fatality risk remains at ORR (9.5E–04), due to thorium-232, and the lowest risk remains at Hanford (2.4E–08). The driving radionuclide at ORR changes between the 100- and 300-year intrusions because strontium-90 decays through about 10 half-lives in the intervening 200 years whereas, thorium-232 has a half-life of approximately 14.1 billion years. As such, more than 99.99% of the material that was present at the close of disposal activities has decayed to lower-risk daughter products.

In general, the risks associated with intrusion at 300 years after closure of the disposal facility are less than those at 100 years due to the decay of radionuclides with time. The incidence of cancer associated with chemical exposures is eight to 12 eight orders of magnitude lower than the risk from exposure to radionuclides, and is well below levels of risk considered to be tolerable. The highest hazard index for any site is in the E–07 range, so exposure to noncarcinogenic chemicals is unlikely to lead to adverse health effects.

D.4 Uncertainty

The risks estimated in the preceding sections of the PEIS will be used to evaluate the alternatives based on cost, health risk, and environmental and socioeconomic impacts. These risks were calculated based on assumptions about the amount of contaminants released into the environment (source terms), the transport

of the contaminants through the air and groundwater to various populations, and the health effects to man resulting from the intake of these contaminants by inhalation or ingestion. These assumptions are necessary because the actual processes may be too complex to simulate or insufficient information is available to properly model the system. Because exact system definition is not possible, a *range* of possible values can be estimated; the most likely value (based on available data) is then chosen for calculating the risk. This range of possible values and the frequency with which these values occur are referred to as the "distribution." The model can be run using this distribution of input parameters to determine the range of risk estimates. This range is known as the risk uncertainty.

The risk uncertainty can be applied to the risk values given in the PEIS to get an estimated range of risks for each alternative. If part of the range of risks for one alternative overlaps the range for another alternative, it may not be possible to make a distinction between the two alternatives to determine which alternative poses the lower risk.

The standard method for determining risk uncertainties is quantitative, and involves estimating the range and distribution of each input parameter, producing a large number of input data sets that simulate those ranges and distributions, then running the model to determine the range of risks that result. However, the PEIS uses too many parameters and data sets for such an uncertainty analysis. Therefore, a qualitative uncertainty analysis was performed to assess the general accuracy of the PEIS risk estimates. This was done by performing an uncertainty analysis on a limited amount of data, then applying the results across all sites and alternatives.

As noted in previous sections, the uncertainties associated with risk analyses depend to a large degree on the various assumptions that are made when determining model methodologies, scenario definitions, and input parameters. Model uncertainties vary according to the model being used and how applicable that model is to the scenario; they are estimated during the verification and validation phase of model development. Usually, the model developers provide the model uncertainties and/or limitations of model applicability.

Scenario uncertainties include overlooking important receptors, not fully considering receptor activities (which could, for instance, lead to under- or overestimates of exposure), and so forth. Since the PEIS defines the scenarios to be analyzed for risk, these types of uncertainties do not apply in the alternative comparisons and, therefore, were not included in the uncertainty analysis.

Parameter uncertainties are caused by errors in measurements of the independent variables involved in the risk calculations and/or the representativeness of the samples taken for measurement. Since the PEIS is concerned with the comparison of *relative* risk estimates, only the parameters that cause a *relative* uncertainty between alternatives should be included. These parameters generally include all site-specific variables such as wind conditions or crop yields, as opposed to parameters that are common across all facilities, such as the breathing rate of humans and toxicity-related measures such as dose conversion factors.

The first step in this uncertainty analysis requires determining which parameters are significant, that is, which ones have the greatest influence on risk. Parameters that do not contribute to relative errors have been excluded from this uncertainty analysis, and are discussed in greater detail where appropriate in the following sections. The second step involves determining the uncertainty of each significant parameter. The third and final step is calculating the total risk uncertainty. Since different mathematical models are used for treatment and storage sites, disposal facilities, and waste management workers, the analysis will vary for each alternative. Uncertainties are presented in the following text, first for treatment and storage sites, then for disposal sites, and finally for waste management workers.

D.4.1 TREATMENT AND STORAGE SITES

Atmospheric transport and subsequent inhalation, ingestion, and external exposure to contaminants were considered to be the only significant exposure pathways for treatment and storage sites (the groundwater and surface water transport pathways were excluded). To determine unit doses for the PEIS for radionuclides, the GENII code (Napier et al., 1988) was used. For hazardous chemicals, the ISC2 dispersion models (EPA, 1992a) were used. The risk uncertainty from using each of these codes had to be evaluated separately. To determine the general trends and magnitudes in risk uncertainty, a single, quantitative uncertainty analysis was performed using representative data from various sites. The results of this analysis are discussed according to their applicability across all sites.

To perform the uncertainty analysis for the PEIS, the measurement uncertainty and/or representativeness of the samples of all parameters having a significant influence on risk are needed. One significant variable is the source term. However, the uncertainties of the source terms for the PEIS were not provided by ANL at the time of this study and were, therefore, not included in this uncertainty analysis.

The uncertainties of other parameters, such as dose conversion factors, risk factors, and RfDs are associated with a high level of uncertainty. However, these parameters are determined apart from the PEIS and remain constant; therefore, any error associated with them is systematically applied across all facilities. In addition, although the health effects vary for each individual for a given exposure, the overall effects averaged across an entire population should be similar from one facility to another if that population is sufficiently large. Since the assumption that the populations were sufficiently large at all facilities was considered appropriate for a qualitative uncertainty analysis, the uncertainties from these parameters were not included in this study. The breathing rate of humans was also not considered in this analysis for similar reasons. Other parameters such as particle deposition velocity, resuspension parameters, stack flow rate, and stack exhaust gas temperature were assumed to be identical at all treatment and storage facilities since the facilities are not yet built and are hypothetical in nature. Therefore, these parameters were not included in this uncertainty analysis.

D.4.1.1 Radionuclides

To calculate the uncertainty associated with the estimated exposure caused by radionuclides, a sensitivity analysis of the GENII model was performed first, then the uncertainty analysis was made using only the significant parameters. The results are presented in the following subsections.

D.4.1.1.1 *Sensitivity Analysis of GENII*

A sensitivity analysis was performed to determine the variables that have a significant influence on the model's predictions of risk. Variables that were included in the sensitivity study included average air concentrations from a unit source for a specific area and population (called "Chi/Q"), agricultural yields, and what are termed "dietary fractions" (the rates at which a receptor consumes various nutrients such as water, grain, etc.). As noted in Section D.4.1, other variables such as breathing rates, particle deposition velocities, etc., were not included.

The GENII-S code (Leigh et al., 1992), developed by SNL-NM specifically for sensitivity and uncertainty analysis, was used to perform the sensitivity studies. The uncertainty associated with the annual effective dose equivalent (AEDE) due to the uncertainties associated with input parameters was determined. Latin

Hypercube sampling (Iman and Shortencarier, 1984) was used to generate a total of 300 input data sets that represent the distributions of the input variables. The results were subjected to regression analysis so that the statistically significant predictor variables could be determined. The regression equation simply fits a linear curve to the outputs from the Latin Hypercube samples:

$$Y = b + c_1x_1 + c_2x_2 + \ . \ . \ . \ + c_ix_i \qquad \text{(D.3-1)}$$

where Y is the predicted variable, b is the y intercept, x is the predictor variable, and c is the coefficient of the predictor variable in the linear formula. The null hypothesis that a coefficient was zero was tested to within the 95% confidence level; in other words, any coefficient that had a probability less than 0.05 of being zero was considered a significant parameter.

The parameters used in the sensitivity study included Chi/Q, 11 crop yields, and dietary fractions of cattle. To perform the sensitivity study, the range and distribution of each parameter had to be determined. To initialize input parameters, SRS was chosen as the site and a representative source term consisting of 1 Ci of each of the following radionuclides was used: tritium, carbon-14, phosphorus-32, sulfur-35, cobalt-60, strontium-90, yttrium-90, technetium-99, ruthenium-106, iodine-125, iodine-129, iodine-135, cesium-137, neptunium-237, thorium-229, uranium-238, americium-242, plutonium-238, and curium-245.

GENII-S uses Chi/Q as an input parameter. However, Chi/Q is actually a derived variable based on the joint frequency data, anemometer height, exhaust stack height, stack flow rate, stack diameter, and stack exhaust gas temperature; therefore, the uncertainty of Chi/Q had to be determined. Only the uncertainty in the site-specific joint frequency data was included in determining the uncertainty of Chi/Q, since the other parameters were not addressed (refer to Section D.4.1).

The joint frequency data for the 26 sites analyzed in the PEIS were collected from the MEPAS code (Droppo et al., 1989) (21 sites), the National Climatic Data Center (4 sites), and an environmental impact statement report (1 site). The joint frequency data comprise six wind speed ranges, seven stability classes per wind speed range (these stability classes indicate the number and intensity of wind gusts for a particular average wind speed range), and 16 wind directions (16 sectors of 22.5 degrees per sector; e.g., north, north-northeast, northeast, east-northeast, etc.). The uncertainties associated with each joint frequency data set are the measurement uncertainties for wind speed and direction and the representativeness of that data set relative to average wind conditions at the site over a specified period of time. The time period of interest

may differ for the release scenario. For a chronic release, the joint frequency data should represent wind speeds and directions averaged over the longest possible time period since the exposure period used in the human health risk analysis is equivalent to the average life span of an individual. However, for acute releases, such as would result from accidents, the data should be representative of a 1-year release since a 1-year constant release was assumed for acute release scenarios. The uncertainty of the joint frequency data is therefore a function of the variability of the wind on an annual basis and of how many years of data were used to estimate the average annual wind conditions.

To estimate the uncertainty in Chi/Q caused by the variations in atmospheric conditions, one site was chosen for which sufficient wind profile data were available to perform the analysis. (However, for a more complete uncertainty analysis, every site would have to be analyzed individually since the method for obtaining the data, the instrumentation used, the location of the meteorological tower relative to the facility, and the number of samples taken vary from site to site.) The meteorological data at the ORNL–East Tower were used since the data are readily available, fairly extensive, and measurement uncertainties are negligibly small compared to wind condition variability. The meteorological data are taken each hour, with measurement uncertainties of one degree for wind directions and 0.1 mph for wind speeds. Since GENII uses 16 wind directions of 22.5 degrees per directional sector, a 1-degree uncertainty in wind direction would have a negligible effect on the wind velocity profiles used for modeling (these profiles present wind velocity as a function of direction, by degree). GENII also uses only six wind speed ranges separated by approximately 2 mph and only seven stability classes. Therefore, wind speed uncertainties of 0.1 mph are negligible relative to model input capabilities for both mean wind speeds and stability classes.

The only uncertainty that must be considered is the representativeness of the joint frequency data to the "actual" conditions one would experience during exposure. To estimate this uncertainty for one site, the hourly data taken at the ORNL–East Tower were averaged over 1 year to produce one joint frequency data set for that year. Since data have been acquired since 1987, seven yearly data sets could then be constructed (1987–1993). The GENII code was run for each of these joint frequency data sets to determine a Chi/Q with all other parameters being constant. The results presented in Table D.4–1 show that the standard deviation for Chi/Q for this set of data is 1.27E–12. Two standard deviations are typically used to bound data within the 95% confidence level. Using two standard deviations, the uncertainty of the resultant Chi/Q is approximately $\pm 10\%$. Therefore, the joint frequency data averaged over 7 years would also be expected to have an uncertainty of no more than $\pm 10\%$.

Shor et al. (1982) (the source of the agricultural yield data) report that the margin of error for the agricultural yields is ±10%; the distribution had to be determined from the data in that study. From evaluating various yields from counties surrounding SRS, it was determined that a normal distribution was appropriate for the crop yields.

After the range and distribution of the input parameters were established, 300 input data sets were developed using the Latin Hypercube sampling technique. The regression analysis was then performed on the 300 model outputs. The coefficients resulting from the regression analysis and the probability of a coefficient being zero from the test of the null hypothesis are presented in Table D.4-2.

Table D.4-1. Descriptive Statistics for Chi/Q From ORR Meteorological Data

Statistic	Value
Mean	2.34E-11
Standard deviation	1.27E-12
Two standard deviations	2.54E-12 (10% of mean value)

Table D.4-2. Results of GENII Sensitivity Study

Variable	Coefficient	Probability
Chi/Q	113,787.87	0.000
Yield rate—Grain for human consumption	326.36	0.00
Yield rate—Fresh forage for beef cattle	202.11	0.05
Beef dietary fraction for stored feed	100.51	0.17
Yield rate—Stored feed for milk cows	74.28	0.09
Yield rate—Stored feed for poultry	31.17	0.73
Yield rate—Root vegetables	27.57	0.62
Yield rate—Stored feed for beef cattle	25.37	0.56
Yield rate—Leafy vegetables	-6.58	0.68
Yield rate—Fruit	-18.43	0.45
Yield rate—Fresh forage for milk cows	-32.35	0.75
Milk dietary fraction for stored feed	-42.69	0.56
Yield rate—Stored feed for laying hens	-102.27	0.25

Of all the variables considered in the analysis, only Chi/Q, the yield of grain for human consumption, and the yield of fresh forage for beef cattle were below the 0.05 probability level of having a zero coefficient. This means that the AEDE was most sensitive to variations in these three variables. Latin Hypercube sampling and regression analysis were performed again using these three variables only. The resulting partial correlations (which indicate the strength of the linear dependence of a parameter and factor out the first-order correlations between input variables) are presented in Table D.4–3.

Table D.4–3 reveals that the most sensitive variable was Chi/Q with a correlation coefficient of 0.99. This means that the uncertainty in Chi/Q will probably affect the uncertainties in risk much more than the uncertainties in the other two parameters. This is similar to the results found in an uncertainty study by Lyon et al. (1992), in which the Chi/Q correlation coefficient was 0.95. Despite the small contributions from the other two variables (grain yield for humans and fresh forage yield for beef cattle), the uncertainty analysis was performed using all three variables to ensure the thoroughness of the analysis.

D.4.1.1.2 *Uncertainty Analysis*

The uncertainty analysis was performed using the GENII–S code again, along with the three parameters shown in Table D.4–3. The results presented in Table D.4–4 show that the deviations in AEDE were ±9%. This is nearly the same uncertainty as that of Chi/Q (which, the reader will recall from preceding discussion, was ±10%); this is as expected, since the correlation coefficient of Chi/Q is 0.99.

Table D.4–3. Correlation Coefficients for Significant Variables

Variable	Partial Correlation
Chi/Q	0.99
Yield rate—Grain for human consumption	0.17
Yield rate—Fresh foliage for beef cattle	0.12

D.4.1.2 Hazardous Chemicals

The ISC2 code (EPA, 1992a) was used in the PEIS to estimate atmospheric fate and transport of hazardous chemicals. ISC2 estimates unit air concentrations for each block in a circular grid comprising 16 directional sectors (e.g., north, north-northeast, northeast, east-northeast, etc.) at 10 radial distances out to 80 km (50 mi) from the point of release, similar to the Chi/Q calculation in GENII. Because of the simplicity of the approach in ISC2, the Chi/Q, cancer potency factors, and RfDs are the only parameters used in modeling, and all are sensitive parameters on risk. However, recall from Section D.4.1 that the uncertainties in cancer potency factors and RfDs were not considered applicable in the PEIS uncertainty analysis since only relative, not absolute, uncertainties were being sought. Therefore, Chi/Q was the only sensitive variable in the ISC2 model for the purposes of this uncertainty analysis. Since the calculation for Chi/Q in ISC2 is almost identical to that in GENII, the uncertainties in Chi/Q are $\pm 10\%$.

D.4.1.3 Conclusion for Treatment and Storage Sites

The relative uncertainty of risk for the PEIS for comparison purposes could not be determined since the uncertainties in source terms were not available for this analysis. For the parameters pertaining to ingestion or inhalation, including Chi/Q, crop yields, and dietary fractions of humans and animals, the only significant parameter was Chi/Q, which had an uncertainty of $\pm 10\%$.

Because the uncertainties for parameters other than the source term are relatively low, the overall risk uncertainties should be of approximately the same order of magnitude as the source term uncertainties determined by ANL.

Table D.4–4. Descriptive Statistics for AEDE From the Uncertainty Analysis

Statistic	Value
Mean	2.5E+04
Deviation (Max-Mean)	2.15E+03 (9% of mean value)

If the critically exposed population in the PEIS is relatively small, the uncertainties in the breathing rates of humans, dose conversion factors, risk factors, and RfDs become significant, and the uncertainties in risk increase accordingly.

D.4.2 DISPOSAL SITES

Groundwater transport was considered the only significant environmental transport pathway for disposal sites. Three computer codes were used to estimate disposal risks. The DUST code (Sullivan, 1992) was used to estimate the amount leached from the disposal site; MEPAS (Droppo et al., 1989) was used to calculate fate and transport of the contaminants; and the DITTY portion of the GENII code (Napier et al., 1988) was used for the ingestion and exposure assessment. The uncertainty in these disposal risk calculations was estimated based on a sensitivity and uncertainty analysis of the MEPAS code conducted in April 1992 by ORNL and PNL (Lyon et al., 1992).

The applicability of the sensitivity and uncertainty analysis of the MEPAS code to the PEIS was evaluated. The locations studied by Lyon et al. were chosen to encompass high-risk sites (sites for which population fatalities were estimated at greater than 1), medium-risk sites (where population fatalities were predicted to range between 1 and 0.0001), and low-risk sites (with population fatalities estimated at less than 0.0001). Of the six contaminated sites studied, four involved the groundwater pathway. These four were ORNL Waste Area Grouping 6, the Hanford Nonradioactive Dangerous Waste Landfill Site, LLNL Site 300 Landfill 6, and FEMP Operable Unit 1. Because these four sites are located at four sites that were included in the PEIS health risk analyses, the results from the 1992 study were considered applicable to the PEIS.

Before relating the results of the study by Lyon et al. to the PEIS results, two differences must be pointed out. First, the PEIS used the DUST model instead of MEPAS to input the rate of contaminant release from the disposal site; however, the methodology used in the PEIS was identical to that used in the MEPAS study by Lyon et al. Second, the risk estimates in the study by Lyon et al. (1992) were time-weighted such that health effects that occurred sooner were weighted more heavily than those occurring later; the PEIS risks were not time-weighted. However, the contaminants in the Lyon study—uranium-238, strontium-90, benzene, and trichloroethene—moved through the groundwater at relatively similar rates and relatively fast; therefore, time-weighting the results would have a negligible effect on the uncertainties. Moreover, these contaminants are some of the primary constituents in the PEIS source terms. Because of these factors, the

variations in risk estimates determined by Lyon et al. (1992) should provide a reasonable estimate of the uncertainties in the PEIS.

Latin Hypercube sampling was used to perform the sensitivity and uncertainty studies. The sensitivity analysis was performed by PNL, which used the time-weighted number of health effects as the dependent variable. The initial sensitivity rankings of the inputs were based on the partial correlation coefficients (indicating the strength of the linear dependence of the parameters). Typically, only three to six parameters showed sufficient sensitivity to be considered for the uncertainty analysis at the various sites. The null hypothesis that a coefficient was zero was tested to the 95% confidence level (i.e., parameters were considered sufficiently sensitive if there was a probability of 0.05 or less that a parameter's coefficient in the regression equation was zero).

Table D.4–5 presents the input parameters with significant correlation coefficients and the number of orders of magnitude difference between the 95th percentile upper and lower confidence levels. The significant parameters are listed in order of the highest to lowest correlation coefficients. The authors concluded that the most vital components of the risk characterization process are the initial concentrations of contaminants,contaminant inventories, and contaminant flux rates at the site. In many cases, the final risk estimate is directly proportional to these values. Uncertainties in the subsurface partitioning coefficient, K_d, were determined to be insignificant relative to these other components.

Table D.4–5 shows that the differences in population risk estimates between the upper and lower 95th-percentile confidence bands ranged from 0.2 to 12.2 orders of magnitude. Note that the uncertainty at Hanford was very high in relation to the other three sites (12 orders of magnitude compared to 0.2, 1.5, and 2.1). This was because of a large decrease in population risk from the lower 80th percentile to the lower 95th percentile, accounting for approximately 10 orders of magnitude of uncertainty; there is only a difference of 2.2 orders of magnitude of uncertainty between the upper 95th percentile to the lower 80th percentile. Excluding the lower 80th to 95th percentile of the uncertainty for Hanford from consideration (because this behavior appears to be unique to Hanford and is extremely uncharacteristic of the other sites), the most reasonable estimate of the uncertainty with respect to disposal risks in the PEIS would be between 1 and 2 orders of magnitude.

Table D.4-5. Uncertainties of Risk Predictions via the Groundwater Pathway

Site	Significant Parameters (from highest to lowest correlation coefficient)	Population Risk Orders of Magnitude Difference[a]
ORR—Waste Area Group 6	1) Contaminant inventory 2) Surface K_d 3) Subsurface K_d 4) Discharge rate of White Oak Lake into the Clinch River	1.5
Hanford—Nonradioactive dangerous waste landfill site	1) Thickness of saturated zone 2) Waste leaching rate 3) Transverse dispersivity in saturated zone 4) K_d in saturated zone 5) K_d in partially saturated zone 6) Population drinking contaminated groundwater	12
LLNL—Site 300 Landfill 6	1) Flux rate 2) Leaching rate 3) K_d in first partially saturated zone 4) K_d in second partially saturated zone 5) K_d in saturated zone 6) Population drinking contaminated groundwater	2.1
FEMP—Operable Unit 1	1) Contaminant inventory 2) Pore water velocity in saturated zone 3) K_d in first partially saturated zone 4) K_d in second partially saturated zone 5) K_d in saturated zone 6) Travel distance in saturated zone to receptor	0.2

[a] Orders of magnitude difference between the 95th percentile upper and lower confidence levels.

This uncertainty estimate does not take into account uncertainties in the waste inventories provided by ANL. If the uncertainties in the inventories are provided by ANL, the risk uncertainty estimated in the preceding paragraph can be adjusted accordingly.

D.4.2.1 Conclusion for Disposal Sites

The most reasonable estimate of the uncertainty in the risk predictions in the PEIS for the disposal sites was expected to be approximately one to two orders of magnitude, based on the study by Lyon et al. (1992).

If ANL provides source term uncertainties in the future, the uncertainties in risk in the PEIS can be adjusted accordingly.

D.4.3 WASTE MANAGEMENT WORKERS

The MicroShield code (Grove Engineering, Inc., 1992) was used to calculate external radiation exposure to waste management workers for the waste management portion of the PEIS. MicroShield is capable of performing sensitivity studies for the shield thickness, distance-from-source-to-shield, and distance-from-source-to-receptor parameters. Sensitivity studies on other parameters such as material density and source strength must be performed manually.

For the comparison of PEIS alternatives, only the parameters that cause relative error, not absolute error, are the ones desired in determining the risk uncertainties. Since the PEIS treatment facilities and operational equipment were hypothetical in nature and were all assumed to be identical for the various treatments required, many parameters could be excluded from this uncertainty study. These included the shielding material and thickness, and the distances of the shield and receptor from the source.

Uncertainties were introduced in the PEIS risk estimates from relating waste throughputs to source volumes (volumes of waste in treatment vessels) and unit dose methodologies. For the PEIS, the throughput of waste for each treatment module for each alternative was provided by ANL. Since MicroShield requires input of the source (or waste) volume rather than the waste throughput, regression equations were used to relate throughputs to treatment vessel volumes using known values for existing facilities, derived from facility data provided by Morrison Knudsen Corporation (1993, 1994). The treatment modules that have variable capacities included feed waste bins, shredders, evaporators, high pressure spray/blast booths, solidification units, aqueous tanks, neutralization tanks, ion exchange tanks, oxidation reactor tanks, incinerators, metal melters, thermal desorption units, mercury roasting kilns, metal deactivation units, lead melting tanks, soil washing tanks, sludge washing tanks, debris washing tanks, and polymer blending tanks. (The size of some modules, such as drum compactors, did not change since the drum sizes remain the same for various throughputs; only the number of drums changed.)

There were two sources of error in the worker exposure calculations. First, the known throughputs and volumes consisted of three or four sizes categorized as extra-small, small, medium, and large. Since only

three or four sizes existed to derive the regression equations for each treatment module, the maximum error of the three or four known values was used, regardless of throughput.

The second source of error resulted from using the unit dose methodology, in which the unit dose to a worker is calculated based on exposure to 1 m^3 of waste in a 1-m^3 container. Since the capacity of some of the treatment modules varied, the unit doses had to be scaled to reflect the doses for the correct waste volumes in these cases. To derive this relationship, MicroShield was executed for each of the variable-size modules for a range of waste volumes, and a regression equation was used to relate the dose from the various waste volumes to the unit dose.

To estimate the uncertainty in risk predictions from these two sources of error, an alternative was chosen in which the treatment train consisted of throughputs and treatment modules for which larger errors on the regression curves existed. The management of LLMW at INEL in Regionalized Alternative 3 was chosen. Since the throughput changed with each of the 57 treatment modules for this alternative, and the number of workers changed with throughput, the actual dose for each treatment module had to be determined. The total actual dose was then calculated in an EXCEL spreadsheet and compared to that in the PEIS, resulting in an approximate $\pm 6\%$ error.

The shielding materials used for the PEIS included air, concrete, iron, and water. Since the construction, operation, and maintenance of all the facilities were assumed to be identical because the facilities are hypothetical in nature, any variations in the densities of concrete, iron, or water that might occur would cause absolute errors in risk predictions but would not cause relative errors (the type of errors sought for comparison purposes). The only site-specific parameter that might cause relative error would be air density since it is a function of the altitude of the treatment site. Because the sea-level air density of 0.00122 g/cm^3 was used for all locations in the PEIS, the error would be the difference between the average density at a specific location and the density at sea level. The altitudes for the facility locations in the PEIS ranged from sea level to approximately 5,300 feet at RFETS in Golden, Colorado. Therefore, the corresponding air densities ranged from 0.00122 to 0.00127 g/cm^3. This variability would have little effect on the shielding properties of air, so its effect on risk estimates would be negligible.

D.4.3.1 Conclusion for Worker Risk

Variability in parameters such as shield thickness, the distance-from-source-to-shield, and distance-from-source-to-receptor would be the major source of absolute error in risk estimates. However, these parameters would not have contributed to *relative* error since they were hypothetical in nature and were assigned identical values at all facilities. Uncertainties in the source terms and waste throughputs are significant for alternative comparisons in the PEIS since they are site-specific parameters. However, as with the source terms for the treatment and storage sites and disposal sites, ANL had not provided the uncertainties in source terms for WM workers at the time of this study; therefore, uncertainties for worker risks could not be determined. Because the uncertainties for parameters, other than source term, that contribute to relative error are relatively low ($\pm 6\%$), the overall risk uncertainties should be approximately of the same order of magnitude as the source term uncertainties determined by ANL.

D.5 Models Used in the PEIS Human Health Risk Evaluation

The ORNL Center for Risk Management used a number of computer codes to generate the PEIS human health risk estimates; these included numerous in-house codes based on established outside models for application of the unit risk approach.

GENII (Generation II of the Hanford Environmental Radiation Dosimetry Software System) (Napier et al., 1988) was used to assess the exposures to the offsite and noninvolved populations resulting from atmospheric releases of radioactive contaminants during routine facility operations and accidents, and to assess the intruder's radiological exposure to contaminated soil.

GENII is the second generation of a model developed for DOE at PNL to incorporate internal dosimetry models recommended by the ICRP into Hanford's existing environmental pathway analysis models. GENII analyzes environmental contamination resulting from both acute and chronic radionuclide releases by calculating radiation doses to individuals or populations from inhalation, ingestion of contaminated food and water, and external exposure through soil, water, and air. The GENII codes were developed under a stringent quality assurance plan based on American National Standards Institute (ANSI) standard NQA-1 as implemented in the *PNL QA Manual* (PNL-MA-70). It includes the DITTY (Dose Integrated Over Ten

Thousand Years) code, which was used to calculate doses to the hypothetical farm family in the disposal scenarios as described below.

GENII has been used worldwide by several hundred users. Some noted applications include the Hanford Defense Waste EIS, Hanford's annual reports, the Hanford Safety Analysis, the Reactor Retirement EIS for PNL, and the ANL New Production Reactor Study. It has also been accepted by the State of Washington.

EPA's ISC2 (Industrial Source Complex Dispersion Models, Version 2) (EPA, 1992a) was used to model atmospheric exposure modeling to chemical contaminants for the offsite and noninvolved worker populations. The code was designed specifically to support the EPA's regulatory modeling programs, and has EPA approval.

The DUST (Disposal Unit Source Term), MEPAS (Multimedia Environmental Pollutant Assessment System), and DITTY models were used in series to estimate exposures to contaminated groundwater. DUST was used to calculate the flux of contaminants released and transported to the disposal facility boundary; these fluxes were then used as the input to MEPAS. The transport portion of MEPAS was used for the vadose and saturated zone plume migration calculations; the output concentrations from MEPAS were then used as input to DITTY. The DITTY code was then used for dose assessment calculations.

DUST was developed at Brookhaven National Laboratory (BNL) (Sullivan, 1992). This code models the release and transport of radionuclides through a shallow land disposal facility. DUST contains models to predict fluid flow, container degradation, waste form leaching, and radionuclide transport. DUST is useful for screening to determine which radionuclide is released at the highest rate, and for parameter sensitivity analysis. It has been extensively tested and verified, and the code predictions have been compared to known analytical solutions and to other code predictions; several verification tests are provided in the *Data Input Guide* (Sullivan, 1992). An important application of DUST was the modeling of field lysimeter release data collected at ORNL and ANL over a 7-year period.

MEPAS (Droppo et al., 1989) was originally developed in 1986 by PNL to assist the DOE Office of Environmental Safety and Health in prioritizing sites for remedial activities. This model is an objective, physics-based, PC-platform system that uses mathematical algorithms and a pathway analysis to evaluate the release of contaminants into the environment; the movement of these contaminants through and between

multiple environmental media; exposure to surrounding human populations via inhalation, ingestion, dermal contact, and external dose; and the human health effects due to exposure to both chemicals and radionuclides.

MEPAS has been the subject of numerous technical reviews and has been widely used. Applications include the identification and prioritization of areas of existing environmental problems and risk at DOE's defense production facilities, and the assessment of potential risks for a number of commercial clients, the Hanford Site Single-Shell Tank Waste Characterization Program, the Hanford grout studies of hazardous waste risks, and 20 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites.

DITTY was used in the PEIS analysis to calculate radiological doses to the hypothetical farm family. DITTY was developed to calculate long-term population exposures from waste disposal sites; the time frame for calculations in DITTY is 10,000 years, divided into 143 periods of 70 years each. DITTY calculates the lifetime cumulative dose equivalent for each time period and the EDE for the period of maximum dose.

The risks due to chemicals for the intruder scenario and the surface water deposition study were estimated using an upgraded version of the PRESTO–II risk assessment code (Fields et al., 1986). PRESTO–II was developed at ORNL to assist EPA in assessing the potential human health impacts from the disposal of LLW. PRESTO–II, originally written for a mainframe computer, was based on methodologies presented in the U.S. Nuclear Regulatory Commission *Reg. Guide 1.109* (NRC, 1977) for the release, transport, uptake, and human health risk assessment of radionuclides released from a shallow land burial trench. The PRESTO–II code was downloaded to a PC and augmented with a windows interface; this version of the code is called PRESTO–W (Fields and Melescue, in preparation). Further code development included adding the capability to simulate near-field scenarios where the contaminant concentrations of the environmental media are known at the receptor location. PRESTO–W was also upgraded to estimate human health risks from chemicals. The chemical database in MEPAS was incorporated into PRESTO–W for initializing chemical properties, cancer slope factors, and RfDs. The hazard index and cancer risks from chemicals were calculated in PRESTO–W using the methodologies presented in the EPA Superfund risk assessment guidelines (EPA, 1989a).

The MicroShield 4 computer code (Grove Engineering, Inc., 1992) was used for assessing external radiation exposure to waste management workers. MicroShield 4 was developed for designing shields and containers, assessing radiation exposure to people and materials, making source strength calculations based on radiation

measurements, and teaching shielding principles. This model uses a highly structured ANSI standard programming language with good numerical precision. Data for attenuation coefficients, buildup factors, and buildup factor coefficients are taken from information distributed by the Radiation Shielding Information Center and included in ANSI/ANS 6.4.3.

MicroShield is currently being used by 400 organizations worldwide. For example, MicroShield was used in assessments of the Chernobyl accident in the former Soviet Union (Grove Engineering, Inc., 1992) and of various commercial nuclear utilities. Numerous universities including Kansas State University, Pennsylvania State University, the Massachusetts Institute of Technology, the Georgia Institute of Technology, and Rensselaer Polytechnic Institute use MicroShield for teaching shielding principles.

INEXPLC is a QuickBASIC program designed by ORNL System Safety Engineering (Bloom, 1993). The code includes relatively simple models that simulate close-in (i.e., less than 50 m downwind from the source) atmospheric dispersion, explosive releases, and particle deposition. These models are based on exact solutions to the differential equation of a convection, turbulent-diffusion model for a point source and a semicircular, finite-area source. In this model, it is assumed that simple gas dispersion takes place with no effects from nearby structures (building wake effects or downwash). The INEXPLC code was used in the WM PEIS worker risk analysis to estimate outdoor air concentrations from accidental chemical releases.

References

ACGIH. *See* American Conference of Governmental Industrial Hygienists.

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U.S. Department of Energy
Office of Environmental Management

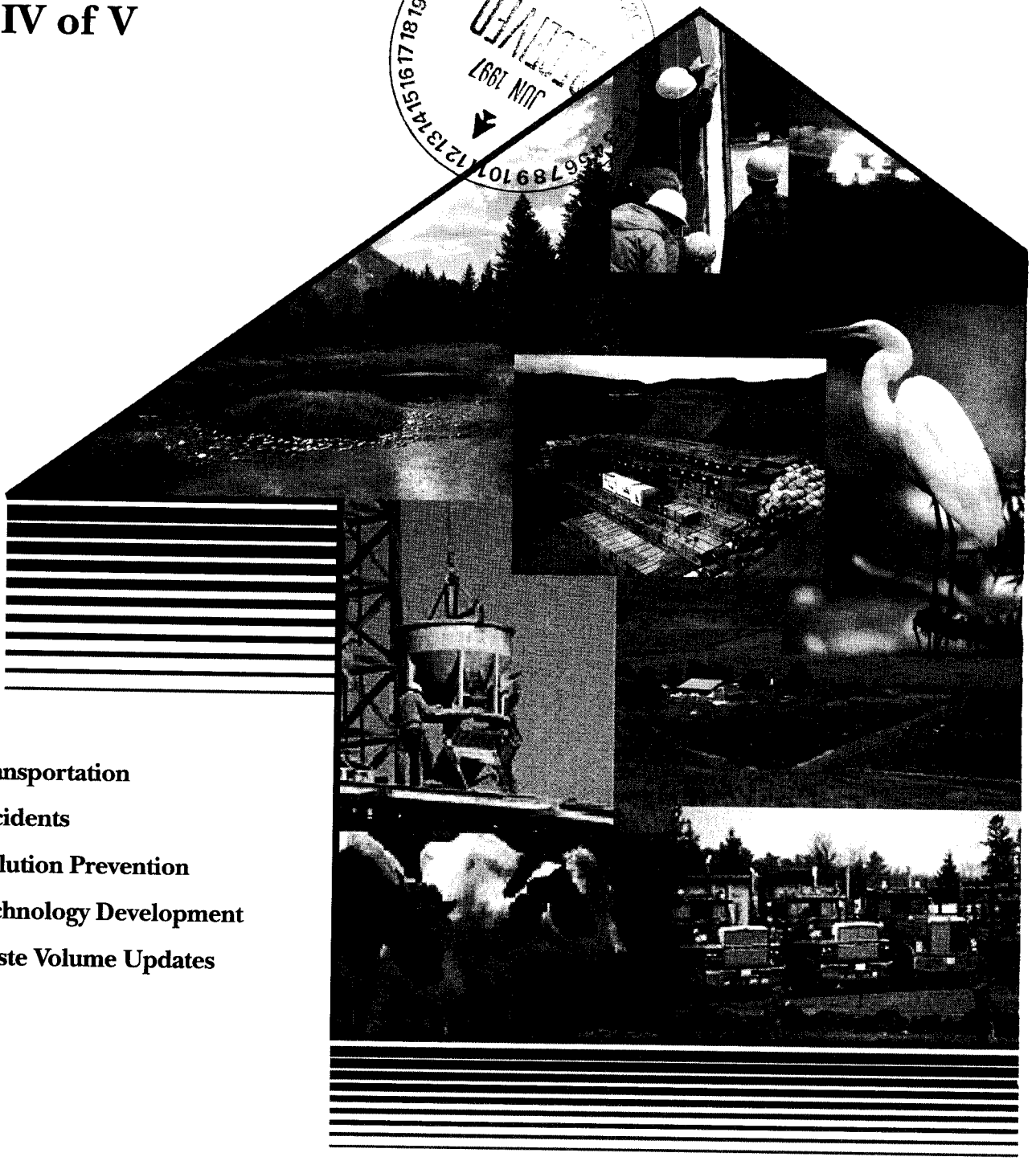
Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

Volume IV of V

DOE/EIS-0200-F

JUN 1997



Appendix E Transportation

Appendix F Accidents

Appendix G Pollution Prevention

Appendix H Technology Development

Appendix I Waste Volume Updates

DOE/EIS-0200-F

FINAL
WASTE MANAGEMENT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
for
Managing Treatment, Storage, and Disposal of
Radioactive and Hazardous Waste

Volume IV of V

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U.S. Department of Energy
Office of Environmental Management
1000 Independence Ave.
Washington, DC 20585

Appendix E

Radioactive and Hazardous Waste Transportation Risk Assessment

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Foreword

This appendix presents a summary of the transportation-related human-health risk assessment conducted for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement (WM PEIS). It also provides references to more detailed sources of information for all waste types. The assessment of risks associated with the transportation of radioactive waste is described in Part I, the assessment for transportation of hazardous waste (HW) in Part II. The information presented in this appendix is supported by data in separate technical reports (ANL, 1996a-f), that is, transportation technical memoranda, which describe the transportation for offsite and onsite shipments of radioactive and hazardous wastes.

Transportation of radioactive waste and HW presents a risk to both crew members and members of the public. Part of this risk results from the nature of transportation itself, independent of the radioactive or hazardous characteristics of the cargo (for example, increased levels of pollution from vehicular exhaust and accidents during transportation); these risks can be viewed as "vehicle-related" risks. In addition, transportation of radioactive waste or HW may pose additional risk because of the characteristics and potential hazards of the material itself; these risks are considered to be "cargo-related" risks.

For radioactive materials, the cargo-related impacts on human health during transportation are caused by exposure to ionizing radiation during routine (for example, incident-free) transportation and during accidents. During routine operations, the external radiation field must be below limits specified in Federal regulations. During transportation-related accidents, human exposures may occur following release and dispersal of radioactive materials via multiple environmental pathways such as exposure to contaminated ground or contaminated air, or ingestion of contaminated food.

In contrast to radioactive materials, hazardous chemicals do not pose cargo-related risks to humans during routine transportation-related operations. Waste transportation operations are generally well regulated with respect to packaging, such that small spills or seepages during routine transport are kept to a minimum and do not result in exposures (for example, containers of liquids are surrounded by absorbent overpacking). Potential cargo-related health risks to humans can occur only if the integrity of a container is compromised during an accident (that is, a container is breached). Under such conditions, some toxic chemicals (such as chlorine gas) may cause an immediate health threat to exposed individuals.

In addition to acute health effects, cargo-related risk of excess cases of latent cancer from accidental chemical exposures has been estimated. The correlation of chemical dose with the induction of human cancer has traditionally been based on the linear/no-threshold hypothesis, similar to radioactive exposure. The treatment of carcinogenic effects of exposures resulting from accidental chemical releases has added uncertainty because the carcinogenic risk is estimated for short-term (1-hour) exposures. Lifetime risks less than 1 in 1 million have been considered negligible and are not estimated. The number of individuals experiencing an increased risk of cancer of 1 in 1 million or greater has been estimated, without attempting to estimate the precise risk for those in the category of greater than 1 in 1 million.

Health impacts from radioactive and hazardous materials are presented separately in Part I and Part II of this appendix. No attempt has been made (even in cases where both radioactive and hazardous components are present in the same materials) to add or compare the estimated risks for the two classes of contaminants. To understand and interpret the estimated health impacts presented in this appendix, readers must keep in mind the fundamental differences between radioactive and chemical contaminants discussed previously. The table on the following page summarizes the human health effects considered for the radioactive-waste and HW risk assessments in this appendix.

***Endpoints Used for Human Health Effects: WM PEIS Transportation Risk Assessment*[a]**

Type of Human Health Effect	Nature of Health Effect	Radioactive Waste	HW
Vehicle-related effects: routine transportation			
Truck-emission-induced cancer fatality	Latent	✓	✓
Vehicle-related effects: accident			
Physical trauma fatality	Acute	✓	✓
Cargo-related effects: routine transportation			
Radiation-induced cancer fatality	Latent	✓	[b]
Radiation-induced cancer incidence	Latent	✓	[b]
Radiation-induced genetic effects	Latent	✓	[b]
Cargo-related effects: accident			
Potential life-threatening effects	Acute	[c]	✓
Potential for any adverse effects	Acute	[c]	✓
Cancer fatality	Latent	✓	[d]
Cancer incidence	Latent[e]	✓	✓
Genetic effects	Latent	✓	[d]

[a] Each check mark represents a quantitative measure of risk computed in this appendix. All end points are relevant to mixed waste because it contains both a radioactive and a hazardous component.
[b] No public exposure to the HW occurs during routine transportation.
[c] Threshold doses for radiological acute effects are generally in excess of 100 rem. Exposures from transportation-related activities (routine or accidents) have not been found to reach such a high dose level.
[d] Not applicable because of lack of scientific data to support the measure.
[e] For radioactive waste, the risk of cancer is expressed as the number of excess cases of cancer in the general population. For HW, the risk of cancer is expressed as the number of individuals in the general population experiencing an excess lifetime cancer risk of 1 in 1 million or greater.

Acronyms and Abbreviations

The following is a list of acronyms and abbreviations (including units of measure) used in this appendix.

Acronyms

ALOHA™	Areal Locations of Hazardous Atmospheres
Ames	Ames Laboratory
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
BCL	Battelle Columbus Laboratories
Bettis	Bettis Atomic Power Laboratory
BNL	Brookhaven National Laboratory
CFR	Code of Federal Regulations
CH	contact-handled
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
FEMP	Fernald Environmental Management Project
Fermi	Fermi National Accelerator Laboratory
FY	fiscal year
GTCC LLW	Greater-Than-Class-C low-level waste
Hanford	Hanford Site
HaWRAM	Hazardous Waste Risk Assessment Modeling
HEAST	Health Effects Assessment Summary Tables
HLW	high-level waste
HMIRS	Hazardous Materials Incident Reporting System
HQ	hazard quotient
HW	hazardous waste
ICRC	increased cancer risk concentration
INEL	Idaho National Engineering Laboratory
IRIS	Integrated Risk Information System
ITRI	Inhalation Toxicology Research Institute
KAPL-S	Knolls Atomic Power Laboratory (Schenectady)
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LC_{50}	lethal concentration causing death in 50% of animals tested
LC_{LO}	lowest reported lethal concentration

LDR	land disposal restriction
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
MEI	maximally exposed individual
Mound	Mound Plant
NRC	U.S. Nuclear Regulatory Commission
NRF	Naval Reactor Facility
NTS	Nevada Test Site
ORISE	Oak Ridge Institute for Science and Education
ORR	Oak Ridge Reservation
PAEC	potential adverse effect concentration
Pantex	Pantex Plant
PEIS	Programmatic Environmental Impact Statement
PGDP	Paducah Gaseous Diffusion Plant
PIH	poison inhalation hazard
Pinellas	Pinellas Plant
PLC	potential lethal concentration
PORTS	Portsmouth Gaseous Diffusion Plant
PPPL	Princeton Plasma Physics Laboratory
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RFETS	Rocky Flats Environmental Technology Site
RH	remote-handled
RMI	Reactive Metals, Inc.
RTECS	Registry of Toxic Effects of Chemical Substances
SFEIS	Supplemental Final Environmental Impact Statement
SLAC	Stanford Linear Accelerator Center
SMAC	Shipment Mobility/Accountability Collection
SNL-CA	Sandia National Laboratories (California)
SNL-NM	Sandia National Laboratories (New Mexico)
SRS	Savannah River Site
STEL	short-term exposure level
TC_{LO}	lowest toxic concentration (lowest concentration causing any adverse effect)
TRUW	transuranic waste
TSCA	Toxic Substance Control Act
TSD	treatment, storage, and disposal
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant

WM	waste management
WVDP	West Valley Demonstration Project
YM	Yucca Mountain

Abbreviations

°C	degree(s) Celsius
d	day(s)
gal	gallon(s)
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
L	liter(s)
m	meter(s)
m^3	cubic meter(s)
mi	mile(s)
mi^2	square mile(s)
mrem	millirem
ppm	part(s) per million
rem	roentgen equivalent man
s	second(s)
yr	year(s)

APPENDIX E—PART I
Radioactive Waste Transportation Risk Assessment

E.1 Introduction

Transportation is an integral component of the alternatives being considered for each type of radioactive waste in the U.S. Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS). The types of radioactive waste considered in Part I are high-level waste (HLW), low-level waste (LLW), transuranic waste (TRUW), and low-level mixed waste (LLMW). For some alternatives, radioactive waste would be shipped among the DOE sites at various stages of the treatment, storage, and disposal (TSD) process. The magnitude of the transportation-related activities varies with each alternative, ranging from minimal transportation for decentralized approaches to significant transportation for some centralized approaches. The human health risks associated with transporting various waste materials were assessed to ensure a complete appraisal of the impacts of each PEIS alternative being considered.

This section provides an overview of the approach used in the PEIS to assess human health risks that may result from transporting radioactive waste. The assessment's scope, computer models used, important assumptions for each waste type, and methods for determining potential routes for transportation are discussed. The risk assessment results are summarized for all alternatives for each waste type. In addition, to aid in understanding and interpreting the results, specific areas of uncertainty are described, emphasizing how the uncertainties may affect comparisons of the alternatives. Finally, possible mitigative measures that could be implemented to reduce potential impacts are discussed.

Transportation of hazardous and radioactive materials, substances, and waste is governed by the U.S. Department of Transportation, the U.S. Nuclear Regulatory Commission (NRC), U.S. Environmental Protection Agency (EPA) regulations, and the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

The methods and assumptions used in the transportation-related radiological risk assessment were selected to ensure meaningful comparisons among programmatic-level alternatives. Therefore, this assessment uses

a number of generic assumptions appropriate to the programmatic nature of the PEIS; for example, because a detailed consideration of every possible waste shipment would be impractical, representative physical and radiological characteristics were determined for each waste type. Similarly, conceptual transportation routes were selected to be consistent with current practice and applicable regulations, so that DOE can ensure that the waste is transported safely and will minimize the potential for adverse impacts to the public and environment. However, these may not be the actual routes that will be used in the future. Actual routes will be determined during the transportation planning process.

Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with states, regional entities, and carriers during large shipping campaigns to ensure that safe routing alternatives and safe havens are utilized.

Extensive studies of transportation risk assessment have been conducted for specific Federal actions (NRC, 1977a; DOE, 1986a; DOE, 1990a). However, care must be exercised when comparing the results of this PEIS transportation-related risk assessment with others. Although some alternatives in this PEIS may be similar to those analyzed in other studies, the results of other transportation risk assessments may differ for many reasons. In general, the other studies did not consider the range of programmatic alternatives being considered in this PEIS. Moreover, the other studies used assumptions and parameters specific to the actions being considered, which are not necessarily appropriate for this PEIS. In addition, revised radiation health risk conversion factors have been recommended (ICRP, 1991), and data on the projected waste inventory and on waste characterization have been revised and updated. Results of this PEIS are not intended to replace results of previous transportation risk assessments for ongoing or planned actions.

This section of the appendix should be read in conjunction with the technical reports describing the development of site-specific data on the waste inventory and characterization for each waste type (ANL, 1996g-k). Data on site-specific waste characterization are used for the transportation accident risk assessment but are not presented explicitly in this appendix. Similarly, the alternatives analyzed for each waste type are only summarized in Part I; detailed alternative definitions for each waste type are provided in the respective chapters of the PEIS for the waste type. The supporting technical reports prepared for each waste type contain detailed information on waste characterization, alternative definitions, and risk assessment results (ANL, 1996a,c-f). Revised site inventory estimates have become available, as discussed in Appendix I, since the original transportation analysis. Due to large changes in site inventory, radiological

profiles, or waste treatment, the risk analysis involving selected sites has been updated. However, the transportation risk analysis has not been recalculated for all alternatives because the same trends among alternatives are expected to apply. Site-specific information in the site data sheets and the cumulative impacts have been updated, however.

E.2 Scope of Assessment

The scope of the PEIS transportation radiological risk assessment—including the alternatives, transportation-related activities, potential vehicle- and cargo-related impacts, receptors, and transportation modes considered—is described in this section. Additional details of the assessment are provided in the sections that follow.

E.2.1 Onsite Versus Offsite Transportation

The transportation risk assessment includes the onsite and offsite transportation of radioactive waste. Onsite transportation involves transporting waste between facilities within a DOE site's boundaries. Transfers of waste within a specific facility are not considered onsite shipments but are considered part of the normal facility operations. Offsite transportation refers to transporting waste between distinct sites, including parts of the routes that may be within the boundaries of the origin and destination sites.

Offsite transportation usually involves the shipment of potentially large quantities of radioactive waste moving through a changing landscape and potentially stopping at any place along a route (usually a major highway). To effectively describe this situation, models that use simplified assumptions and generalizations are used to estimate risk from offsite shipments. National average or typical values are chosen for variables such as road and track dimensions, vehicular speed, traffic density, weather conditions, and stop times; population densities are modeled as being uniformly distributed. Conversely, onsite transportation occurs at a fixed location, which allows for a site-specific analysis. The onsite risk assessment uses site-specific characteristics, such as local weather, nonuniform distributions of population, and data on agricultural productivity.

The human health risks associated with onsite transportation are generally much smaller than those from offsite transportation, largely because of the limited distances for onsite shipment, limited population

densities along the routes, and limited average travel speeds (DOE, 1992b). Accordingly, the impacts of onsite transportation are not likely to contribute significantly to differences among the alternatives being considered. Therefore, for purposes of the PEIS, the onsite risk assessment has been limited to one representative site—the Hanford Site (Hanford). This site was selected primarily because it is relatively large and conducts activities for managing all waste types. The impacts calculated for the Hanford Site are believed to be typical of other large DOE sites and conservatively estimate the impacts expected for smaller sites. The risk assessment conducted for onsite transportation is intended to estimate the magnitude of potential risk for comparison with the risks of offsite transportation. The risk assessment also characterizes the typical site-specific transportation scenarios and impacts not encompassed in the offsite analysis.

E.2.2 WASTE TYPE-SPECIFIC ALTERNATIVES

The transportation risk assessment conducted for the PEIS estimates the human health risks associated with transporting radioactive waste for a large number of alternatives. In general, the PEIS alternatives are considered independently for each waste type and reflect decentralized, regionalized, and centralized approaches. For each waste type, several options, referred to as "cases," have been defined for each broad alternative. The individual cases differ in the numbers, locations, and types of TSD facilities being considered.

For the offsite transportation risk assessment, each specific case is defined as a set of pairs (origin and destination) representing shipping linkages among generator, treatment, and disposal sites. The number of origin-and-destination pairs varies among cases, ranging from a small number of pairs for decentralized cases to many pairs for centralized ones. Examples of the linkages for shipment in two sample cases are shown in Figures E–1 and E–2. Figure E–1 represents a decentralized LLW case involving 12 disposal sites. The sites that would not have the capability for disposal ship their wastes to a site that does. Figure E–2 represents a LLW centralized disposal case in which all sites would dispose of their wastes at a single site. Chapter 3 of the PEIS contains detailed descriptions of the alternatives for each waste type. The alternatives are summarized in the following paragraphs.

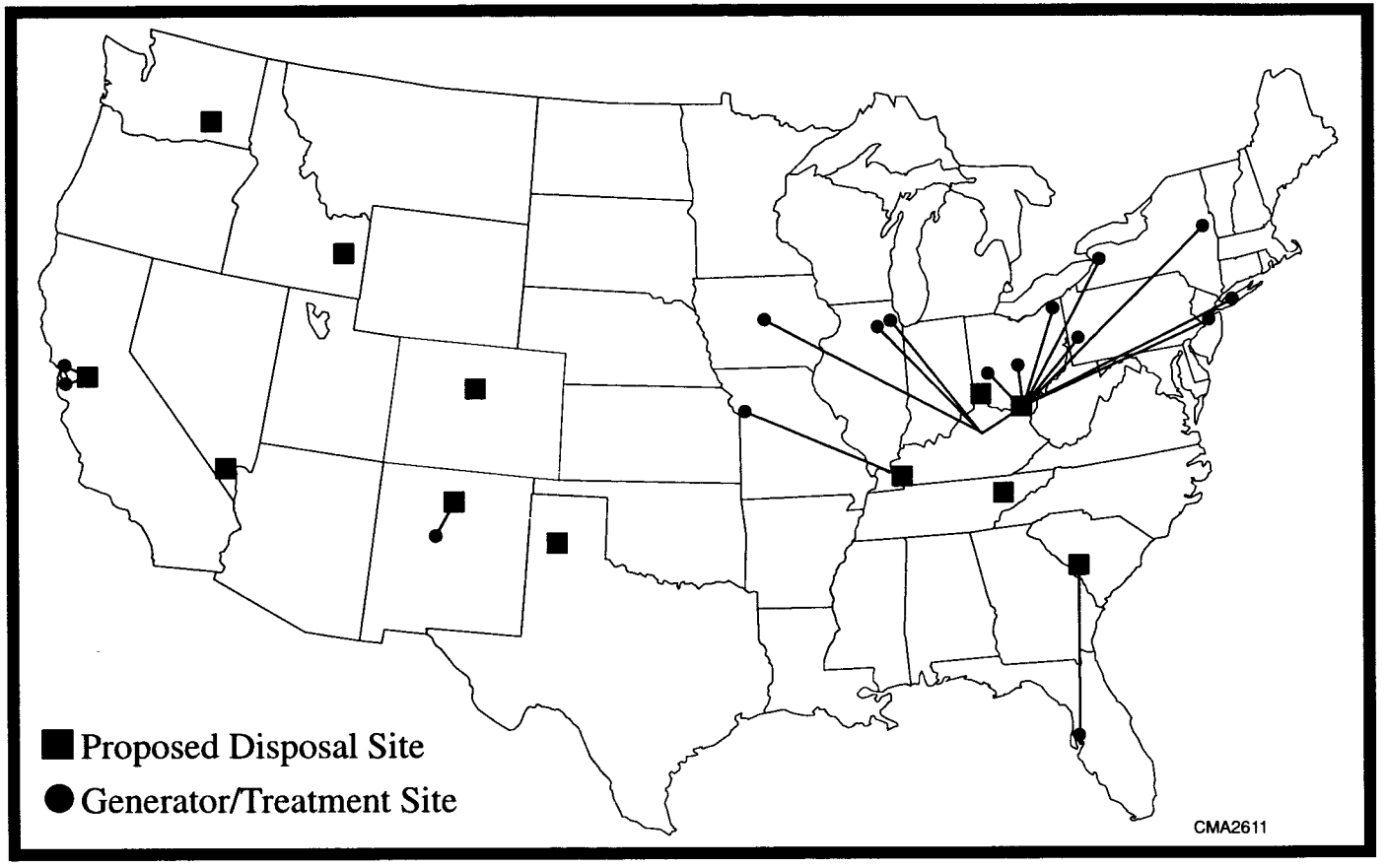

Figure E-1. Example of Shipping Linkages Among Generator, Treatment, and Disposal Sites for a LLW Decentralized Alternative.

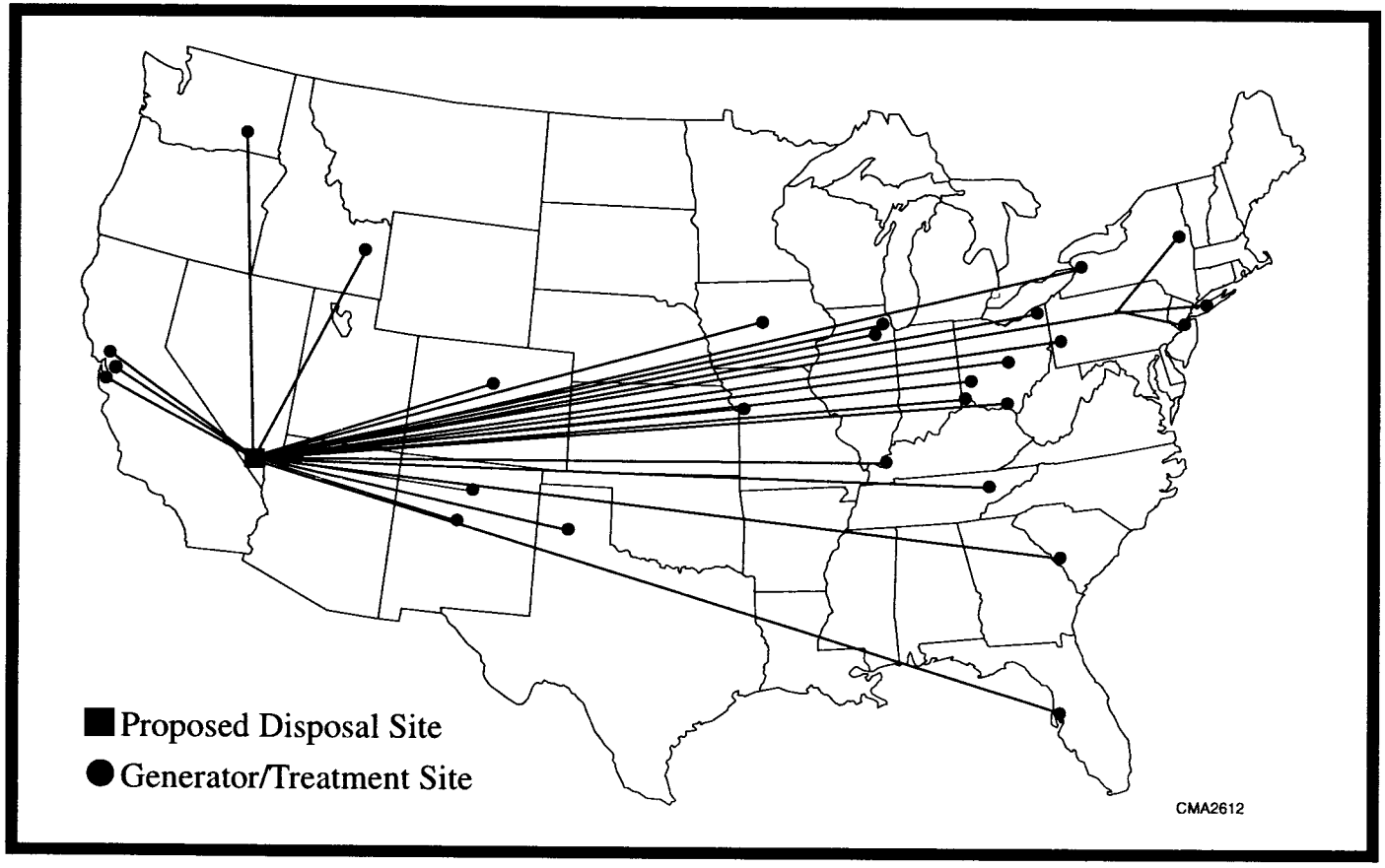

Figure E–2. Example of Shipping Linkages Among Generator, Treatment, and Disposal Sites for a LLW Centralized Alternative.

E.2.2.1 Alternatives for HLW

The generation, treatment, and management of HLW and the cases considered in the PEIS are described in detail in the HLW technical report (ANL, 1996g). In summary, canisters of vitrified HLW would be produced at the four DOE sites that have historically generated and currently store HLW and would be transported to a geologic repository for final disposal.

The analysis of HLW investigates storage options under the No Action, Decentralized, Regionalized, and Centralized Alternatives. For each of the latter three alternatives, two cases are analyzed. The first assumes the repository will open as scheduled in 2015, while the second case assumes the repository opens after 2015. The cases differ primarily in the location of interim canister storage before final disposal in a repository. For assessing the impacts of transportation, this PEIS assumes the repository to be located at the candidate site of Yucca Mountain in Nevada, which is the only site authorized by legislation for investigation. The alternatives are defined in Chapter 3 of the PEIS and are summarized as follows:

- *No Action.* Store HLW canisters on an interim basis at Hanford, the Savannah River Site (SRS), and the West Valley Demonstration Project (WVDP) in existing and approved interim storage facilities until acceptance of HLW canisters at a geologic repository. Store HLW at Idaho National Engineering Laboratory (INEL) in bin-sets as calcine or in tank farms as liquid HLW.
- *Decentralized.* Provide adequate interim HLW canister storage capacity at each of the four sites that would produce HLW canisters until acceptance of HLW canisters at a geologic repository.
- *Regionalized 1.* Transport HLW canisters from WVDP to SRS and provide adequate interim storage capacity for HLW canisters at Hanford, SRS, and INEL until acceptance of HLW canisters at a geologic repository.
- *Regionalized 2.* Transport the HLW canisters from WVDP to Hanford and provide adequate interim storage capacity for HLW canisters at Hanford, SRS, and INEL until acceptance of HLW canisters at a geologic repository.
- *Centralized.* Transport the HLW canisters from the WVDP, INEL and SRS to Hanford and provide adequate interim storage capacity for HLW canisters at Hanford until acceptance of HLW canisters at a geologic repository. Case 1 assumes the repository opens on time in the year 2015. Case 2 assumes the repository opens later and all HLW is stored temporarily at Hanford.

E.2.2.2 Alternatives for LLW

Transportation risks have been calculated for 14 LLW cases. The cases range from decentralized to centralized approaches to TSD. Case 1 represents the No Action Alternative. The number of disposal sites varies from 16 (decentralized disposal) to 1 (centralized disposal). Treatment options also vary from decentralized to centralized approaches. In general, sites without treatment or disposal capability would ship to the nearest site with such capability. The alternatives are defined in Chapter 3 of the PEIS and are summarized as follows:

- *No Action (Case 1).* All sites would treat LLW using existing, planned, and approved treatment facilities and dispose of LLW at the six current disposal sites in accordance with current arrangements.
- *Decentralized (Case 2).* All sites would minimally treat LLW, stabilizing fines and liquids, and dispose of LLW at 16 sites (Argonne National Laboratory-East [ANL-E], Brookhaven National Laboratory [BNL], Fernald Environmental Management Project [FEMP], Hanford, INEL, Lawrence Livermore National Laboratory [LLNL], Los Alamos National Laboratory [LANL], the Nevada Test Site [NTS], Oak Ridge Reservation [ORR], Paducah Gaseous Diffusion Plant [PGDP], Pantex Plant [Pantex], Portsmouth Gaseous Diffusion Plant [PORTS], Rocky Flats Environmental Technology Site [RFETS], Sandia National Laboratories-New Mexico [SNL-NM], SRS, and WVDP).
- *Regionalized 1 (Case 3).* All sites would minimally treat LLW, stabilizing fines and liquids, and dispose of LLW at 12 sites (Hanford, INEL, NTS, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS).
- *Regionalized 2 (Case 9).* Eleven Sites (Hanford, INEL, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS) would thermally treat, supercompact, reduce the size of, and grout volume-reducible waste; all sites would minimally treat other waste; disposal would occur at 12 sites (Hanford, INEL, NTS, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS).
- *Regionalized 3 (Case 4).* All sites would minimally treat LLW, stabilizing fines and liquids, and dispose of LLW at the nearest of six sites (Hanford, INEL, NTS, LANL, ORR, and SRS).
- *Regionalized 4 (Case 12).* Seven sites (Hanford, INEL, LANL, ORR, PORTS, RFETS, and SRS) would thermally treat, supercompact, reduce the size of, and grout volume-reducible waste; all sites would minimally treat other waste; disposal would occur at six sites (Hanford, INEL, NTS, LANL, ORR, and SRS).
- *Regionalized 5 (Case 19).* Four sites (Hanford, INEL, ORR, and SRS) would thermally treat, supercompact, reduce the size of, and grout volume-reducible waste; all sites would minimally treat other waste; disposal would occur at six sites (Hanford, INEL, NTS, LANL, ORR, and SRS).

- *Regionalized 6 (Case 5).* All sites would minimally treat LLW, stabilizing fines and liquids, and dispose of LLW at the nearer of two sites (Hanford and SRS).
- *Regionalized 7 (Case 6).* All sites would minimally treat LLW, stabilizing fines and liquids, and dispose of LLW at the nearer of two sites (NTS and SRS).
- *Centralized 1 (Case 7).* All sites would minimally treat LLW, stabilizing fines and liquids, and dispose of LLW at one site (Hanford).
- *Centralized 2 (Case 8).* All sites would minimally treat LLW, stabilizing fines and liquids, and dispose of LLW at one site (NTS).
- *Centralized 3 (Case 14).* Seven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, and RFETS) would thermally treat, supercompact, reduce the size of, and grout volume-reducible waste; all sites would minimally treat other waste; disposal would occur at one site (Hanford).
- *Centralized 4 (Case 14a).* Seven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, and RFETS) would thermally treat, supercompact, reduce the size of, and grout volume-reducible waste; all sites would minimally treat other waste; disposal would occur at one site (NTS).
- *Centralized 5 (Case 21).* One site (Hanford) would thermally treat, supercompact, reduce the size of, and grout volume-reducible waste; all sites would minimally treat other waste; disposal would occur at one site (Hanford).

E.2.2.3 Alternatives for TRUW

Transportation risks have been calculated for six TRUW alternatives. Each alternative is comprised of a case that deals with contact-handled TRUW (CH-TRUW) and a case that deals with remote-handled TRUW (RH-TRUW). The cases range from decentralized to centralized approaches to treatment and storage before final geologic disposal. In general, sites without treatment capability ship to the nearest site with such capability. The treatment options considered are (1) treatment that meets the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria (WAC); (2) treatment to reduce gas generation using shredding, grouting, and nonsteel containers, resulting in waste that exceeds current WIPP-WAC requirements but does not meet land disposal restrictions (LDRs); and, finally, (3) treatment to a level that meets or exceeds LDR requirements. The transportation assessment assumes that all TRUW will ultimately be shipped to WIPP for disposal. The alternatives are defined as follows:

- *No Action (CH-TRUW Case 1, RH-TRUW Case 10).* Continue storing CH-TRUW at ANL-E, Hanford, INEL, LANL, Lawrence Berkeley Laboratory (LBL), LLNL, Mound Plant (Mound), NTS, ORR, PGDP, RFETS, SNL, SRS, and WVDP in accordance with current practices. Storage of RH-TRUW

would continue at ANL-E, Hanford, INEL, LANL, and ORR in accordance with current practices. No transportation of waste is assumed.

- *Decentralized (CH-TRUW Case 4, RH-TRUW Case 11).* Ten sites (ANL-E, Hanford, INEL, LANL, LLNL, Mound, NTS, ORR, RFETS, and SRS) would treat CH-TRUW to meet the WIPP-WAC. Five sites (ANL-E, Hanford, INEL, LANL, and ORR) would treat RH-TRUW to WIPP-WAC. All treated TRUW would be disposed at WIPP.
- *Regionalized 1 (CH-TRUW Case 5, RH-TRUW Case 14).* Five sites (Hanford, INEL, LANL, RFETS, and SRS) would treat CH-TRUW to reduce gas generation. Two sites (Hanford and ORR) treat RH-TRUW to reduce gas generation. All treated TRUW would be disposed at WIPP.
- *Regionalized 2 (CH-TRUW Case 6, RH-TRUW Case 15).* Five sites (Hanford, INEL, LANL, RFETS, and SRS) would treat CH-TRUW to LDR levels. Two sites (Hanford and ORR) treat RH-TRUW to LDR levels. All treated TRUW would be disposed at WIPP.
- *Regionalized 3 (CH-TRUW Case 8, RH-TRUW Case 15).* Three sites (Hanford, INEL, and SRS) would treat CH-TRUW to LDR levels. Two sites (Hanford and ORR) treat RH-TRUW to LDR levels. All treated TRUW would be disposed at WIPP.
- *Centralized (CH-TRUW Case 9, RH-TRUW Case 15).* One site (WIPP) would treat CH-TRUW to LDR levels. Two sites (Hanford and ORR) treat RH-TRUW to LDR levels. All treated TRUW would be disposed at WIPP.

E.2.2.4 Alternatives for LLMW

Transportation risks have been calculated for seven LLMW alternatives. The alternatives range from decentralized to centralized approaches to TSD. The number of disposal sites varies from 16 sites to 1. Treatment options also vary from decentralized to centralized approaches. In general, sites without treatment or disposal capability ship to the nearest site with such capability. The alternatives are defined in Chapter 3 of the PEIS and are summarized as follows:

- *No Action* (Case 1). Treatment and indefinite storage of LLMW generated in the future. No transportation occurs.
- *Decentralized (Case 2a).* Forty-nine sites treat LLMW to LDR levels, and 16 sites dispose.
- *Regionalized 1 (Case 4).* Eleven sites treat LLMW, and 12 sites dispose.
- *Regionalized 2 (Case 7).* Seven sites treat LLMW, and 6 sites dispose.
- *Regionalized 3 (Case 10a).* Seven sites treat LLMW, and 1 site disposes (NTS).

- *Regionalized 4 (Case 15).* Four sites treat LLMW, and 6 sites dispose.
- *Centralized (Case 17).* One site treats LLMW (Hanford), and 1 site disposes (Hanford).

E.2.3 DESCRIPTION OF TRANSPORTATION ACTIVITIES

The transportation risk assessment determines transportation-related risks by considering the total amount of waste shipped over each route for each alternative. The assessment considers waste currently stored or generated over the next 20 years. The assessment takes into account differences in the quantity and properties of wastes at each site. In addition, characteristics of the routes between sites are considered. For onsite transportation, most solid radioactive waste at the Hanford Site is assumed to be initially shipped to a central waste complex, regardless of possible offsite shipment for treatment or disposal. Therefore, the onsite transportation risks presented here apply equally to all alternatives. The onsite assessment is not intended to be used as a basis for comparison among alternatives.

The transportation risk assessment is limited to estimating the human health risks incurred during the actual transportation of waste for each alternative. The risks to workers or to the public during the loading, unloading, and handling of waste before or after shipment are considered as part of normal facility operations and are not included in the transportation assessment. Similarly, the transportation risk assessment does not address how increased levels of transportation may affect local traffic flow, noise levels, logistics, or infrastructure.

E.2.4 CARGO-RELATED IMPACTS (RADIOLOGICAL)

The cargo-related impacts on human health during the transportation of radioactive materials would be caused by exposure to ionizing radiation. For all cases, radiological risks (risks resulting from the radioactive nature of the waste) are assessed for routine (normal) transportation and for accidents. The radiological risk associated with routine transportation results from the potential exposure of people to low levels of external radiation near a loaded shipment. The radiological risk from transportation-related accidents lies in the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people through multiple exposure pathways, such as exposure to contaminated soil, inhalation, or the ingestion of contaminated food.

All radiologically related impacts are calculated in terms of committed dose and associated health effects in the exposed populations. The dose of radiation calculated is the total effective dose equivalent (Title 10, Part 20, of the *Code of Federal Regulations* [10 CFR 20]), which is the sum of the effective dose equivalent from exposure to external radiation and the 50-year committed effective dose equivalent (ICRP, 1977) from exposure to internal radiation. Doses of radiation are calculated in units of roentgen equivalent man (rem) for individuals and in units of person-rem for collective populations.

The potential exposures to the public from transporting radioactive materials, either from routine operations or from postulated accidents, are usually at such a low dose that the primary adverse health effect is the potential induction of latent cancers (that is, cancers that occur years after the exposure). The correlation of radiation dose and human health effects for low doses has traditionally been based on what is called the "linear/no-threshold hypothesis," which has been described by various international authorities on protection against radiation. This hypothesis implies, in part, that even small doses of radiation have some cancer risk and that doubling the radiation dose means doubling the expected numbers of cancers. The types of cancer induced by radiation are similar to "naturally occurring" cancers and might be expressed at some point in the lifetime of the exposed individuals.

On the basis of the analyses presented in this appendix, transportation-related operations for all waste types are not expected to cause acute (short-term) radiation-induced fatalities or to produce immediately observable effects in exposed individuals. Acute radiation-induced fatalities occur at doses well in excess of 100 rem (ICRP, 1991), which generally would not occur for a wide range of transportation activities, including routine operations and accident conditions. (In general, individual acute whole-body doses in the range of 300 to 500 rem are expected to cause death in 50% of the exposed individuals within 30 to 60 days [ICRP, 1991].) For all severe accident scenarios analyzed, other short-term effects, such as temporary sterility and changes in blood chemistry, are not expected.

The radiological impacts discussed in this appendix are expressed as health risks in terms of the number of estimated latent cancer fatalities, the incidence of cancer, and the genetic effects in exposed populations for each alternative. The health risk conversion factors (expected latent health effects per dose absorbed) were derived from ICRP Publication 60 (ICRP, 1991).

E.2.5 VEHICLE-RELATED IMPACTS (NONRADIOLOGICAL)

In addition to the radiological risks posed by transportation-related activities, risks are also assessed for vehicle-related causes for the same routes for offsite transportation. These risks are independent of the radioactive nature of the cargo and would be incurred for similar shipments of any commodity. The vehicle-related risks are assessed for routine conditions and accidents. Vehicle-related risks during routine transportation are caused by potential exposure to increased vehicular exhaust emissions. The routine risks are primarily associated with travel in urban environments. The vehicle-related accident risk refers to the potential for transportation-related accidents that result in fatalities caused by physical trauma unrelated to the cargo. State-specific rates for transportation-related fatalities are used in the assessment. Vehicle-related risks are presented in terms of estimated fatalities for each alternative.

E.2.6 TRANSPORTATION MODES

Although radioactive waste can be transported by various modes, all shipments have been assumed to take place either by truck or rail. For each alternative, risks have been calculated separately for all truck and all rail options, although the actual shipping campaigns for a selected alternative may involve a combination of the two modes. Rail shipments are assumed to take place by regular freight train. Since the largest risk (fatalities) from rail transport is from the physical trauma due to accidents, the use of special or dedicated rail service would only reduce the overall risk by at most a factor of two for only those sites shipping enough waste to warrant dedicated shipment. Shipments by barge, though feasible for some sites, have not been explicitly considered because this mode of transportation is somewhat limited and has not been established as a major programmatic option for the PEIS assessment. Similarly, shipments by aircraft and other modes were not considered.

The assumption that waste would be shipped entirely by truck or entirely by rail has been made for calculational purposes. All DOE sites can ship waste by truck, but not all sites have readily available rail access. A review of the transportation facilities at 35 major DOE sites shows that 15 sites have onsite rail access: an additional 12 sites have access within 16 km (10 mi), and 8 more have access within 16 to 161 km (10 to 100 mi) of the site (Johnson, 1994). To ship by rail, sites that do not have direct rail access would likely ship waste by truck to the nearest rail siding, where the waste would be transferred to railcars. This type of shipment involving cargo transfer has not been considered in the risk assessment.

E.2.7 RECEPTORS

Transportation-related risks are calculated and presented separately for workers and members of the general public. The workers considered are truck and rail crew members involved in the actual transportation of waste. The public includes all persons who could be exposed to a shipment while it is moving or stopped en route. Potential risks are estimated for the collective populations of exposed people, as well as for maximally exposed individuals (MEIs). The collective population risk is a measure of the radiological risk posed to society as a whole by the alternative being considered. As such, the collective population risk is used as the primary means of comparing various alternatives.

E.3 Packaging and Representative Shipment Configurations for Radioactive Waste

Regulations that govern the transportation of radioactive materials are designed to protect the public from the potential loss or dispersal of radioactive materials, as well as from routine doses of radiation during transit. The primary regulatory approach for ensuring safety is by specifying standards for the packaging of radioactive materials.

Because packaging represents the primary barrier between the radioactive material being transported and exposure of the public and the environment to radiation, packaging requirements are an important consideration for the transportation risk assessment. Regulatory packaging requirements and the representative packaging and shipment configurations assumed for each type of radioactive waste considered in the PEIS are described in this section. The information about shipment configuration includes truck and railcar payload capacities for each waste type.

E.3.1 PACKAGING

Although several Federal and State organizations are involved in regulating the transportation of radioactive waste, the U.S. Department of Transportation (DOT) and the U.S. Nuclear Regulatory Commission (NRC) have primary regulatory responsibility. In addition, DOE has formalized agreements with the NRC and DOT to delineate responsibilities of each agency. All transportation- related activities must be in accordance with applicable regulations of these agencies specified in 49 CFR 173 and 10 CFR 71.

Packaging for transporting radioactive materials must be designed, constructed, and maintained to ensure that they will contain and shield their contents during normal transportation. For more highly radioactive material, the packaging must contain and shield their contents in severe accidents. The type of packaging used is determined by the radioactive hazard associated with the packaged material. The basic types of packaging required by the applicable regulations are designated as Type A, Type B, or "strong and tight" (generally for low specific-activity material).

Type A packaging must withstand the conditions of normal transportation without the loss or dispersal of the radioactive contents. "Normal" transportation refers to all transportation conditions except those resulting from accidents or sabotage. Approval of Type A packaging is achieved by demonstrating that the packaging can withstand specified testing conditions intended to simulate normal transportation. Type A packaging, typically a 0.21-m^3 (55-gallon [gal]) drum or standard waste box, is commonly used to transport wastes with low radioactivity levels. Type A packaging is routinely used in waste management for storage, transportation, and disposal. Type A packaging usually does not require special handling, packaging, or transportation equipment.

"Strong and tight" packagings may be used to transport certain low specific-activity materials (for example, mill tailings, uranium ore, natural uranium hexafluoride, and some LLW). Shipments of "strong and tight" packagings are excepted from certain packaging specifications and marking and labeling requirements but must still comply with many administrative controls. Functionally, "strong and tight" packagings are equivalent to Type A packaging because contents must not leak under normal transport conditions. Examples of "strong and tight" packages currently in use include steel drums, rectangular metal bins, and wooden boxes.

In addition to meeting the standards for Type A packaging, Type B packaging must provide a high degree of assurance that the package integrity will be maintained, even during severe accidents, with essentially no loss of the radioactive contents or serious impairment of the shielding capability. Type B packaging is required for shipping large quantities of radioactive material and must satisfy stringent testing criteria (specified in 10 CFR 71). The testing criteria were developed to simulate conditions of severe hypothetical accidents, including impact, puncture, fire, and immersion in water. The most widely recognized Type B packagings are the massive casks used for transporting highly radioactive spent nuclear fuel from nuclear power stations. Large-capacity cranes and mechanical lifting equipment are usually necessary for handling Type B packagings. Many Type B packagings are transported on trailers specifically designed for the package being used.

External radiation allowed to escape from a package must be below specified limits that minimize exposure of the handling personnel and the public. Most DOE waste shipments are handled only by the shipper and the receiver, an arrangement referred to as an "exclusive-use" shipment. For this type of shipment (regardless of the waste type or package), the dose rate for external radiation during normal transportation must be maintained below the following limits (49 CFR 173):

- Dose of 10 millirem per hour (mrem/h) at any point 2 m (6.6 ft) from the vertical planes projected by the outer lateral surfaces of the car or vehicle
- Dose of 2 mrem/h in any normally occupied position in the car or vehicle

Additional restrictions apply to radiation levels on the package surface; however, these restrictions do not affect the transportation-related radiological risk assessment. Representative external dose rates for each waste type are described in Section E.6.2.

For the purposes of risk assessment, specifying the actual package that will be used is unnecessary because all packagings of a certain type are designed to meet the same performance criteria; for instance, a 0.21-m^3 (55-gal) drum and a standard waste box, each designed to meet Type A packaging criteria, would be expected to behave similarly under routine transportation and accident conditions.

E.3.2 Representative Packaging and Shipment Configurations by Waste Type

To conduct the transportation risk assessment, assumptions must be made about the types of packaging, the transporting vehicles, and the shipment capacities used for future waste shipments. Certain assumptions, such as types of vehicles and their legal weight restrictions, are common to all waste types; however, the radiological and physical characteristics of waste types differ, so separate packaging assumptions must be made for each. In all cases, waste is assumed to be characterized, treated, packaged, and labeled in accordance with applicable regulations before shipment.

E.3.2.1 Offsite Transportation

For all waste types, transportation is assumed to be in certified or certified-equivalent packagings, and exclusive-use vehicles are assumed to be used. Legal-weight heavy-haul combination (tractor-trailer) trucks are assumed to be used for highway transportation. Typically, Type A packages are transported on common

flatbed or covered trailers; Type B packages are generally shipped on trailers designed specifically for the packaging being used. For transportation by truck, the maximum payload weight is considered to be 19,958 kg (44,000 lb), based on DOT highway weight limitations and an average tractor-trailer weight of 16,329 kg (36,000 lb).

Regular freight-train service is assumed for the rail transportation. The use of special or dedicated train service was not considered in the analysis. For rail transportation, average payload weights for boxcars range from 45,359 to 68,039 kg (100,000 to 150,000 lb). A median payload weight of 54,431 kg (120,000 lb) has been assumed for this assessment.

The above shipment capacities for truck and rail were assumed to be reasonable based on current practice. In reality, truck and rail shipment capacities vary from shipment to shipment at a given site, depending on the characteristics of the waste, operational practices, and site regulations. Because of the programmatic nature of the PEIS, representative shipment capacities were assumed for each waste type based on current practices. For truck shipments, payloads were taken to be near the regulatory weight limit because the density of most waste is such that volume tends not to be limiting, and it is common practice to load trucks near the legal weight limit for economical reasons. On the other hand, railcar capacities are seldom limited by the weight restrictions of the railcar and can vary over a wide range depending upon the density of the material. Therefore, a "median" railcar capacity of 54,431 kg (120,000 lb) was assumed for calculational purposes because railcar weights are not normally distributed. In addition, the total risk remains relatively unchanged if the size of each shipment is changed. If the maximum payloads are used, the number of shipments is minimized, resulting in the least number of potential accidents, although the consequences are higher. Conversely, smaller payloads require more shipments, resulting in more potential accidents, each of lessor consequence.

As discussed previously, the packaging type is determined primarily by radiological characteristics of the waste material. For the purposes of risk assessment, representative packagings have been determined for each type of radioactive waste on the basis of average waste characteristics and currently accepted practice. In practice, packagings are selected on a case-by-case basis and may differ from the representative types presented here. Assumptions about packaging and shipment are discussed in this section and are summarized in Table E–1.

Table E–1. Representative Packaging and Shipment Assumptions for Radioactive Waste Types

Waste	Packaging	Shipment Capacity[a]
HLW	Type B: similar to the defense HLW cask	Truck cask = 1 canister; rail cask = 5 canisters
LLW	Type A: 208-L (55-gal) drums or standard waste boxes or strong and tight packaging	Assumed to be limited by vehicular weight restrictions; payload capacity: truck = 19,958 kg (44,000 lb) and rail = 54,431 kg (120,000 lb)
TRUW	Type B	Assumed to be limited by package volume restrictions
	CH = TRUPACT-II	3 TRUPACT-IIs per truck and 6 per railcar; payload capacity: truck = 8.4 m^3 (11 yd^3) and rail = 16.8 m^3 (22 yd^3)
	RH = RH-72B	1 RH-72B per truck and 2 per railcar; payload capacity: truck = 0.89 m^3 (1.2 yd^3) and rail = 1.8 m^3 (2.4 yd^3)
LLMW	Type A: 208-L (55-gal) drums or standard waste boxes or strong and tight packaging	Similar to LLW

Notes: CH = contact-handled waste; RH = remote-handled waste.
[a] Truck shipments are assumed to be legal weight. Truck payload capacities were calculated by assuming a 36,287-kg (80,000-lb) gross vehicular weight limit and a tractor-trailer weight of 16,329 kg (36,000 lb). Rail shipments are by regular freight service. The median railcar payload capacity was taken to be 54,431 kg (120,000 lb).

E.3.2.1.1 *HLW Shipments*

Canisters of vitrified HLW are assumed to be shipped in a Type B package similar to the "defense HLW cask" being developed for SRS. The number of canisters to be transported in a cask differs for the truck and rail modes. The truck cask is assumed to accept one HLW canister, and rail capacity is assumed to be five canisters (DOE, 1987a). In the future, DOE will likely develop a multiple-canister HLW truck cask to minimize the number of shipments for major shipping campaigns; however, because a multiple-canister cask does not yet exist, impacts were calculated by assuming that a single-canister cask would be used. If a multiple-canister cask were designed and used in the future, risks would be significantly less than those in this analysis.

E.3.2.1.2 *LLW Shipments*

All LLW is assumed to be transported in strong and tight or Type A packaging, such as 208-L (55-gal) drums or standard waste boxes. Suitable Type A packagings are readily available from commercial sources. The number of shipments from a specific site is calculated by projecting site-specific information about waste inventory (weight) and limitations on shipment capacity for each transportation mode. The effects of potential waste treatment, such as volume reduction or incineration, are reflected in changes in waste density. All shipments are assumed to be at the maximum weight limits for truck and rail shipments. On the basis of typical LLW densities, roughly 80 drums with a 208-L (55-gal) capacity each would be shipped per truck, and 300 per railcar.

E.3.2.1.3 *TRUW Shipments*

The radiological characteristics of TRUW require the use of Type B packaging. The DOE has agreed to have the NRC certify the containers used for CH-TRUW and RH-TRUW shipments as meeting Type B specifications (DOE, 1990a). Shipments of TRUW will essentially consist of a number of Type A packages within reusable certified Type B packages. The Type B packages are assumed to be the TRUPACT-II for CH-TRUW and the RH-72B for RH-TRUW.

The TRUPACT-II was certified as meeting the NRC regulations for Type B packaging in August 1989 (DOE, 1990a). The container is a cylinder with a flat bottom and domed top that is transported in an upright position. Each TRUPACT-II is approximately 2.4 m (8 ft) in diameter and 3.1 m (10 ft) in height. The TRUPACT-II was designed to maximize payload in volume and in weight. The usable volume of each TRUPACT-II is approximately 2.8 m^3 (3.7 yd^3) . The payload capacity of each TRUPACT-II is 3,300 kg (7,275 lb). Three TRUPACT-IIs are assumed to be transported per truck, and six per railcar. The total number of required shipments has been calculated on the basis of waste volume, which is 8.4 m^3 (11 yd^3) for truck shipments and 16.8 m^3 (22 yd^3) for rail shipments.

The RH-72B shipping cask is assumed to be used for all RH-TRUW shipments. The RH-72B is being designed to meet Type B packaging specifications and is a scaled-down version of the certified NuPac 125B cask (DOE, 1990a). (The NuPac 125B was used to transport core debris from the damaged Three Mile Island nuclear power station to INEL.) The RH-72B cask is approximately 3.7 m (12 ft) long with a diameter of 1.1 m (3.5 ft). The usable volume of each RH-72B is approximately 0.89 m^3 (1.2 yd^3). The

payload capacity of each RH-72B is limited to 3,629 kg (8,000 lb). One RH-72B is assumed to be transported per truck, and two per railcar. The total number of required shipments has been calculated on the basis of waste volume, which is 0.89 m^3 (1.2 yd^3) for truck shipments and 1.8 m^3 (2.4 yd^3) for rail shipments.

E.3.2.1.4 *LLMW Shipments*

Shipment of LLMW is assumed to be similar to LLW. Shipments of LLMW would meet any additional requirements for characterization and labeling associated with the HW component. In addition, shipments of liquid waste would meet regulatory requirements specified for liquids; that is, packages would contain adequate absorbent material to absorb twice the volume of the transported liquid, or a leak-tight overpack would be used (10 CFR 71).

E.3.2.2 Onsite Transportation

The policy at the Hanford Site is to use certified packaging whenever practicable for transporting radioactive materials onsite (Mercado et al., 1992). Therefore, the packaging used for onsite transportation is assumed to be the same as that used for offsite transportation. If an alternative means of packaging is necessary, a concept of equivalent safety is maintained while achieving the same shipping results. Onsite transportation safety is attained through such measures as limiting vehicular speeds, appropriate traffic controls, or increasing shielding for crew members and distance from the package.

In addition, the public has access to a number of routes on the Hanford Site. Unless such routes are barricaded while radioactive waste is being transported, shipments must meet all pertinent Federal regulations pertaining to public highways. Stringent procedures are followed at the Hanford Site to ensure the safety of workers and the public, providing the same level of safety for onsite and offsite shipments (WHC, 1993).

E.4 Analysis of Truck and Rail Routing

As discussed previously and illustrated in Figures E–1 and E–2, each case can be defined as a set of origin-and-destination pairs representing shipping linkages among generator, treatment, and disposal sites. The calculation of the transportation risk for an alternative depends, in part, on the characteristics of the transportation routes between the origin and destination sites. Regulatory routing criteria and the methods used to determine conceptual truck and rail routes for the transportation risk assessment are described in this section.

E.4.1 Routing Regulations

The DOT routing regulations for public highways are prescribed in 49 CFR 177 (commonly referred to as HM-164). The objectives of the regulations are to reduce the impacts of transporting radioactive materials, to establish consistent and uniform requirements for route selection, and to identify the role of State and local governments in routing radioactive materials. The regulations attempt to reduce potential hazards by avoiding populous areas and by minimizing travel times. In addition, the regulations require that the carrier of radioactive materials ensure that the vehicle is operated on routes that minimize radiological risks, and that accident rates, transit times, population density and activity, time of day, and day of week are considered in determining risk.

A vehicle transporting a shipment of a "highway route controlled quantity" of radioactive materials is required by HM-164 to use the interstate highway system except when moving from origin to interstate or from interstate to destination, when making necessary repair or rest stops, or when emergency conditions make continued use of the interstate unsafe or impossible. Carriers are required to use interstate circumferential or bypass routes, if available, to avoid populous areas. Any State or Native American tribe may designate other "preferred highways" to replace or supplement the interstate system. Under its authority to regulate interstate transportation safety, DOT can prohibit State and local bans and restrictions as "undue restraint of interstate commerce." State or local bans can be preempted if inconsistent with HM-164.

The DOT has no railroad routing regulations specific to the transportation of radioactive materials. Routes are generally fixed by the location of rail lines, and urban areas cannot readily be bypassed.

E.4.2 REPRESENTATIVE TRANSPORTATION ROUTES

E.4.2.1 Offsite Transportation

The scope of this PEIS assessment involves every DOE site that generates, stores, or disposes radioactive waste. The transportation linkages among generator, treatment, and disposal sites depend on the type of waste and are defined explicitly for each case under consideration. For this PEIS, representative offsite truck and rail routes were determined for all possible pairs of origin and destination sites. Table E–2 gives the truck route distances between major DOE sites, and Table E–3 gives the rail route distances. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines; however, because the routes were determined for the purposes of risk assessment, they do not necessarily represent actual routes that would be used to transport waste in the future.

The conceptual truck routes were determined by using the routing model HIGHWAY 3.1 (Johnson et al., 1993a), and INTERLINE 5.0 was used to determine the rail routes (Johnson et al., 1993b). For truck and rail transportation, the route characteristics most important to the radiological risk assessment include the total shipping distance between each origin-and-destination pair and the fractions of travel in rural, suburban, and urban zones of population density. The route selected determines the total potentially exposed population along a route and the expected frequency of transportation-related accidents. Because of the large number of unique origin-and-destination pairs considered for the PEIS alternatives, detailed route characteristics are provided in the technical reports prepared for each waste type (ANL, 1996a,c-f).

E.4.2.1.1 *HIGHWAY 3.1*

The HIGHWAY 3.1 computer program is used for predicting highway routes for transporting radioactive materials by truck within the United States. The HIGHWAY database is a computerized road atlas that describes at least 386,243 km (240,000 mi) of roads. This database includes a complete description of the interstate highway system and of all U.S. highways. In addition, most principal State highways and many local and community highways are identified. The code is updated periodically to reflect current road conditions and has been compared with reported mileages and observations of commercial trucking firms.

Routes are calculated within the model by minimizing the total impedance between origin and destination. The impedance is basically defined as a function of distance and driving time along a particular segment

Table E–2. Truck Route Distances (mi) Between Major DOE Sites[a]

	Ames	ANL-E	ANL-W	BCL	Bettis	BNL	Fermi	FEMP	Hanford	INEL	ITRI	KCP	KAPL-S	LBL	LLNL	LANL	Mound	NRF
Ames	0	351	1287	675	894	1206	341	611	1703	1287	1129	234	1163	1844	1853	1136	644	1287
ANL-E	351	0	1582	348	567	874	36	294	1998	1582	1333	520	831	2139	2148	1431	317	1582
ANL-W	1287	1582	0	1906	2125	2437	1572	1842	599	0	1177	1325	2393	963	972	1144	1875	0
BCL	675	348	1906	0	223	653	380	113	2322	1906	1463	650	626	2463	2472	1552	72	1906
Bettis	894	567	2125	223	0	506	599	312	2541	2125	1682	869	543	2682	2691	1771	291	2125
BNL	1206	874	2437	653	506	0	906	760	2853	2437	2113	1299	241	2994	3003	2201	721	2437
Fermi	341	36	1572	380	599	906	0	326	1975	1572	1359	519	863	2129	2138	1421	349	1572
FEMP	611	294	1842	113	312	760	326	0	2258	1842	1399	586	733	2399	2408	1488	49	1842
Hanford	1703	1998	599	2322	2541	2853	1975	2258	0	599	1593	1741	2809	875	894	1560	2291	599
INEL	1287	1582	0	1906	2125	2437	1572	1842	599	0	1177	1325	2393	963	972	1144	1875	0
ITRI	1129	1333	1177	1463	1682	2113	1359	1399	1593	1177	0	895	2085	1194	1154	111	1432	1177
KCP	234	520	1325	650	869	1299	519	586	1741	1325	895	0	1272	1881	1890	984	619	1325
KAPL-S	1163	831	2393	626	543	241	863	733	2809	2393	2085	1272	0	2950	2959	2174	694	2393
LBL	1844	2139	963	2463	2682	2994	2129	2399	875	963	1194	1881	2950	0	45	1274	2432	963
LLNL	1853	2148	972	2472	2691	3003	2138	2408	894	972	1154	1890	2959	45	0	1233	2441	972
LANL	1136	1431	1144	1552	1771	2201	1421	1488	1560	1144	111	984	2174	1274	1233	0	1521	1144
Mound	644	317	1875	72	291	721	349	49	2291	1875	1432	619	694	2432	2441	1521	0	1875
NRF	1287	1582	0	1906	2125	2437	1572	1842	599	0	1177	1325	2393	963	972	1144	1875	0
NTS	1520	1815	712	2078	2297	2670	1805	2014	1128	712	918	1428	2626	719	678	997	2047	712
ORISE	887	571	2077	399	586	808	603	299	2493	2077	1420	752	872	2592	2551	1509	335	2077
ORR	900	584	2048	412	563	821	616	312	2464	2048	1391	723	885	2563	2523	1480	348	2048
PGDP	629	385	1766	477	696	1115	417	409	2182	1766	1230	441	1099	2322	2327	1319	441	1766
Pantex	834	1038	1468	1168	1387	1817	1064	1104	1884	1468	313	600	1790	1485	1445	402	1137	1468
Pinellas	1481	1204	2617	1065	1252	1329	1236	965	3033	2617	1959	1293	1393	2945	2904	2048	1001	2617
PORTS	755	428	1986	84	265	689	460	173	2402	1986	1543	730	688	2543	2552	1632	152	1986
PPPL	1217	822	2448	546	398	189	854	635	2864	2448	2006	1192	291	3005	3014	2094	614	2448
RMI	751	419	1982	214	175	531	451	321	2398	1982	1673	860	416	2538	2547	1762	282	1982
RFETS	722	1017	716	1283	1500	1870	1005	1217	1132	716	483	631	1827	1283	1292	452	1250	716
SNL-NM	1120	1324	1168	1454	1673	2103	1350	1390	1584	1168	9	886	2076	1185	1145	102	1423	1168
SNL-CA	1853	2148	972	2472	2691	3003	2138	2408	894	972	1154	1890	2959	45	0	1233	2441	972
SRS	1175	892	2311	720	656	897	924	620	2727	2311	1653	987	961	2791	2750	1742	656	2311
SLAC	1885	2180	1004	2524	2723	3035	2167	2440	916	1004	1198	1939	2979	47	64	1294	2473	1004
WVDP	909	577	2140	372	257	492	609	479	2556	2140	1832	1018	314	2697	2706	1921	440	2140
WIPP	1301	1505	1759	1625	1813	2192	1531	1526	2175	1759	614	1067	2256	1509	1468	693	1561	1759
YM	1554	1849	746	2112	2331	2704	1839	2048	1162	746	952	1462	2660	753	712	1031	2081	746

Table E-2. Truck Route Distances (mi) Between Major DOE Sites[a]—Continued

	NTS	ORISE	ORR	PGDP	Pantex	Pinellas	PORTS	PPPL	RMI	RFETS	SNL-NM	SNL-CA	SRS	SLAC	WVDP	WIPP	YM
Ames	1520	887	900	629	834	1481	755	1217	751	722	1120	1853	1175	1885	909	1301	1554
ANL-E	1815	571	584	385	1038	1204	428	822	419	1017	1324	2148	892	2180	577	1505	1849
ANL-W	712	2077	2048	1766	1468	2617	1986	2448	1982	716	1168	972	2311	1004	2140	1759	746
BCL	2078	399	412	477	1168	1065	84	546	214	1283	1454	2472	720	2524	372	1625	2112
Bettis	2297	586	563	696	1387	1252	265	398	175	1500	1673	2691	656	2723	257	1813	2331
BNL	2670	808	821	1115	1817	1329	689	189	531	1870	2103	3003	897	3035	492	2192	2704
Fermi	1805	603	616	417	1064	1236	460	854	451	1005	1350	2138	924	2167	609	1531	1839
FEMP	2014	299	312	409	1104	965	173	635	321	1217	1390	2408	620	2440	479	1526	2048
Hanford	1128	2493	2464	2182	1884	3033	2402	2864	2398	1132	1584	894	2727	916	2556	2175	1162
INEL	712	2077	2048	1766	1468	2617	1986	2448	1982	716	1168	972	2311	1004	2140	1759	746
ITRI	918	1420	1391	1230	313	1959	1543	2006	1673	483	9	1154	1653	1198	1832	614	952
KCP	1428	752	723	441	600	1293	730	1192	860	631	886	1890	987	1939	1018	1067	1462
KAPL	2626	872	885	1099	1790	1393	688	291	416	1827	2076	2959	961	2979	314	2256	2660
LBL	719	2592	2563	2322	1485	2945	2543	3005	2538	1283	1185	45	2791	47	2697	1509	753
LLNL	678	2551	2523	2327	1445	2904	2552	3014	2547	1292	1145	0	2750	64	2706	1468	712
LANL	997	1509	1480	1319	402	2048	1632	2094	1762	452	102	1233	1742	1294	1921	693	1031
Mound	2047	335	348	441	1137	1001	152	614	282	1250	1423	2441	656	2473	440	1561	2081
NRF	712	2077	2048	1766	1468	2617	1986	2448	1982	716	1168	972	2311	1004	2140	1759	746
NTS	0	2180	2151	1864	1209	2720	2158	2620	2214	836	909	678	2414	739	2373	1365	46
ORISE	2180	0	10	333	1125	692	358	702	595	1383	1411	2551	369	2584	753	1410	2214
ORR	2151	10	0	304	1096	685	371	715	608	1354	1382	2523	379	2584	766	1381	2185
PGDP	1864	333	304	0	940	874	0	1009	687	1072	1226	2327	568	2359	845	1258	1903
Pantex	1209	1125	1096	940	0	1664	1248	1710	1378	774	304	1445	1358	1506	1537	308	1243
Pinellas	2720	692	685	874	1664	0	1024	1152	1261	1924	1950	2904	620	2969	1419	1762	2754
PORTS	2158	358	371	0	1248	1024	0	588	276	1361	1534	2552	540	2584	434	1632	2192
PPPL	2620	702	715	1009	1710	1152	588	0	528	1823	1997	3014	767	3046	489	2086	2654
RMI	2214	595	608	687	1378	1261	276	528	0	1415	1664	2547	726	2579	162	1822	2248
RFETS	836	1383	1354	1072	774	1924	1361	1823	1415	0	474	1292	1618	1324	1573	1067	868
SNL-NM	909	1411	1382	1226	304	1950	1534	1997	1664	474	0	1145	1644	1198	1823	605	943
SNL-CA	678	2551	2523	2327	1445	2904	2552	3014	2547	1292	1145	0	2750	64	2706	1468	712
SRS	2414	369	379	568	1358	620	540	767	726	1618	1644	2750	0	2820	1023	1524	2448
SLAC	739	2584	2584	2359	1506	2969	2584	3046	2579	1324	1198	64	2820	0	2738	1529	773
WVDP	2373	753	766	845	1537	1419	434	489	162	1573	1823	2706	1023	2738	0	1980	2407
WIPP	1365	1410	1381	1258	308	1762	1632	2086	1822	1067	605	1468	1524	1529	1980	0	1399
YM	46	2214	2185	1903	1243	2754	2192	2654	2248	868	943	712	2448	773	2407	1399	0

Notes: Ames = Ames Laboratory; ANL-E = Argonne National Laboratory-East; ANL-W = Argonne National Laboratory-West; BCL = Battelle Columbus Laboratories; Bettis = Bettis Atomic Power Laboratory; BNL = Brookhaven National Laboratory; Fermi = Fermi National Accelerator Laboratory; FEMP = Fernald Environmental Management Project; Hanford = Hanford Site; INEL = Idaho National Engineering Laboratory; ITRI = Inhalation Toxicology Research Institute; KCP = Kansas City Plant; KAPL-S = Knolls Atomic Power Laboratory (Schenectady); LBL = Lawrence Berkeley Laboratory; LLNL = Lawrence Livermore National Laboratory; LANL = Los Alamos National Laboratory; Mound = Mound Plant; NRF = Naval Reactor Facility; NTS = Nevada Test Site; ORISE = Oak Ridge Institute for Science and Education; ORR = Oak Ridge Reservation; PGDP = Paducah Gaseous Diffusion Plant; Pantex = Pantex Plant; Pinellas = Pinellas Plant; PORTS = Portsmouth Gaseous Diffusion Plant; PPPL = Princeton Plasma Physics Laboratory; RMI = Reactive Metals, Inc.; RFETS = Rocky Flats Environmental Technology Site; SNL-NM = Sandia National Laboratories (New Mexico); SNL-CA = Sandia National Laboratories (California); SRS = Savannah River Site; SLAC = Stanford Linear Accelerator Center; WVDP = West Valley Demonstration Project; WIPP = Waste Isolation Pilot Plant; and YM = Yucca Mountain.

[a] Truck routes generated by using the HIGHWAY 3.1 routing model (Johnson et al., 1993a).

Table E–3. Rail Route Distances (mi) Between Major DOE Sites[a]

	Ames	ANL-E	ANL-W	BCL	Bettis	BNL	Fermi	FEMP	Hanford	INEL	ITRI	KCP	KAPL-S	LBL	LLNL	LANL	Mound	NRF
Ames	0	329	1242	700	823	1365	291	717	1788	1242	1187	275	1126	1873	2018	1124	715	1242
ANL-E	329	0	1655	401	518	1066	49	412	2201	1655	1351	439	827	2549	2506	1288	416	1655
ANL-W	1242	1655	0	1942	2133	2607	1533	1907	658	0	1247	1238	2468	1102	1100	1179	1926	0
BCL	700	401	1942	0	280	855	427	135	2488	1942	1759	753	615	2573	2718	1696	65	1942
Bettis	823	518	2133	280	0	772	543	475	2611	2133	1857	943	533	2696	2840	1794	345	2133
BNL	1365	1066	2607	855	772	0	1088	984	3153	2607	2414	1518	239	3238	3383	2351	920	2607
Fermi	291	49	1533	427	543	1088	0	441	1971	1533	1356	453	853	2343	2341	1405	443	1533
FEMP	717	412	1907	135	475	984	441	0	2505	1907	1751	717	745	2590	2735	1688	69	1907
Hanford	1788	2201	658	2488	2611	3153	1971	2505	0	658	1793	1784	2914	986	973	1725	2472	658
INEL	1242	1655	0	1942	2133	2607	1533	1907	658	0	1247	1238	2468	1102	1100	1179	1926	0
ITRI	1187	1351	1247	1759	1857	2414	1356	1751	1793	1247	0	932	2177	1266	1222	104	1767	1247
KCP	275	439	1238	753	943	1518	453	717	1784	1238	932	0	1250	2016	2013	869	708	1238
KAPL-S	1126	827	2468	615	533	239	853	745	2914	2468	2177	1250	0	2999	3144	2122	680	2468
LBL	1873	2549	1102	2573	2696	3238	2343	2590	986	1102	1266	2016	2999	0	46	1354	2717	1102
LLNL	2018	2506	1100	2718	2840	3383	2341	2735	973	1100	1222	2013	3144	46	0	1326	2695	1100
LANL	1124	1288	1179	1696	1794	2351	1405	1688	1725	1179	104	869	2122	1354	1326	0	1704	1179
Mound	715	416	1926	65	345	920	443	69	2472	1926	1767	708	680	2717	2695	1704	0	1926
NRF	1242	1655	0	1942	2133	2607	1533	1907	658	0	1247	1238	2468	1102	1100	1179	1926	0
NTS	1674	2348	756	2374	2496	3039	1997	2391	1302	756	1065	1670	2800	860	1370	1169	2386	756
ORISE	956	651	2099	366	714	1221	679	331	2644	2099	1989	881	981	2890	2868	1926	301	2099
ORR	954	649	2055	393	903	1152	682	358	2601	2055	1749	838	957	2686	2831	1686	328	2055
PGDP	646	390	1699	581	816	1346	469	468	2245	1699	1539	482	1106	2490	2469	1476	564	1699
Pantex	809	972	1141	1381	1479	2035	977	1373	1686	1141	379	554	1807	1561	1534	483	1396	1141
Pinellas	1623	1319	2721	1151	1293	1585	1344	1116	3267	2721	2079	1503	1390	3278	3491	2183	1086	2721
PORTS	727	422	1975	91	429	921	451	207	2515	1975	1761	758	681	2767	2745	1698	156	1975
PPPL	1197	898	2507	655	400	410	924	938	2985	2507	2248	1289	214	3298	3276	2186	719	2507
RMI	717	418	2060	207	136	648	445	337	2505	2060	1769	842	408	2851	2829	1706	272	2060
RFETS	782	1194	738	1502	1692	2266	1016	1466	1284	738	572	778	2027	1320	1394	504	1485	738
SNL-NM	1187	1351	1247	1759	1857	2414	1356	1751	1793	1247	0	932	2177	1266	1222	104	1767	1247
SNL-CA	2018	2506	1100	2718	2840	3383	2341	2735	973	1100	1222	2013	3144	46	0	1326	2695	1100
SRS	1281	976	2407	740	947	1239	1001	774	2953	2407	2315	1161	1044	3192	3183	2252	744	2407
SLAC	1924	2536	1160	2947	2746	3289	2393	2641	1036	1160	1253	2073	3050	56	60	1357	2930	1160
WVDP	881	579	2123	370	244	549	603	631	2669	2123	1929	1033	309	2773	2898	1866	562	2123
WIPP	1115	1279	1447	1688	1785	2342	1284	1679	1993	1447	477	861	2114	1660	1633	581	1703	1447
YM	1674	2348	756	2374	2496	3039	1997	2391	1302	756	1065	1670	2800	860	1370	1169	2386	756

Table E-3. Rail Route Distances (mi) Between Major DOE Sites[a]—Continued

	NTS	ORISE	ORR	PGDP	Pantex	Pinellas	PORTS	PPPL	RMI	RFETS	SNL-NM	SNL-CA	SRS	SLAC	WVDP	WIPP	YM
Ames	1674	956	954	646	809	1623	727	1197	717	782	1187	2018	1281	1924	881	1115	1674
ANL-E	2348	651	649	390	972	1319	422	898	418	1194	1351	2506	976	2536	579	1279	2348
ANL-W	756	2099	2055	1699	1141	2721	1975	2507	2060	738	1247	1100	2407	1160	2123	1447	756
BCL	2374	366	393	581	1381	1151	91	655	207	1502	1759	2718	740	2947	370	1688	2374
Bettis	2496	714	903	816	1479	1293	429	400	136	1692	1857	2840	947	2746	244	1785	2496
BNL	3039	1221	1152	1346	2035	1585	921	410	648	2266	2414	3383	1239	3289	549	2342	3039
Fermi	1997	679	682	469	977	1344	451	924	445	1016	1356	2341	1001	2393	603	1284	1997
FEMP	2391	331	358	468	1373	1116	207	938	337	1466	1751	2735	774	2641	631	1679	2391
Hanford	1302	2644	2601	2245	1686	3267	2515	2985	2505	1284	1793	973	2953	1036	2669	1993	1302
INEL	756	2099	2055	1699	1141	2721	1975	2507	2060	738	1247	1100	2407	1160	2123	1447	756
ITRI	1065	1989	1749	1539	379	2079	1761	2248	1769	572	0	1222	2315	1253	1929	477	1065
KCP	1670	881	838	482	554	1503	758	1289	842	778	932	2013	1161	2073	1033	861	1670
KAPL-S	2800	981	957	1106	1807	1390	681	214	408	2027	2177	3144	1044	3050	309	2114	2800
LBL	860	2890	2686	2490	1561	3278	2767	3298	2851	1320	1266	46	3192	56	2773	1660	860
LLNL	1370	2868	2831	2469	1534	3491	2745	3276	2829	1394	1222	0	3183	60	2898	1633	1370
LANL	1169	1926	1686	1476	483	2183	1698	2186	1706	504	104	1326	2252	1357	1866	581	1169
Mound	2386	301	328	564	1396	1086	156	719	272	1485	1767	2695	744	2930	562	1703	2386
NRF	756	2099	2055	1699	1141	2721	1975	2507	2060	738	1247	1100	2407	1160	2123	1447	756
NTS	0	2530	2487	2131	1376	3153	2401	2871	2391	987	1065	1370	2839	862	2554	1475	0
ORISE	2530	0	40	632	1611	786	392	1176	575	1658	1989	2868	443	3103	889	1918	2530
ORR	2487	40	0	527	1371	797	442	760	600	1586	1749	2831	417	3031	889	1678	2487
PGDP	2131	632	527	0	1103	1056	495	1145	698	1220	1539	2469	714	2597	861	1410	2131
Pantex	1376	1611	1371	1103	0	1825	1382	1867	1387	465	379	1534	1937	1564	1551	307	1376
Pinellas	3153	786	797	1056	1825	0	1106	1207	1361	2280	2079	3491	485	3280	1568	2019	3153
PORTS	2401	392	442	495	1382	1106	0	838	279	1535	1761	2745	655	2651	585	1689	2401
PPPL	2871	1176	760	1145	1867	1207	838	0	511	2066	2248	3276	848	3121	426	2185	2871
RMI	2391	575	600	698	1387	1361	279	511	0	1619	1769	2829	920	2641	163	1705	2391
RFETS	987	1658	1586	1220	465	2280	1535	2066	1619	0	572	1394	1938	1377	1782	769	987
SNL-NM	1065	1989	1749	1539	379	2079	1761	2248	1769	572	0	1222	2315	1253	1929	477	1065
SNL-CA	1370	2868	2831	2469	1534	3491	2745	3276	2829	1394	1222	0	3183	60	2898	1633	1370
SRS	2839	443	417	714	1937	485	655	848	920	1938	2315	3183	0	3194	1223	2243	2839
SLAC	862	3103	3031	2597	1564	3280	2651	3121	2641	1377	1253	60	3194	0	2804	1662	862
WVDP	2554	889	889	861	1551	1568	585	426	163	1782	1929	2898	1223	2804	0	1858	2540
WIPP	1475	1918	1678	1410	307	2019	1689	2185	1705	769	477	1633	2243	1662	1858	0	1475
YM	0	2530	2487	2131	1376	3153	2401	2871	2391	987	1065	1370	2839	862	2540	1475	0

Notes: Ames = Ames Laboratory; ANL-E = Argonne National Laboratory-East; ANL-W = Argonne National Laboratory-West; BCL = Battelle Columbus Laboratories; Bettis = Bettis Atomic Power Laboratory; BNL = Brookhaven National Laboratory; Fermi = Fermi National Accelerator Laboratory; FEMP = Fernald Environmental Management Project; Hanford = Hanford Site; INEL = Idaho National Engineering Laboratory; ITRI = Inhalation Toxicology Research Institute; KCP = Kansas City Plant; KAPL-S = Knolls Atomic Power Laboratory (Schenectady); LBL = Lawrence Berkeley Laboratory; LLNL = Lawrence Livermore National Laboratory; LANL = Los Alamos National Laboratory; Mound = Mound Plant; NRF = Naval Reactor Facility; NTS = Nevada Test Site; ORISE = Oak Ridge Institute for Science and Education; ORR = Oak Ridge Reservation; PGDP = Paducah Gaseous Diffusion Plant; Pantex = Pantex Plant; Pinellas = Pinellas Plant; PORTS = Portsmouth Gaseous Diffusion Plant; PPPL = Princeton Plasma Physics Laboratory; RMI = Reactive Metals, Inc.; RFETS = Rocky Flats Environmental Technology Site; SNL-NM = Sandia National Laboratories (New Mexico); SNL-CA = Sandia National Laboratories (California); SRS = Savannah River Site; SLAC = Stanford Linear Accelerator Center; WVDP = West Valley Demonstration Project; WIPP = Waste Isolation Pilot Plant; and YM = Yucca Mountain.

[a] Rail routes generated by using the INTERLINE 5.0 routing model (Johnson et al., 1993b).

of highway. A special feature of the HIGHWAY 3.1 model is its ability to calculate routes that maximize the use of interstate highways. This feature allows the user to predict routes for shipping radioactive materials that conform to DOT transportation regulations, specifically HM-164. The population densities along a route are derived from 1990 census data from the U.S. Bureau of the Census. Rural, suburban, and urban areas are characterized according to the following breakdown: rural population densities range from 0 to 54 persons/km^2 (0 to 39 persons/mi^2); the suburban range is 55 to 1,284/km^2 (140 to 3,326/mi^2); and urban covers all population densities greater than 1,284/km^2 (3,326/mi^2).

E.4.2.1.2 *INTERLINE 5.0*

The INTERLINE 5.0 computer program is designed to simulate routing of the U.S. rail system. The INTERLINE database consists of 94 separate subnetworks and represents various competing rail companies in the United States. The database used by INTERLINE was originally based on data from the Federal Railroad Administration and reflected the U.S. railroad system in 1974. The database has been expanded and modified over the past two decades. The code is updated periodically to reflect current track conditions and has been compared with reported mileages and observations of commercial rail firms.

The INTERLINE 5.0 model uses a shortest route algorithm that finds the path of minimum impedance within an individual subnetwork. A separate method is used to find paths along the subnetworks. The routes chosen for this study used the standard assumptions in the INTERLINE model that simulate the process of selection that railroads would use to direct shipments of radioactive waste. For sites that do not have direct rail access, the rail siding nearest the site was used for routing. The population densities along a route are derived from 1990 census data. Rural, suburban, and urban areas are characterized according to the following breakdown: rural population densities range from 0 to 54 persons/km^2 (0 to 139/mi^2); the suburban range for population density is 55 to 1,284/km^2 (140 to 3,326/mi^2); and urban covers all population densities greater than 1,284/km^2 (3,326/mi^2).

E.4.2.2 Onsite Transportation

Most radioactive waste at the Hanford Site is shipped by truck. The routes for onsite transportation used for this analysis are typical of those used for shipping radioactive waste onsite at the Hanford Site (DOE, 1989). Because the Hanford Site maintains an extensive onsite railroad network, consideration of rail

transport was included to maintain consistency with the analyses of offsite transportation. Rail routes were chosen to minimize distance traveled.

E.5 Methods for Calculating Transportation-Related Risks

The technical approach for conducting the transportation risk assessment was developed after a thorough and critical review of the literature and existing documentation in the National Environmental Policy Act for Federal actions involving transportation of radioactive materials. Consideration was also given to recent DOE commitments arising from litigation and public awareness. The approach selected uses several computer models and databases to determine risks for each case. The method for offsite assessment is discussed in Section E.5.1; the method for onsite assessment is discussed in Section E.5.2.

E.5.1 Offsite Transportation

The approach for offsite transportation risk assessment is summarized in Figure E–3 and discussed in detail in this section. For each case, risks are assessed for routine transportation and accidents. For the routine assessment, risks are calculated for the collective populations of potentially exposed individuals, as well as for the MEIs. The accident assessment consists of two components: (1) an accident risk assessment, which considers the probabilities and consequences of a range of possible transportation-related accidents, including low-probability accidents that have high consequences, and high-probability accidents that have low consequences; and (2) an accident consequence assessment, which considers only the radiological consequences of the severe transportation-related accidents that are postulated to result in the largest releases of radioactive material.

The RADTRAN 4 computer code (Neuhauser and Kanipe, 1993) is used for routine and accident risk assessments to estimate the impacts to collective populations. RADTRAN 4 was developed by SNL-NM to calculate population risks associated with transporting radioactive materials by various means, including truck, rail, air, ship, and barge. The code has been extensively reviewed, updated, and used for transportation risk assessments since it was issued in the late 1970s.

The RADTRAN 4 calculations of population risk take into account the consequences and the probabilities of potential exposures. The collective population risk is a measure of the total radiological risk posed to

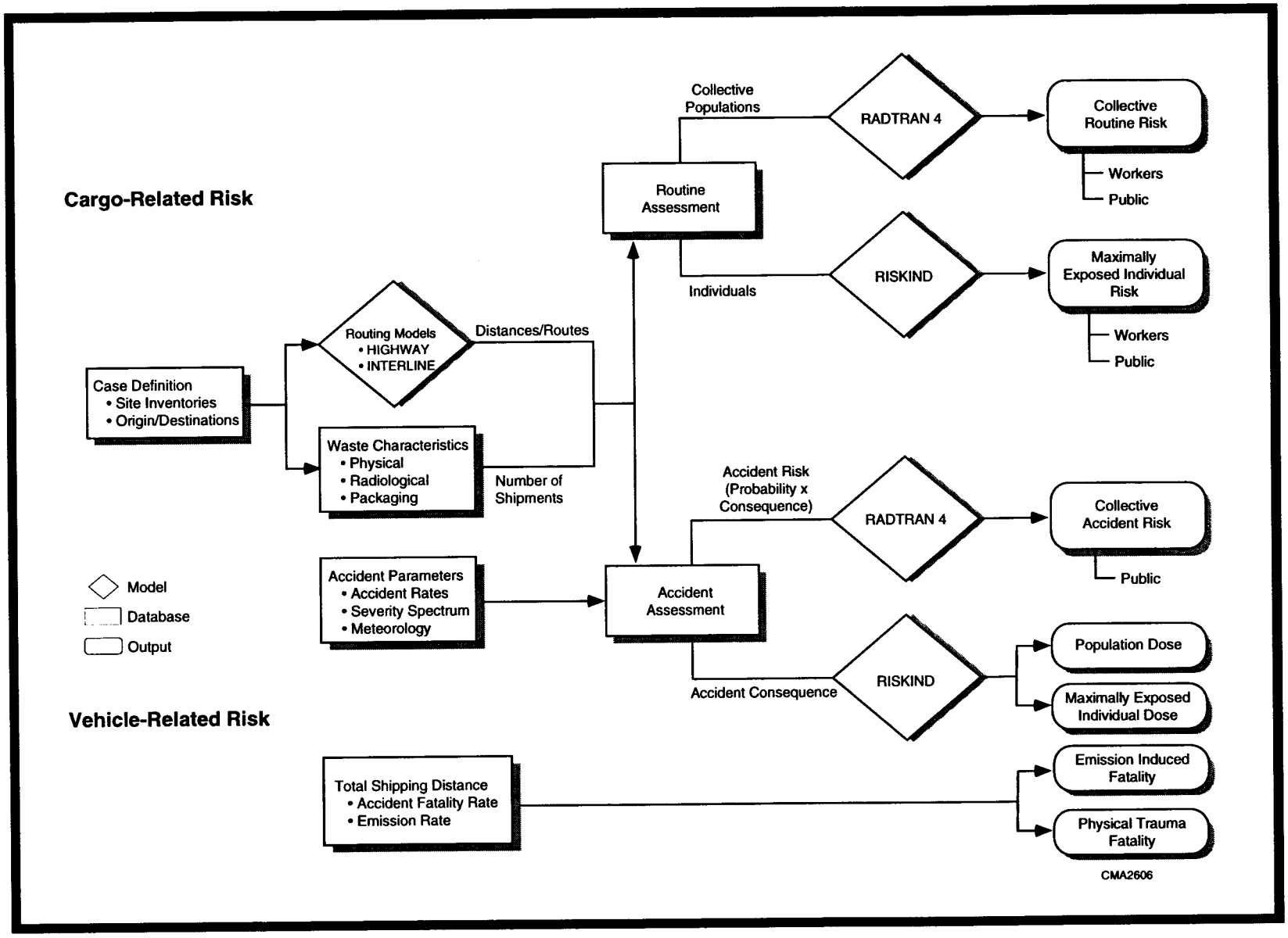

Figure E–3. Approach for the Offsite Transportation Radiological Risk Assessment.

society as a whole by the alternative being considered. The collective population risks are used as the primary means of comparing the various alternatives.

As a complement to the RADTRAN calculations, the RISKIND computer code (Yuan et al., 1993) is used to estimate scenario-specific doses to MEIs for routine operations and accidents and to estimate population impacts for the accident consequence assessment. The RISKIND computer code was developed for the DOE Office of Civilian Radioactive Waste Management specifically to analyze radiological consequences to individuals and population subgroups associated with transporting spent nuclear fuel. Minor modifications to the code were made for WM PEIS applications to accommodate shipments of all types of radioactive waste.

The RISKIND calculations are conducted for the WM PEIS to supplement the results for collective risk calculated with RADTRAN 4. Whereas the results for collective risk provide a measure of the overall risks of each case, the RISKIND calculations are meant to address areas of specific concern to individuals and subgroups of population. Essentially, the RISKIND analyses are meant to address hypothetical questions, such as, "What if I live next to a site access road?" or "What if an accident happens near my town?"

E.5.1.1 Routine (Incident-Free) Risk Assessment Method

E.5.1.1.1 *Collective Population Risk*

The radiological risk associated with routine transportation results from the potential exposure of people to low-level external radiation from loaded shipments. The maximum allowable external dose rates for exclusive-use shipments were presented in Section E.3.1.

For routine transportation, the RADTRAN 4 computer code considers all major groups of potentially exposed persons. The RADTRAN 4 calculations of risk for routine highway and rail transportation include exposures of the following population groups:

- *Persons Along the Route (Off-Link Population).* Collective doses are calculated for all persons living or working within 0.8 km (0.5 mi) on each side of a transportation route. The total number of persons within the 1.6-km (1-mi) corridor is calculated separately for each route considered in the assessment.

- *Persons Sharing the Route (On-Link Population)*. Collective doses are calculated for persons in all vehicles sharing the transportation route. This group includes persons traveling in the same or the opposite direction as the shipment, as well as persons in vehicles passing the shipment.
- *Persons at Stops*. Collective doses are calculated for people who may be exposed while a shipment is stopped en route. For truck transportation, these include stops for refueling, food, and rest. For rail transportation, stops are assumed to occur for purposes of classification.
- *Crew Members*. Collective doses are calculated for truck and rail transportation crew members.

The doses calculated for the first three population groups are added generically to yield the collective dose to the public; the dose calculated for the fourth group represents the collective dose to workers. The RADTRAN 4 models for routine dose are not intended to be used for estimating specific risks to individuals.

The RADTRAN 4 calculations for routine dose are based on generically expressing the dose rate as a function of distance from a point source (Neuhauser and Kanipe, 1993). Associated with the calculation of routine doses for each exposed population group are parameters such as the radiation field strength, source-receptor distance, duration of exposure, vehicular speed, stopping time, traffic density, and route characteristics such as population density. The RADTRAN manual contains derivations of the equations and descriptions of these parameters (Neuhauser and Kanipe, 1993). The values for many of the most important parameters are presented in Section E.6.

The collective routine risks are calculated for each specific alternative as follows. Each alternative is first defined as a set of origin-and-destination pairs. Representative highway and rail routes are determined for each unique pair, as described in Section E.4. The number of shipments transported across each linkage is then calculated for truck and rail modes by using estimated site-specific waste inventories and information on shipment capacity, which is in Section E.3. For shipments between each origin-and-destination pair, RADTRAN 4 is used to calculate collective risks to workers and the public on the basis of representative radiological and physical properties of the waste type being considered. The collective risks are then summed over the set of origin-destination pairs to estimate the collective routine risks associated with that case.

E.5.1.1.2 *Maximally Exposed Individual Risk*

In addition to assessing the routine collective population risk, the RISKIND model has been used to estimate risk to MEIs for a number of hypothetical exposure scenarios. The receptors include transportation crew members, departure inspectors, and members of the public exposed during traffic delays, while working at a service station, or while living near a DOE site.

The dose to each MEI considered is calculated with RISKIND for an exposure scenario defined by a given distance, duration, and frequency of exposure specific to that receptor. The distances and durations of exposure are similar to those given in previous transportation risk assessments (DOE, 1987b; DOE, 1990a) and are presented in Section E.6. The scenarios are not intended to be exhaustive but were selected to provide a range of potential exposure situations.

The RISKIND external dose model considers direct external exposure and exposure from radiation scattered from the soil and air. The RISKIND model is used to calculate dose as a function of distance (millirems per hour) for stationary exposures and millirems per event (for moving shipments) from a waste shipment on the basis of the shipment dimensions. The code approximates the shipment as a cylindrical volume source; and the calculated dose includes secondary radiation-scattering contributions from buildup (scattering by waste contents), cloudshine (scattering by air), and groundshine (scattering by the ground). The dose rates calculated by using RISKIND have been shown to be comparable with output from existing shielding codes for various waste configurations. The RISKIND model produces realistic but conservative results. As a conservative measure, credit for potential shielding between the cask and the receptor is not considered, although RISKIND allows for shielding provisions.

E.5.1.1.3 *Vehicle-Related (Nonradiological) Routine Risk*

Vehicle-related health risks resulting from routine transportation may be associated with the transporting vehicles that generate air pollutants during waste shipment, independent of the nature of the shipment. The health endpoint assessed under routine transport conditions is the excess (additional) latent mortality caused by inhalation of vehicular exhaust emissions. A risk factor for latent mortality from pollutant inhalation, generated by Rao et al. (1982), is 1×10^{-7}/km (1.6×10^{-7}/mi) of truck travel in an urban area (1.3×10^{-7}/railcar-km for rail). This risk factor is based on regression analyses of the effect of sulfur dioxide and particulate releases from diesel exhaust on mortality. Excess latent mortality is assumed to be equivalent

to cancer fatalities. Vehicle-related risks from routine transportation are calculated for each case by multiplying the total distance traveled in urban areas by the appropriate risk factor. Similar risk factors are not available for rural and suburban areas.

Risks are summed over the entire route and over all shipments for each alternative. This method has been used in several reports to calculate risks from routine transport of radioactive wastes (DOE, 1986b, 1987a, 1990a) and provides a convenient method of comparing the risks of routine transport for HW shipment alternatives and the risks of HW versus radioactive waste shipments under routine conditions. Lack of information for rural and suburban areas is an obvious gap in the data, although the risk factor would presumably be lower because total emissions from all sources in rural and suburban areas are lower.

E.5.1.2 Accident Assessment Method

E.5.1.2.1 *Radiological Accident Risk Assessment*

The risk analysis for potential accidents differs fundamentally from the risk analysis for routine transportation because occurrences of accidents are statistical. The accident risk assessment is treated probabilistically in RADTRAN 4. Accident risk is defined as the product of the accident consequence (dose) and the probability of the accident occurring. In this respect, the RADTRAN 4 code estimates the collective accident risk to populations by considering a spectrum of transportation-related accidents. The spectrum of accidents is designed to encompass a range of possible accidents, including low-probability accidents with high consequences and high-probability accidents with low consequences ("fender benders"). The results for collective accident risk can be directly compared with the results for routine collective risk because the former results incorporate the probabilities of accident occurrences.

The RADTRAN 4 calculation of collective accident risk employs models that quantify the range of potential accident severities and the responses of transported packages to accidents. The spectrum of accident severity is divided into a number of categories. Each category of severity is assigned a conditional probability of occurrence—that is, the probability that an accident will be of a particular severity if an accident occurs. The more severe the accident, the more remote the chance of such an accident. Release fractions, defined as the fraction of the material in a package that could be released in an accident, are assigned to each accident severity category on the basis of the physical and chemical form of the waste material. The models

take into account the transportation mode and the packaging type being considered. The accident rates, the definition of accident severity categories, and the release fractions used in this analysis are discussed further in Section E.6.

For accidents involving the release of radioactive material, RADTRAN 4 assumes that the material is dispersed into the environment according to standard Gaussian diffusion models. For the risk assessment, default data for atmospheric dispersion were used, representing an instantaneous ground-level release and a small-diameter source cloud (Neuhauser and Kanipe, 1993). The calculation of the collective population dose after the release and dispersal of radioactive material includes the following exposure pathways:

- External exposure to the passing radioactive cloud
- External exposure to contaminated soil
- Internal exposure from inhaling airborne contaminants
- Internal exposure from ingesting contaminated food

For the pathway of ingestion, State-specific food transfer factors, which relate the amount of radioactive material ingested to the amount deposited on the ground, were calculated in accordance with the methods described by NRC Regulatory Guide 1.109 (NRC, 1977b) and were used as input to the RADTRAN code. Doses of radiation from ingesting or inhaling radionuclides are calculated with standard dose conversion factors (DOE, 1988a-b).

The collective accident risk for each case is determined in a manner similar to that described for routine collective risks. Accident risks are first calculated for each unique origin-and-destination pair and then are summed over all pairs to estimate the total risk for the case. The accident risk assessment uses site-specific and waste type-specific radiological and physical waste characteristics, which are described further in Section E.6. In addition, the assessment uses route-specific information and accident rates derived for individual States.

E.5.1.2.2 *Radiological Accident Consequence Assessment*

The RISKIND code is used to provide a scenario-specific assessment of radiological consequences of severe transportation-related accidents for each waste type. The RADTRAN 4 accident risk assessment considers the entire range of accident severities and their related probabilities, whereas the RISKIND accident

consequence assessment focuses on accidents that result in the largest releases of radioactive material to the environment.

For each waste type, accident consequences are presented for a shipment of waste that represents the highest potential radiological risk if an accident occurs. This "maximum reasonably foreseeable accident" is identified for each waste type by screening the site-specific radiological waste characteristics (that is, activity concentrations) developed for this PEIS, taking into account the physical forms of waste and the relative hazards of individual radionuclides. For most waste shipments, the consequences of severe accidents would be less than those presented for the maximum reasonably foreseeable case. The accident consequence assessment is intended to provide an estimate of the maximum potential impacts posed by a severe transportation-related accident involving a particular waste type.

The severe accidents considered in the consequence assessment are characterized by extreme mechanical and thermal forces. In all cases, these accidents result in a release of radioactive material to the environment. The accidents correspond to those within the highest accident severity category, as described previously. These accidents represent low-probability high-consequence events. Therefore, accidents of this severity are expected to be extremely rare. However, the overall probability that such an accident could occur is dependent upon the potential accident rates for this severity category and the shipping distance for each case.

The RISKIND model was used to assess accident consequences for two reasons. First, its code can model the complex atmospheric (or site-specific) dispersion from severe accidents. The atmospheric dispersion is modeled as an instantaneous release by using standard Gaussian puff methods. In addition, because severe accidents routinely involve fires, modeling the potential radiological consequences takes into account physical phenomena resulting from the fire, such as buoyant plume rise. Second, RISKIND can estimate the dose to MEIs near an accident. RISKIND is used to determine the MEI's location on the basis of the atmospheric conditions assumed at the time of the accident and the thermal characteristics of the release.

For each waste type, the accident consequences are calculated for local populations and for MEIs. The population dose includes the population within 80 km (50 mi) of the accident site. The exposure pathways considered are similar to those discussed previously for the accident risk assessment. Although remedial activities after the accident (for example, evacuation or ground cleanup) would reduce the consequences, these activities were not considered in the consequence assessment.

Because predicting the exact location of a severe transportation-related accident is impossible, separate consequences are calculated for accidents occurring in rural, suburban, and urban zones of population density. Moreover, to address the effects of the atmospheric conditions existing at the time of an accident, two different atmospheric conditions are considered. The first case assumes neutral atmospheric conditions, and the second assumes stable conditions. Atmospheric conditions are discussed further in Section E.6.

E.5.1.2.3 *Vehicle-Related (Nonradiological) Accident Risk Assessment*

The vehicle-related accident risk refers to the potential for transportation-related accidents that directly result in fatalities that are not related to the shipment's cargo. This risk represents fatalities from mechanical causes. State-specific transportation fatality rates are used in the assessment and are discussed in Section E.6. Vehicle-related accident risks are calculated for each case by multiplying the total distance traveled in each State by the appropriate State rate for transportation-related fatalities. In all cases, the vehicle-related accident risks are calculated by using distances for round-trip shipment.

E.5.2 ONSITE TRANSPORTATION

The RISKIND computer code was used to calculate the routine and accident doses to MEIs and to collective onsite populations from onsite transportation at the Hanford Site. The RISKIND code allows for extensive use of site-specific data. Sitewide characteristics, such as weather data, nonuniform population densities, and surrounding agricultural productivity, are variable input parameters. In addition, the characteristics of receptors, such as shielding, intake rates, and location relative to the shipping route, can be specified.

E.5.2.1 Routine (Incident-Free) Risk Assessment Method

For routine conditions, RISKIND is used to calculate the dose and risk to specific individuals distinguished by their location relative to a shipment when it is stationary or moving. As a conservative assumption, potential shielding between the waste shipments and the receptor is not considered.

The following four groups of receptors are considered for the onsite routine risk assessment:

- Truck and rail crew members (crew dose)
- Workers near the transportation route (off-link worker population dose)

- Persons sharing the transportation route (on-link dose)
- Guards at the gates of individual facilities or at checkpoints along the route

The dose to the crew members is calculated by multiplying the distance traveled times the dose per kilometer calculated by RADTRAN 4 at the crew compartment. The dose rate in the crew compartment is limited to a value of 2 mrem/h by Federal regulations. RADTRAN 4 was used for estimating the dose to the crew to retain consistency with the offsite transportation assessment.

Onsite workers at the Hanford Site are located within well-defined facilities or work areas. All areas within 0.8 km (0.5 mi) on each side of the route were considered. RISKIND was used to calculate the population dose to each affected area by specifying the minimum distance from the route, the maximum distance from the route, and the average population density of that specific work area. The dose for each area was calculated while the shipment was immediately next to the area.

RISKIND was used to calculate the dose to individuals sharing the truck transportation route with waste shipments on the basis of the average vehicular occupancy and speed, road type, and one-way traffic densities. Members of the public, as well as workers, receive this dose because a section of a principal onsite route is over public-access roadways. No on-link dose was calculated for rail transportation because the tracks at the Hanford Site are used exclusively by Hanford; no parallel sets of tracks exist over the route.

For truck routes, the guard at the boundary of the shipping facility or the one at the checkpoint along the route is potentially the closest individual to the shipment outside of the loading facilities. This dose was calculated directly by using RISKIND.

E.5.2.2 Accident Consequence Assessment Method

For each waste type, the radiological accident consequences of the onsite transportation and its attendant health risks were calculated. The probabilities for onsite transportation accidents at Hanford Site (Wang et al., 1991) were used to estimate the likelihood of potential accidents and the associated maximum credible radioactive release for each waste type.

Doses to an MEI and to onsite and offsite populations are calculated by using RISKIND and parameters specific to Hanford. Doses include contributions from inhalation, cloudshine, and groundshine; no pathway for food ingestion has been considered for MEIs or for onsite worker populations. The food-ingestion pathway was considered only for offsite rural populations.

E.6 Input Parameters and Assumptions

The transportation risk assessment is designed to ensure—through uniform and judicious selection of models, data, and assumptions—that relative comparisons of risk among the various alternatives are meaningful. This goal is accomplished by uniformly applying to all alternatives the input parameters and assumptions common to each waste type. The principal input parameters and assumptions used in the transportation risk assessment are discussed in this section.

E.6.1 Waste Inventory and Characterization Data

The computational model WASTE_MGMT was developed at ANL-E to support the PEIS analyses of risks and costs (ANL, 1996l). Input to the model includes data on the waste inventory and on waste characterization at each DOE site, data on operations for the TSD facilities used for the wastes, and definitions of various alternatives. The sources and development of the model input data are described in the supporting technical reports specific to each waste type (ANL, 1996g-k).

One output of the model consists of the quantity, physical form, and radiological characteristics of the waste shipped between sites for each case. Table E–4 shows an example of output for an LLW case. The output presents part of a waste transportation data file that includes, for each origin- and-destination pair, the total quantity of waste shipped (both volume and mass), as well as the total activity (curies) of radionuclides in the waste being shipped. The effects of potential waste treatment, such as volume reduction or incineration, are considered in the model and are reflected in changes in waste density and activity concentrations. The WASTE_MGMT output files are used directly as input to the transportation risk assessment.

For each waste type, the physical forms of the waste are generally classified into a small number of categories, such as vitrified waste, liquid waste, metal waste, and heterogeneous solid waste. The package release fractions are developed according to the physical characteristics of the waste in each category.

Table E-4. Example of a Partial Argonne National Laboratory WASTE_MGMT Computational Model Output File Used as Input for the Transportation Radiological Risk Assessment[a]

Waste Stream LLW		
Origin Site AMES		
Destination	**Volume**	**Mass**
Site NTS	**m^3/yr 1.16E+01**	**kg/yr 2.99E+04**
	Radionuclide	Activity Ci/yr
	T1-208	4.50E-07
	Pb-212	1.19E-06
	Bi-212	1.19E-06
	Po-212	7.68E-07
	Po-216	1.19E-06
	Ra-224	1.19E-06
	Ra-228	7.12E-06
	Ac-228	7.12E-06
	Th-228	1.19E-06
	Th-231	6.86E-06
	Th-232	7.23E-05
	Th-234	8.79E-03
	Pa-234	9.01E-07
	Pa-234m	8.79E-03
	U-235	6.83E-06
	U-238	8.79E-03
	Pu-238	6.94E-04
	Pu-239	5.30E-05
	Pu-240	1.85E-04
	Pu-241	2.55E-02
	Am-241	1.06E-06
	Cm-242	1.48E-05
	Cm-244	5.30E-06

[a] A complete WASTE_MGMT output file contains the above shipment information for all origin-and-destination pairs for a given case. For illustrative purposes, only shipments between one origin and one destination are shown.

E.6.2 SHIPMENT EXTERNAL DOSE RATES

The dose (and, correspondingly, the risk) to populations and MEIs during routine transportation is directly proportional to the assumed external dose rate from the shipment. The Federal regulations for maximum allowable external dose rates for exclusive-use shipments are presented in Section E.3.1. The actual shipment dose rate is a complex function of the composition and configuration of shielding and containment materials used in the waste packaging, the geometry of the loaded shipments, and the characteristics of the waste material itself. The external dose rates assumed for each waste type are summarized in Table E-5 and are discussed in detail in the text. In practice, external dose rates vary not only from site to site and from waste type to waste type but also from shipment to shipment at a given site.

E.6.2.1 HLW Shipments

For HLW shipments, the external dose rate has been assumed to be equal to the regulatory limit of 10 mrem/h at 2 m (6.6 ft) for all shipments. The regulatory limit was assumed because extensive historical data for HLW shipments do not exist. In practice, the dose rates may range well below the regulatory limit assumed for this assessment. Therefore, assuming that the dose rates are equal to the regulatory limit provides a conservative estimate.

Table E-5. Shipment External Dose Rates for Each Waste Type

Waste Type	External Dose Rate
HLW[a]	10 mrem/h at 2 m (6.6 ft)
LLW[b]	1 mrem/h at 1 m (3.3 ft)
TRUW[c]	CH = 3 mrem/h at 1 m (3.3 ft) RH = 7 mrem/h at 1 m (3.3 ft)
LLMW	1 mrem/h at 1 m (3.3 ft)[d]

Notes: CH = contact handled waste; RH = remote-handled waste.
[a] Regulatory limit (10 CFR 71).
[b] Based on historical DOE LLW shipments as reported to the Shipment Mobility/Accountability Collection (Morris, 1993).
[c] Derived from DOE (1990a).
[d] Based on comparison of LLMW and LLW radiological characteristics.

E.6.2.2 LLW Shipments

For LLW shipments, the external dose rates from historical waste shipments were investigated by using the Shipment Mobility/Accountability Collection (SMAC) system (Morris, 1993). The SMAC database contains information about unclassified commercial freight shipments made by DOE and its contractors. The information available in the SMAC database is collected from site shipping and receiving documents. Available information for shipments of radioactive materials includes the types of material shipped, the number of packages in each shipment, shipment weights, external dose rates, and package isotopic inventories. Approximately two-thirds of all DOE unclassified shipments are estimated to be reported to the SMAC database.

Shipment information from the SMAC database was examined for fiscal years 1983 to the present (Morris, 1993). Information was provided for three general categories of radioactive material: irradiated fuel, "other" highway route controlled quantities, and LLW. (The material categories chosen were dictated by the format in which data are submitted and entered into the SMAC database and are not consistent with the definitions of waste types used in this PEIS.) Of the 15,000 LLW shipments recorded in the SMAC database, approximately 2,500 reported external dose rates. The average dose rate reported was approximately 1 mrem/h, measured at 1 m (3.3 ft) from the surface of a shipment. This value was used for future LLW shipments for the PEIS analysis.

E.6.2.3 TRUW Shipments

For TRUW shipments, external package dose rates have been derived from information in the Supplemental Final Environmental Impact Statement (SFEIS) for WIPP (DOE, 1990a). In the WIPP SFEIS, site-specific external package dose rates were presented for CH-TRUW and for RH-TRUW packages. For this PEIS, the average external dose rates were calculated by using the SFEIS values and were used for purposes of assessment. The average external package dose rates were calculated to be 3 mrem/h for CH-TRUW and 7 mrem/h for RH-TRUW at 1 m (3.3 ft).

E.6.2.4 LLMW Shipments

Because very limited data exists for historical LLMW shipments, and the fact that the radiological characteristics of LLMW were assumed to be similar to LLW for the PEIS, the external dose rate for shipments of LLMW was assumed to be the same as for the LLW shipments. As with LLW shipments, an average dose rate of 1 mrem/h measured at 1 m (3.3 ft) from the surface of a shipment was assumed for analysis purposes.

E.6.3 Population Density Zones

Three population density zones—rural, suburban, and urban—were used for the offsite population risk assessment. The fractions of travel in each zone were determined by using the HIGHWAY and INTERLINE routing models. The rural, suburban, and urban zones are assigned average population densities of 6/km^2 (15.5/mi^2), 719/km^2 (1,862/mi^2), and 3,861/km^2 (10,000/mi^2), respectively. These population densities are typical of rural, suburban, and urban environments (NRC, 1977a). Occurrence of the three population density zones is based on an aggregation of the 12 population density zones provided in the HIGHWAY and INTERLINE model outputs. For calculation purposes, information about population density was generated at the State level and used as RADTRAN input for all origin-and-destination pairs. For the onsite analysis, the population density of the Hanford Site was used.

E.6.4 Accident Rates

For calculating accident risks, vehicle accident involvement and fatality rates are taken from data provided in Saricks and Kvitek (1994). For each transport mode, accident rates are generically defined as the number of accident involvements (fatalities) in a given year per unit of travel of that mode in the same year. Therefore, the rate is a fractional value—the accident-involvement count is the numerator, and vehicular activity (total traveled distance) is the denominator. Accident rates are derived from multiple-year averages that automatically account for such factors as heavy traffic and adverse weather conditions. For assessment purposes, the total number of expected accidents or fatalities is calculated by multiplying the total shipping distance for a specific case by the appropriate accident or fatality rate.

For truck transportation, the rates presented in Saricks and Kvitek (1994) are specifically for heavy combination trucks involved in interstate commerce. Heavy combination trucks are rigs composed of a

separable tractor unit containing the engine and one to three freight trailers connected to each other and the tractor. Heavy combination trucks are typically used for shipping radioactive wastes. Truck accident rates are computed for each State on the basis of statistics compiled by the DOT Office of Motor Carriers for 1986 to 1988. Saricks and Kvitek (1994) present accident involvement and fatality counts, estimated kilometers of travel by State, and the corresponding average accident involvement, fatality, and injury rates for the 3 years investigated. Fatalities (including crew members) are deaths attributable to the accident that occurred any time within 30 days of the accident.

Rail accident rates are computed and presented similarly to truck accident rates in Saricks and Kvitek (1994); however, for rail transport, the unit of haulage is the railcar. State-specific rail accident involvement and fatality rates are based on statistics compiled by the Federal Railroad Administration for 1985 to 1988. Rail accident rates include both mainline accidents and those occurring in rail yards.

The accident assessment presented in this appendix uses separate accident rates for travel in rural, suburban, and urban population density zones in each State. Therefore, total accident risk for a case depends on the total distance traveled in various population zones in each State and does not rely on national average accident statistics. However, for comparative purposes, the national average truck accident rate presented in Saricks and Kvitek (1994) is 2.4×10^{-7} accidents/km (3.9×10^{-7} accidents/mi). The national average railcar accident rate is 5.6×10^{-8} accidents/km (9.0×10^{-8} accidents/mi). For the onsite accident assessment, accident probabilities at the Hanford Site were taken from Wang et al. (1991).

Note that the accident rates used in this assessment were computed using all interstate shipments, regardless of the cargo. Saricks and Kvitek (1994) point out that shippers and carriers of radioactive material generally have a higher-than-average awareness of transportation risk and prepare cargos and drivers for such shipments accordingly. This preparation should have the twofold effect of reducing component and equipment failure and mitigating the contribution of human error to accident causation. These effects were not considered in the accident assessment.

E.6.5 Accident Severity Categories

A method to characterize the potential severity of transportation-related accidents is described in a NRC report commonly referred to as NUREG-0170 (NRC, 1977a). The NRC method divides the spectrum of transportation accident severities into eight categories. Other studies have divided the same accident

spectrum into 6 categories (Wilmot, 1981) and into 20 categories (Fischer et al., 1987); however, these studies focused primarily on accidents involving spent nuclear fuel shipments.

The NUREG-0170 scheme for accident classification is shown in Figure E–4 for truck transportation, and Figure E–5 for rail transportation. Severity is described as a function of the magnitudes of the mechanical forces (impact) and thermal forces (fire) to which a package may be subjected during an accident. Because all accidents can be described in these terms, severity is independent of the specific accident sequence. In other words, any sequence of events that results in an accident in which a package is subjected to forces within a certain range of values is assigned to the accident severity category associated with that range. The scheme for accident severity is designed to take into account all credible transportation-related accidents, including accidents with low probability but high consequences and those with high probability but low consequences.

Each severity category represents a set of accident scenarios defined by a combination of mechanical and thermal forces. A conditional probability of occurrence (that is, the probability that if an accident occurs, it is of a particular severity) is assigned to each category. The fractional occurrences for accidents by the accident severity category and the population density zone are shown in Table E–6.

Category I accidents are the least severe but the most frequent, whereas Category VIII accidents are very severe but very infrequent. To determine the expected frequency of an accident of a given severity, the conditional probability in the category is multiplied by the baseline accident rate. Each population density zone has a distinct baseline accident rate and distribution of accident severities related to differences in average vehicular velocity, traffic density, and other factors, including location—rural, suburban, or urban.

For the accident consequence assessment, the doses were assessed for populations and individuals by assuming an accident of severity Category VIII. This accident severity category represents the most severe accident scenarios, which would result in the largest releases of radioactive material. Accidents of this severity are extremely rare, occurring approximately once in every 70,000 truck or 100,000 rail accidents involving a radioactive waste shipment. On the basis of national accident statistics (Saricks and Kvitek, 1994), for every 1.6 km (1 mi) of shipment (loaded), the probability of an accident of this severity is 6×10^{-12} for shipment by truck and 1×10^{-12} for shipment by rail. For the PEIS waste alternatives (the largest estimated shipment mileage is 560 million mi for LLW), no accident of such severity is expected to occur.

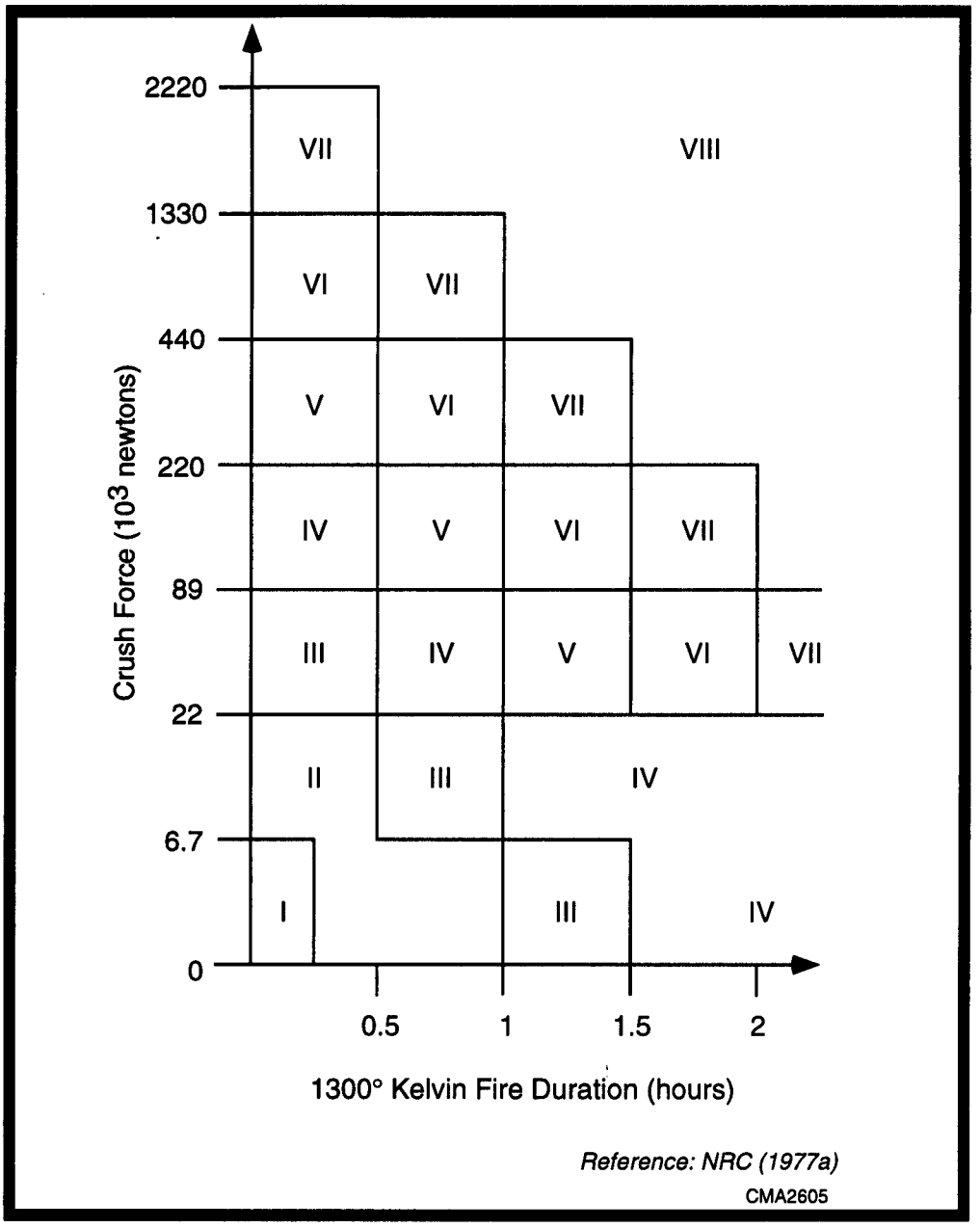

Figure E–4. Scheme for NUREG-0170 Classification by Accident Severity Category for Truck Accidents.

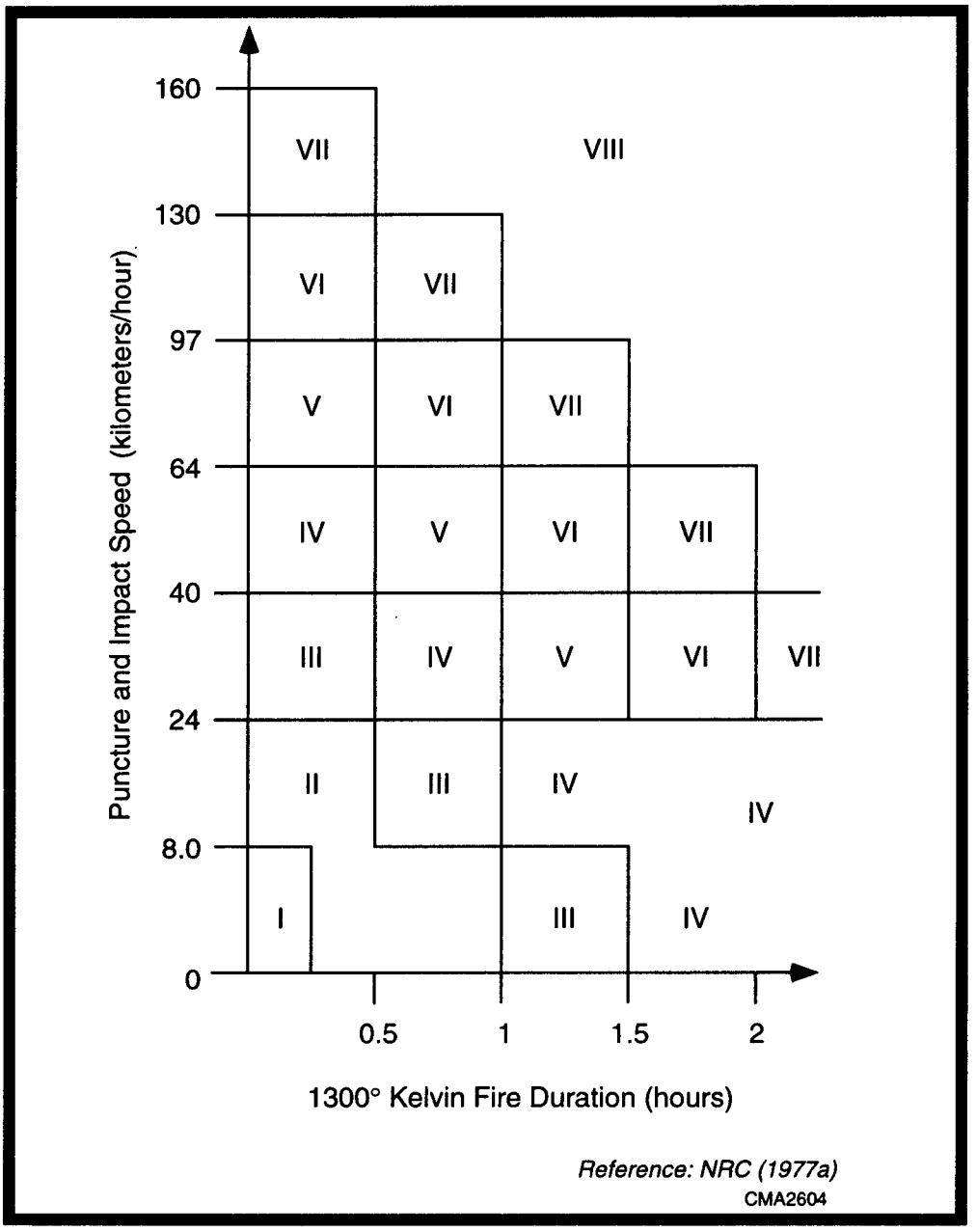

Figure E–5. Scheme for NUREG-0170 Classification by Accident Severity Category for Rail Accidents.

Table E–6. Fractional Occurrences for Accidents by Severity Category and Population Density Zone

Severity Category	Fractional Occurrence	Fractional Occurrence by Population Density Zone		
		Rural	Suburban	Urban
Truck				
I	5.5E-01	1.0E-01	1.0E-01	8.0E-01
II	3.6E-01	1.0E-01	1.0E-01	8.0E-01
III	7.0E-02	3.0E-01	4.0E-01	3.0E-01
IV	1.6E-02	3.0E-01	4.0E-01	3.0E-01
V	2.8E-03	5.0E-01	3.0E-01	2.0E-01
VI	1.1E-03	7.0E-01	2.0E-01	1.0E-01
VII	8.5E-05	8.0E-01	1.0E-01	1.0E-01
VIII	1.5E-05	9.0E-01	5.0E-02	5.0E-02
Rail				
I	5.0E-01	1.0E-01	1.0E-01	8.0E-01
II	3.0E-01	1.0E-01	1.0E-01	8.0E-01
III	1.8E-01	3.0E-01	4.0E-01	3.0E-01
IV	1.8E-02	3.0E-01	4.0E-01	3.0E-01
V	1.8E-03	5.0E-01	3.0E-01	2.0E-01
VI	1.3E-04	7.0E-01	2.0E-01	1.0E-01
VII	6.0E-05	8.0E-01	1.0E-01	1.0E-01
VIII	1.0E-05	9.0e-01	5.0E-02	5.0E-02

Source: NRC (1977a).

E.6.6 PACKAGE RELEASE FRACTIONS

Radiological consequences are calculated by assigning package release fractions to each accident severity category. The release fraction is defined as the fraction of the radioactive material in a package that could be released from that package during an accident of a certain severity. Release fractions take into account all mechanisms necessary to create release of radioactive material from a damaged package to the environment. Release fractions vary according to the package type and the physical form of the waste. Type B packagings are designed to withstand the forces of severe accidents and, therefore, have smaller release fractions than Type A packagings.

Package release fractions for accidents of each severity category are given in Table E–7 for the package types considered in this assessment. The values for release fractions were obtained from various sources, but all were derived on the basis of the methods described in NUREG-0170 (NRC, 1977a). Also important

Table E–7. Estimated Release Fractions for Shipping Packagings Under Various Accident Severity Categories

Severity Category	Estimated Release Fraction			
		Type B		
	Type A[a]	HLW Cask[a]	TRUPACT-II[b]	RH-72B[b]
Truck				
I	0	0	0	0
II	1.0E-02	0	0	0
III	1.0E-01	1.0E-02	8.0E-09	6.0E-09
IV	1.0E+00	1.0E-01	2.0E-07	2.0E-07
V	1.0E+00	1.0E+00	8.0E-05	1.0E-04
VI	1.0E+00	1.0E+00	2.0E-04	1.0E-04
VII	1.0E+00	1.0E+00	2.0E-04	2.0E-04
VIII	1.0E+00	1.0E+00	2.0E-04	2.0E-04
Rail				
I	0	0	0	0
II	1.00E-02	0	0	0
III	1.00E-01	1.0E-02	2.0E-08	2.0E-08
IV	1.00E+00	1.0E-01	7.0E-07	7.0E-07
V	1.00E+00	1.0E+00	8.0E-05	1.0E-04
VI	1.00E+00	1.0E+00	2.0E-04	1.0E-04
VII	1.00E+00	1.0E+00	2.0E-04	2.0E-04
VIII	1.00E+00	1.0E+00	2.0E-04	2.0E-04

[a] Values are for total material release fraction. To determine the amount of material dispersed in the environment, these values must be multiplied by the aerosolized and respirable fractions give in Table E–8 for the various physical waste forms.
[b] Values are for respirable release fraction.
Sources: NRC (1977a); DOE (1990a).

for the purposes of risk assessment are the fraction of the released material that can be entrained in an aerosol (that is, part of an airborne radioactive plume) and the fraction of the aerosolized material that is also respirable (of a size that can be inhaled into the lungs). These fractions depend on the physical form of the waste material. Most solid materials are difficult to release in particulate form and are, therefore, relatively nondispersible. Conversely, liquid or gaseous materials are relatively easy to release if the container is compromised in an accident. The aerosolized and respirable fractions for various physical forms of waste have been compiled in RADTRAN (Neuhauser and Kanipe, 1993) and are given in Table E–8. (Note that the release fractions for TRUW packages incorporate the aerosolized and respirable fractions on the basis of the characteristics of TRUW.)

Table E–8. Aerosolized and Respirable Material Release Fractions for Various Physical Waste Forms

Physical Waste Form	Aerosolized Fraction	Respirable Fraction
Vitrified waste (HLW)[a]	1.0E-06	5.0E-02
Activated metals (LLW)[a]	1.0E-06	5.0E-02
Heterogeneous solids (LLW, LLMW)[b]	1.0E-01	5.0E-02
Nonvolatile liquids (LLMW)	1.0E-01	5.0E-02
Volatile liquids (LLMW)	1.0E+00	1.0E+00

[a] Considered to behave as immobile material.
[b] Considered to behave as a loose powder.
Source: Neuhauser and Kanipe (1993).

E.6.7 ATMOSPHERIC CONDITIONS

Radioactive material released to the atmosphere is transported by the wind. The amount of dispersion, or dilution, of the radioactive material in the air depends on the meteorologic conditions at the time of the accident. Because predicting the specific location of an offsite transportation-related accident is impossible, generic atmospheric conditions were selected for the accident risk and consequence assessments.

For the accident risk assessment, neutral weather conditions were assumed; these conditions were represented by Pasquill stability Class D with a windspeed of 4 m/s (9 mi/h). Because neutral meteorologic conditions constitute the most frequently occurring atmospheric stability condition in the United States, these conditions are most likely to be present if an accident occurs involving a waste shipment. Observations at National Weather Service surface meteorologic stations from more than 300 U.S. locations indicate that on a yearly average, neutral conditions (represented by Pasquill Classes C and D) occur about half (50%) the time, while stable conditions occur about one-third (33%) of the time (Pasquill Classes E and F), and unstable conditions (Pasquill Classes A and B) occur about one-sixth (17%) of the time (Doty et al., 1976). The neutral category predominates in all seasons but is most prevalent (nearly 60% of the observations) during winter.

For the accident consequence assessment, doses were assessed under neutral atmospheric conditions (Pasquill Stability Class D with a windspeed of 4 m/s [9 mi/h] and stable conditions (Pasquill Stability Class F with a windspeed of 1 m/s [2.2 mi/h]). The results calculated for neutral conditions represent the most likely consequences, and the results for stable conditions represent a weather situation in which the least amount of dilution is evident with the highest air concentrations of radioactive material.

E.6.8 HEALTH RISK CONVERSION FACTORS

The health risk conversion factors used throughout this PEIS to estimate the number of expected cancer-caused fatalities, the incidence of cancer, and the serious genetic effects from radiological exposures were derived from ICRP (1991): 5.0×10^{-4} cases of fatal cancer per person-rem for members of the public, and 4.0×10^{-4} cases for workers; 1.7×10^{-3} cases of induced cancer per person-rem for members of the public, and 1.4×10^{-3} cases for workers; and 1.0×10^{-4} adverse genetic effects per person-rem for members of the public, and 6.0×10^{-5} adverse genetic effects for workers. Cancer-caused fatalities and cancer incidence are determined over the lifetimes of exposed populations. Genetic effects occur in descendants of the exposed population, and the estimates for these effects are based on the total dose to the reproductive organs. The genetic health risk conversion factors used in this analysis include all generations.

E.6.9 MAXIMALLY EXPOSED INDIVIDUAL EXPOSURE SCENARIOS

The risk to MEIs has been estimated for a number of hypothetical exposure scenarios for offsite transportation. The receptors include crew members, departure inspectors, and members of the public exposed during traffic obstructions (traffic jams), while working at a service station, or by living near a treatment, storage, or disposal site. The dose and risk to MEIs were calculated for particular distances and durations of exposure. The distances and durations of exposure for each receptor are similar to those used in previous transportation assessments (DOE, 1987b, 1990a). The scenarios for exposure are not intended to be exhaustive but were selected to provide a range of potential exposure situations. The assumptions for exposure scenarios are as follows:

- *Crew Members*. Truck and rail crew members are assumed to be occupational radiation workers and would be monitored by a dosimetry program. Therefore, the maximum allowable dose would be 5 rem/yr. As an administrative procedure, DOE limits doses to its workers to 2 rem/yr (DOE, 1992b).
- *Inspectors (Truck and Rail)*. Inspectors are assumed to be either Federal or State vehicle inspectors. Inspectors are not assumed to be monitored by a dosimetry program. An average exposure distance of 3 m (9.8 ft) and an exposure duration of 30 minutes are assumed.
- *Rail-Yard Crew Member*. A rail-yard crew member is not assumed to be monitored by a dosimetry program. An average exposure distance of 10 m (32.8 ft) and an exposure duration of 2 hours are assumed.
- *Resident (Truck and Rail)*. A resident is assumed to live 30 m (98 ft) from a site entrance route (truck or rail). Shipments pass at an average speed of 24 km/h (15 mi/h), and the resident is exposed

unshielded. Cumulative doses are assessed for each site on the basis of the number of shipments entering or exiting the site, with the assumption that the resident is present for 100% of the shipments.

- *Person in Traffic Obstruction (Truck and Rail).* A person is assumed to be stopped next to a waste shipment (because of traffic or other obstructions). The person is assumed to be exposed unshielded at a distance of 1 m (3.3 ft) for 30 minutes.
- *Person at Truck Service Station.* A person is assumed to be exposed at an average distance of 20 m (65.6 ft) for 2 hours. This receptor could be a worker at a truck stop.
- *Resident Near a Rail Stop.* A resident is assumed to live near a rail classification yard. The resident is assumed to be exposed unshielded at a distance of 200 m (656 ft) for 20 hours.

The largest uncertainty in predicting the dose to MEIs during transportation involves determining the frequency of exposure occurrence. This difficulty arises from uncertainties in future shipment schedules and route selection and from the inherent uncertainty in predicting the frequency of random or chance events; for example, it is conceivable that an individual may be stopped in traffic next to a shipment of radioactive waste, but it is difficult to predict how often the same individual would experience this event. Therefore, doses are assessed on a per-event basis for most receptors considered. To account for possible multiple exposures, ranges of realistic total doses are discussed qualitatively. One exception is the dose calculation for hypothetical residents living near an entrance route to a treatment, storage, or disposal site.

For these residents, total doses are calculated on the basis of the number of shipments entering or exiting each site for each PEIS alternative.

E.6.10 General RADTRAN Input Parameters

In addition to the specific parameters discussed previously, values for several general parameters must be specified within the RADTRAN code. These general parameters define basic characteristics of the shipment and traffic and are specific to the transportation mode. The user's manual for the RADTRAN code (Neuhauser and Kanipe, 1993) contains derivations and descriptions of these parameters. Table E-9 summarizes the general RADTRAN input parameters used in the transportation risk assessment.

Table E-9. General RADTRAN Input Parameters[a]

Parameter	Truck	Rail
Package type	Waste-type specific	Waste-type specific
No. of crew	2	5
Distance from source to crew (m)	3	152
Average vehicular speed (km/h)		
Rural	88	64
Suburban	40	40
Urban	24	24
Stop time (h/km)	0.011	0.033
No. of people exposed while stopped	25	100
No. of people per vehicle sharing route	2	3
Population densities (persons/km^2)		
Rural	6	6
Suburban	719	719
Urban	3,861	3,861
One-way traffic count (vehicles/h)		
Rural	470	1
Suburban	780	5
Urban	2,800	5

[a]Accident conditional probabilities are listed by severity category in Table E-6; accident release fractions are given in Table E-7.

Source: Neuhauser and Kanipe (1993).

E.6.11 Onsite Assessment Accident Location

The onsite transportation accident consequence was estimated for a potential accident occurring on the roadway or railroad adjacent to the 300 Area at the Hanford Site. This location would maximize exposure to worker populations onsite and to the public offsite. The highest accident severity category possible for each waste type was assumed to determine the amounts of radioactive material released.

E.7 Results of Risk Assessment

This section presents results of the transportation risk assessment for each of the four types of radioactive waste considered in the PEIS. For each waste type, results are presented for the alternatives summarized in Section E.2.2 and defined in detail in the waste type-specific chapters (Chapters 6 through 10). As stated

previously, the number and location of potential treatment, storage, or disposal sites differs for each specific alternative, and the number of alternatives considered varies among waste types.

Although the method for risk assessment and important assumptions about assessment have been presented in detail previously, the following sections give a brief overview of the risk assessment process. This overview is intended to help readers interpret results as they are presented for each waste type.

For each waste type, the impacts of transportation are calculated in four areas: (1) collective population risks during routine conditions and accidents for each alternative, (2) risks to MEIs during routine conditions for each alternative, (3) consequences to individuals and populations after the most severe accidents involving release of radioactive material, and (4) onsite transportation risks. Each of these areas is described briefly.

Collective Population Risk. The collective population risk is a measure of the total risk posed to society as a whole by the alternative being considered. For the collective population risk assessment, the persons exposed are considered as a group, without specifying individual receptors. The collective population risk is used as the primary means to compare the various alternatives.

Collective population risks are calculated from vehicle- and cargo-related causes for routine transportation and accidents. Vehicle-related risks are independent of the shipment's cargo and include risks from vehicular exhaust emissions and traffic accidents (fatalities caused by physical trauma). Vehicle-related risks are presented in terms of estimated fatalities for each alternative.

For radioactive material, cargo-related risk refers to the risk posed by the radioactive nature of the material. The RADTRAN 4 model is used to calculate collective population risks for each alternative. The RADTRAN 4 calculations for population risk take into account the consequences and the probabilities of potential exposure-causing events (such as accidents). The accident risk values are referred to as "dose risk" because they incorporate the probabilities of a spectrum of accidents. The collective population risks are presented in terms of the total dose (person-rem) to workers and to members of the public for each alternative. The collective population risks are also presented in terms of estimated fatalities from latent cancer by using the ICRP Publication 60 (ICRP, 1991) health risk conversion factors described in Section E.6.8. Other health endpoints, such as the incidence of cancer and severe genetic effects, are not explicitly presented but can be calculated by multiplying the total doses by the appropriate conversion factors given in Section E.6.8.

Maximally Exposed Individuals During Routine Conditions. During the routine transportation of radioactive waste, specific individuals close to a shipment may be exposed to radiation. For each waste type, the RISKIND model has been used to estimate risk to these individuals for a number of hypothetical exposure-causing events. The receptors include transportation crew members, inspectors, and members of the public exposed during traffic delays, while working at a service station, or living near a DOE site. The assumptions about exposure are given in Section E.6.9. The scenarios for exposure are not meant to be exhaustive but were selected to provide a range of potential exposures.

For most individual receptors considered, doses are assessed and presented on a per-event basis. No attempt has been made to estimate the frequency of exposure-causing events, although the range of possible exposures is qualitatively discussed. However, one exception is the calculation of the dose to a hypothetical resident living near the entrance route to a treatment, storage, or disposal site. For these residents, cumulative doses are calculated on the basis of the total number of shipments entering or exiting each site for each alternative.

Accident Consequence Assessment. The RISKIND code is used to provide a detailed assessment of the consequences of the most severe transportation-related accidents for each waste type. The RADTRAN 4 collective accident risk assessment considers the entire range of accident severities and their related probabilities, whereas the RISKIND accident consequence assessment assumes that an accident of the highest severity category (Category VIII) has occurred. The consequences, in terms of committed dose (rem) and latent cancer fatalities, are calculated for exposed populations and individuals near an accident.

For each waste type, accident consequences are calculated for a waste shipment that represents the highest potential radiological risk if an accident occurs. The most hazardous waste is identified for each waste type by screening the site-specific characteristics for radiological waste (that is, activity concentrations) developed for the PEIS, by taking into account the physical forms of the waste and relative hazards of individual radionuclides. For most waste shipments, the consequences of severe accidents would be fewer than those presented for the most hazardous waste. Separate accident consequence calculations are not performed for each case for a given waste type. The accident consequence assessment is intended to provide an estimate of the maximum potential impacts posed by a severe transportation-related accident.

Onsite Assessment. The risk assessment conducted for onsite transportation is intended to provide an estimate of the magnitude of the potential onsite transportation risk for comparison with offsite transportation risks. For the PEIS, onsite transportation is defined as transportation of waste between

facilities within the boundaries of a DOE Site. Transfers of waste within a specific facility are not considered onsite shipments but are part of the normal facility operations. (Offsite transportation refers to transporting waste between distinct sites, including parts of the routes that may be within the boundaries of the origin and destination sites.)

For purposes of the PEIS, the onsite risk assessment has been limited to one representative site—the Hanford Site. The Hanford Site was selected primarily because it is a relatively large site that conducts waste management activities for all waste types. The impacts calculated for the Hanford Site are believed to be typical of other large DOE sites and would conservatively bound the impacts expected for smaller sites. The routine risks presented for the Hanford Site are expected to be the same among alternatives for each waste type. This is because all radioactive waste is shipped to a centrally located processing facility regardless of final treatment/disposal, onsite or offsite.

E.7.1 HIGH-LEVEL WASTE

The generation, treatment, and management of HLW and the alternatives considered in the PEIS are described in detail in ANL (1996g). In summary, canisters of vitrified HLW are assumed to be produced at the four DOE sites that have historically generated and currently store HLW, and these canisters would be transported to a geologic repository for final disposal. Untreated HLW is transferred between facilities by a special pipeline system. Treated (vitrified) HLW will be stored in facilities in close proximity to the vitrification facilities. No significant onsite transportation of HLW is assumed to occur.

Transportation risks have been calculated for four HLW alternatives summarized in Section E.2.2. The six alternative cases differ primarily in the location for interim storage of canisters before final disposal in a geologic repository. For assessing the impacts of transportation, the PEIS assumes the location of the geologic repository to be at the candidate site of Yucca Mountain in Nevada, the only site currently authorized by legislation for investigation.

The analysis for transportation of HLW to a geologic repository for the Centralized Alternative is divided into Centralized Alternative 1 and Centralized Alternative 2. Centralized Alternative 1 for HLW refers to shipment to a geologic repository by 2015. Centralized Alternative 2 refers to shipment of HLW to a geologic repository later than 2015.

E.7.1.1 Shipment Summary

The number of canisters of vitrified HLW shipped varies from approximately 20,000 for the No Action Alternative to over 28,000 for the second case of the Centralized Alternative. The impacts of transportation have been calculated for shipping the entire estimated inventory of HLW canisters. However, the repository is expected to accept approximately 800 canisters per year when it becomes operational. Impacts have been calculated separately for all truck and rail modes of shipment.

The total number of shipments and the mileage for loaded shipments for each case are summarized in Table E–10 for truck shipments, and Table E–11 for rail shipments. For the six HLW cases, the total

Table E–10. Total Population Impacts of HLW Transportation for the WM PEIS Cases: Truck Mode

	Alternative[a]						
Parameter	**No Action**	**Decentralized**	**Regionalized 1**	**Regionalized 2**	**Centralized 1**	**Centralized 2**	**Onsite[b]**
Shipment summary							
Shipments	19,912	21,612	21,952	21,952	24,325	28,224	NA
Mileage (10^6 mi)	29.4	30.7	31.0	31.2	34.6	39.5	NA
Population impacts							
Cargo-related[c]							
Dose risk (person-rem)							
Routine crew[d]	2,600	2,720	2,750	2,760	3,050	3,460	NA
Routine public	3,520	3,670	3,710	3,730	4,120	4,690	NA
Accident[e]	0.68	0.684	0.680	0.688	0.725	0.760	NA
Latent cancer fatalities[f]							
Crew fatalities	1.0	1.1	1.1	1.1	1.2	1.4	NA
Public fatalities	1.8	1.8	1.9	1.9	2.1	2.3	NA
Vehicle-related[g]							
Emission fatalities	0.21	0.23	0.23	0.23	0.25	0.27	NA
Accident fatalities	1.8	1.9	1.9	1.9	2.1	2.3	NA
Total population health effects (fatalities)	4.8	5.0	5.1	5.1	5.7	6.3	NA

Note: NA = not applicable.
[a] Alternative definitions are summarized in Section E.2.2 and provided in detail in Chapter 3 of the WM PEIS.
[b] By definition, no onsite HLW shipments exist at the Hanford Site.
[c] Cargo-related impacts are impacts attributable to the radioactive nature of the waste material.
[d] Rail crew values are expected to range from impacts listed in this table (for dedicated shipments) to slightly higher than the truck crew impacts identified in the previous table. See Section E.7 for a more detailed explanation.
[e] Dose risk is a societal risk and is the product of accident probability and accident consequence.
[f] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.
[g] Vehicle-related impacts are impacts independent of the shipment's cargo.

Table E-11. Total Population Impacts of HLW Transportation for the WM PEIS Cases: Rail Mode

Parameter	Alternative[a]						
	No Action	Decentralized	Regionalized 1	Regionalized 2	Centralized 1	Centralized 2	Onsite[b]
Shipment summary							
Shipments	3,983	4,323	4,391	4,391	4,866	5,646	NA
Mileage (10^6 mi)	6.68	6.93	7.04	7.03	7.70	8.74	NA
Population impacts							
Cargo-related[c]							
Dose risk (person-rem)							
Routine crew	153	161	163	163	180	205	NA
Routine public	168	175	178	177	192	215	NA
Accident[d]	0.0215	0.0215	0.0208	0.0217	0.0234	0.0250	NA
Latent cancer fatalities[e]							
Crew fatalities	0.061	0.064	0.065	0.065	0.072	0.082	NA
Public fatalities	0.084	0.088	0.089	0.089	0.096	0.11	NA
Vehicle-related[f]							
Emission fatalities	0.041	0.043	0.043	0.043	0.046	0.050	NA
Accident fatalities	0.014	0.015	0.015	0.015	0.016	0.018	NA
Total population health effects (fatalities)	0.20	0.21	0.21	0.21	0.23	0.26	NA

Note: NA = not applicable.
[a] Alternative definitions are summarized in Section E.2.2 and provided in detail in Chapter 3 of the WM PEIS.
[b] By definition, no onsite HLW shipments exist at the Hanford Site.
[c] Cargo-related impacts are impacts attributable to the radioactive nature of the waste material.
[d] Dose risk is a societal risk and is the product of accident probability and accident consequence.
[e] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.
[f] Vehicle-related impacts are impacts independent of the shipment's cargo.

number of truck shipments ranges from 19,912 if the canisters from currently available storage are shipped directly to a repository (No Action Alternative) to about 28,224 if the repository opens after 2015 and all the canisters are consolidated at one site for interim storage (Centralized 2 Alternative). For rail transportation, the corresponding numbers of shipments range from about 3,983 to 5,646. The total mileage for loaded shipments ranges from about 47.3 to 63.6 million km (29.4 to 39.5 million mi) for truck transportation and from about 10.8 to 14.0 million km (6.7 to 8.7 million mi) for rail transportation.

For purposes of comparison, within the United States for the years 1986 to 1988, the average annual reported mileage for interstate truck shipments of all commodities was approximately 45.1 billion km (28 billion mi), and for train shipments approximately 48.8 billion railcar-km (30.3 billion railcar-mi) (Saricks and Kvitek, 1994). The entire number of HLW shipments for the Centralized 2 Alternative would

thus represent less than 0.2% of the annual amount of truck and rail transportation activity within the United States.

E.7.1.2 Collective Population Risk Results

The results for collective risk assessment for HLW shipments are also summarized in Table E–10 for truck shipments and Table E–11 for rail shipments. The collective risk results are presented for shipment of the total estimated inventory of HLW canisters.

An examination of the results of the transportation risk assessment shows that differences in population risk among the various cases are dependent primarily on the number of shipments made and then on total shipping distances. The number of shipments and total shipping distance for each case is determined by the case definition (storage capacity, repository availability, shipment origin, and destination sites), the site-specific waste inventories (specifically waste volume and mass, which directly determine the total number of shipments), and the route distances among all pairs of origin and destination sites.

For truck transportation, the total estimated number of fatalities from radiological causes ranges from approximately 2.8 to 3.7. For rail transportation, the number of fatalities from radiological causes ranges from 0.15 to 0.19. In general, shipment by rail results in slightly lower doses to crew members and the public, primarily because of the reduced number of shipments. The vehicle- and cargo-related risks are comparable for truck shipments. The cargo-related risks are generally greater than the vehicle-related risks for rail transportation.

E.7.1.3 Maximally Exposed Individual Assessment

The estimated doses during routine transportation for each individual receptor considered (see Section E.6.9 for exposure assumptions) are presented in Table E–12 on a per-event basis. The total dose for repeated exposures can be estimated by multiplying the per-event dose by the number of exposure-causing events. The potential exists for significant individual exposures if multiple exposure-causing events occur. For example, the dose to a person stuck in traffic next to an HLW shipment for 30 minutes is estimated to be 11 mrem. If the duration of exposure were longer, the dose would rise proportionally. Therefore, conceivably, a person could receive a dose of approximately 30 to 50 mrem while stopped in traffic next

Table E-12. Estimated Routine Doses and Lifetime Risk of Fatal Cancer to MEIs From Shipments of HLW (per Exposure Event)[a]

Receptor[b]	Dose (rem)		Lifetime Risk[c]	
	Truck	Rail	Truck	Rail
Workers				
Crew member	d	d	d	d
Inspector	2.9E-03	2.9E-03	1.0E-06	1.0E-06
Rail-yard crew member	NA	1.3E-03	NA	5.0E-07
Public				
Resident	4.0E-07	4.0E-07	2.0E-10	2.0E-10
Person in traffic jam	1.1E-02	1.1E-02	6.0E-06	6.0E-06
Person at service station	3.1E-04	NA	2.0E-07	NA
Resident near rail stop	NA	1.3E-05	NA	7.0E-09

Note: NA = not applicable.
[a] The external dose rate is assumed to be 10 mrem/h at 2 m (6.6 ft) for all shipments.
[b] Receptor assumptions are described in Section E.6.9.
[c] Lifetime risk of fatal cancer based on ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.
[d] The DOE administrative control level limits doses to DOE workers to 2 rem/yr.

to an HLW shipment. In addition, a person working at a truck service station could receive an increased dose if trucks used the same stops repeatedly. If a truck stop worker is present for 100 shipment stops (at the distance and duration given previously), the calculated dose would be approximately 30 mrem. Administrative controls could be instituted to control the location and duration of truck stops if multiple exposures were to occur routinely.

Table E-13 summarizes for each case the potential cumulative dose to a resident living along a site entrance route. The cumulative doses assume that a resident is present for every shipment entering or exiting a site and is unshielded at a distance of 30 m (98 ft) from the entrance route. The maximum cumulative dose would occur near the repository, except for the Centralized 2 case, because of the large number of shipments entering the site for all alternatives. The maximum total dose to this resident would be approximately 9 mrem for the all-truck case and 2 mrem for the all-rail case. For the Centralized 2 case where temporary storage of all HLW occurs at Hanford, the maximum total dose to a resident would be approximately 11 mrem for the all-truck case and 2 mrem for the all-rail case. The estimated dose to a resident would be well below the annual limit of 100 mrem specified for members of the public (DOE, 1990b).

Table E-13. Cumulative Routine Dose and Lifetime Risk to an MEI Living Along a Site Entrance Route for Shipments of HLW[a]

Alternative and Site	All Truck			All Rail		
	Total Shipments	Dose (rem)	Lifetime Risk[b]	Total Shipments	Dose (rem)	Lifetime Risk[b]
No Action						
Repository	19,912	8.0E-03	4E-06	3,983	1.6E-03	8E-07
Hanford	15,000	6.0E-03	3E-06	3,000	1.2E-03	6E-07
SRS	4,572	1.8E-03	9E-07	915	3.7E-04	2E-07
WVDP	340	1.4E-04	7E-08	68	2.7E-05	1E-08
INEL	0	0.0E+00	0E+00	0	0.0E+00	0E+00
Decentralized						
Repository	21,612	8.6E-03	4E-06	4,323	1.7E-03	9E-07
Hanford	15,000	6.0E-03	3E-06	3,000	1.2E-03	6E-07
SRS	4,572	1.8E-03	9E-07	915	3.7E-04	2E-07
INEL	1,700	6.8E-04	3E-07	340	1.4E-04	7E-08
WVDP	340	1.4E-04	7E-08	68	2.7E-05	1E-08
Regionalized 1						
Repository	21,612	8.6E-03	4E-06	4,323	1.7E-03	9E-07
Hanford	15,000	6.0E-03	3E-06	3,000	1.2E-03	6E-07
SRS	5,252	2.1E-03	1E-06	1,051	4.2E-04	2E-07
INEL	1,700	6.8E-04	3E-07	340	1.4E-04	7E-08
WVDP	340	1.4E-04	7E-08	68	2.7E-05	1E-08
Regionalized 2						
Repository	21,612	8.6E-03	4E-06	4,323	1.7E-03	9E-07
Hanford	15,680	6.3E-03	3E-06	3,136	1.3E-03	6E-07
SRS	4,572	1.8E-03	9E-07	915	3.7E-04	2E-07
INEL	1,700	6.8E-04	3E-07	340	1.4E-04	7E-08
WVDP	340	1.4E-04	7E-08	68	2.7E-05	1E-08
Centralized 1						
Repository	21,612	8.6E-03	4E-06	4,323	1.7E-03	9E-07
Hanford	20,426	8.2E-03	4E-06	4,086	1.6E-03	8E-07
SRS	4,572	1.8E-03	9E-07	915	3.7E-04	2E-07
INEL	1,700	6.8E-04	3E-07	340	1.4E-04	7E-08
WVDP	340	1.4E-04	7E-08	68	2.7E-05	1E-08
Centralized 2						
Hanford	28,224	1.1E-02	6E-06	5,646	2.3E-03	1E-06
Repository	21,612	8.6E-03	4E-06	4,323	1.7E-03	9E-07
SRS	4,572	1.8E-03	9E-07	915	3.7E-04	2E-07
INEL	1,700	6.8E-04	3E-07	340	1.4E-04	7E-08
WVDP	340	1.4E-04	7E-08	68	2.7E-05	1E-08

[a] The external dose rate is assumed to be 10 mrem/h at 2 m (6.6 ft). The resident is assumed to be present for all shipments that either enter or exit the Site. Shipments are assumed to pass at a distance of 30 m (98 ft) and an average speed of 24 km/h (15 mi/h).

[b] Lifetime risk of fatal cancer based on ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.

E.7.1.4 Accident Consequence Assessment

Table E–14 presents results of the accident consequence assessment for HLW. As stated previously, the results are calculated for transportation-related accidents that result in the maximum release of radioactive material. The results were calculated for SRS HLW, which was found to result in the highest accident-related doses of the four types of site-specific HLW; however, all maximum accident-related doses for the

Table E–14. Estimated Consequences for the Most Severe Accidents Involving Shipments of HLW[a,b]

	Neutral Conditions[c]				Stable Conditions[d]			
	Population[e]		MEI[f]		Population[e]		MEI[f]	
Mode and Accident Location	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatality)	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatality)
Truck								
Urban	4.2E+00	2.0E-03	3.4E-03	1.7E-06	3.4E+01	1.7E-02	1.2E-02	6.0E-06
Suburban	7.8E+01	4.0E-04	3.4E-03	1.7E-06	6.2E+00	3.1E-03	1.2E-02	6.0E-06
Rural	1.6E-02	8.0E-06	3.4E-03	1.7E-06	1.3E-01	6.5E-05	1.2E-02	6.0E-06
Rail								
Urban	2.1E+01	1.0E-02	1.7E-02	8.5E-06	1.7E+02	8.5E-02	6.0E-02	3.0E-05
Suburban	3.9E+00	2.0E-03	1.7E-02	8.5E-06	3.1E+01	1.6E-02	6.0E-02	3.0E-05
Rural	8.0E-02	4.0E-05	1.7E-02	8.5E-06	6.5E-01	3.3E-04	6.0E-02	3.0E-05

[a] The most severe accidents correspond to the highest NUREG-0170 accident severity category (Category VIII) (NRC, 1977a). Results are presented for HLW from SRS.
[b] Buoyant plume rise resulting from fire for a severe accident was included in the exposure model. One HLW canister is assumed to be breached in a truck accident; five canisters are assumed to be equally breached in a rail accident.
[c] Neutral weather conditions result in moderate dispersion and dilution of the released plume. Neutral conditions were considered to be Pasquill Stability Class D with a windspeed of 4 m/s (9 mi/h). Neutral conditions occur approximately 50% of the time in the United States.
[d] Stable weather conditions result in minimal dispersion and dilution of the released plume and thus are unfavorable. Stable conditions were taken to be Pasquill Stability Class F with a windspeed of 1 m/s (2.2 mi/h). Stable conditions occur approximately one-third of the time in the United States.
[e] Populations extend at a uniform population density to a radius of 80 km (50 mi) from the accident site. Population exposure pathways include acute inhalation; acute cloudshine; groundshine; resuspended inhalation; resuspended cloudshine; and ingestion of food, including initially contaminated food (rural only). No decontamination or mitigative actions are taken.
[f] The MEI is assumed to be at the location of maximum exposure. The locations of maximum exposure would be 160 m (525 ft) from the accident site under neutral atmospheric conditions and 400 m (1,312 ft) under stable atmospheric conditions. Individual exposure pathways include acute inhalation, acute cloudshine, and groundshine during passage of the plume. No ingested dose is considered.

four HLW types were within a factor of 5. The population doses are for a uniform population density within an 80-km (50-mi) radius of accidents in rural, suburban, and urban population density zones.

The location of the MEI after an accident is determined on the basis of atmospheric conditions and the buoyant characteristics of the released plume. The locations of maximum exposure are 160 m (525 ft) from the accident site for neutral conditions, and 400 m (1,312 ft) for stable conditions. The dose to the MEI is independent of the accident location. The maximum dose to an individual is approximately 60 mrem under stable weather conditions, which corresponds to a lifetime fatal cancer risk of 3×10^{-5}.

E.7.1.5 Onsite Assessment Results

As defined previously, no onsite transportation of HLW will occur at the Hanford Site. Therefore, no onsite transportation impacts have been calculated for the site.

E.7.2 Low-Level Waste

The projected rate of LLW generation for each site, the waste characteristics, the potential treatments, and the alternatives considered in the PEIS are described in detail in the LLW technical report (ANL, 1996h). Transportation risks have been calculated for the 14 LLW alternatives summarized in Section E.2.2. The cases range from decentralized to centralized approaches to TSD. The number of disposal sites varies from 16 sites for decentralized disposal to 1 site for centralized disposal. Options for treatment also vary from decentralized to centralized approaches.

The PEIS considers current inventories of LLW plus 20 years of generation for all DOE Sites. All impacts are calculated as totals for the entire inventory of waste under consideration. The average annual risk can be estimated by dividing the summarized results by the duration of the shipping campaigns. For the No Action Alternative, shipments would be distributed uniformly over a 20-year period; however, for all other alternatives, shipments would occur uniformly over a 10-year period, with the assumption of a 10-year period to build TSD facilities. These timeframes are consistent with the assumptions used in the facility assessments for estimating throughputs.

E.7.2.1 Shipment Summary

The total number of shipments and the mileage for loaded shipments for each LLW case are summarized in Table E-15 for truck shipments, and Table E-16 for rail shipments. The estimated number of shipments and the total mileage for the various alternatives span a wide range. The total number of truck shipments ranges from approximately 24,420 for the Decentralized Alternative to about 264,000 shipments for the Centralized 4 Alternative. For rail transportation, the corresponding numbers of shipments range from 9,210 to 102,100. The total mileage for loaded shipments ranges from 13.9 to 906 million km (8.63 to 563 million mi) for truck transportation and from 5.6 to 360 million km (3.5 to 224 million mi) for rail transportation. The average annual number of shipments and mileage can be estimated by dividing the total results by a shipping duration of either 10 or 20 years.

For comparison, within the United States for the years 1986 to 1988, the average annual reported mileage for interstate truck shipments of all commodities was approximately 45 billion km (28 billion mi), and for train shipments approximately 48.8 billion railcar-km (30.3 billion railcar-mi) (Saricks and Kvitek, 1994). The estimated annual LLW shipments for the maximum transportation alternative would represent approximately 0.2% of the annual truck and rail transportation activity within the United States.

E.7.2.2 Collective Population Risk Results

The results for the collective risk assessment for the 14 LLW alternatives are also summarized in Table E-15 for truck shipments, and Table E-16 for rail shipments. The results for collective risk are presented for shipment of the current inventories plus the estimated generation of LLW for a period of 20 years.

Examination of the results of the transportation risk assessment shows that differences in population risk among the various cases are primarily dependent on total shipping distances. Thus, in general, centralized options predictably show larger transportation risks than regionalized or decentralized approaches because the centralized options involve greater transportation distances. The total shipping distance for each alternative is determined by the definition of the case (shipment origin and destination sites), site-specific waste inventories (specifically waste volume and mass, which directly determine the total number of shipments), packaging assumptions, and route distances among all pairs of origin and destination sites.

Table E–15. Total Population Impacts of Transportation of Current LLW Inventories Plus 20 Years of LLW Generation: Truck Mode

Impact	Alternative[a]														
	No Action	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Regionalized 4	Regionalized 5	Regionalized 6	Regionalized 7	Centralized 1	Centralized 2	Centralized 3	Centralized 4	Centralized 5	Onsite[b]
Shipment summary															
Shipments	87,360	24,420	25,800	25,880	84,200	87,390	92,200	174,390	188,930	242,730	257,270	250,020	264,060	241,540	11,640
Mileage (10^6 mi)	166	8.63	9.31	9.19	38.1	36.9	63.8	124	125	563	505	530	478	560	0.27
Population impacts															
Cargo-related[c]															
Dose risk (person-rem)															
Routine crew	4,690	319	343	338	1,210	1,190	1,900	3,870	3,890	15,800	14,500	14,900	13,700	15,700	10.1
Routine public	5,620	335	362	357	1,340	1,310	2,180	4,350	4,410	18,700	17,200	17,700	16,300	18,700	0.224
Accident[d]	2.45	0.132	0.648	0.648	1.52	2.13	344	233	205	580	563	580	567	580	NA
Latent cancer fatalities[e]															
Crew fatalities	1.9	0.13	0.1	0.1	0.5	0.48	0.8	1.5	1.6	6.3	5.8	6.0	5.5	6.3	0.004
Public fatalities	2.7	0.17	0.2	0.2	0.7	0.66	1.1	2.3	2.2	9.7	8.6	9.1	8.4	9.3	0.0001
Vehicle-related[f]															
Emission fatalities	1.0	0.088	0.1	0.1	0.2	0.22	0.3	0.67	0.8	2.4	2.9	2.2	2.8	2.4	NA
Accident fatalities	10.8	0.43	0.5	0.5	2.6	2.5	4.4	8.7	9.0	35	35.1	33	34	35.0	NA
Total population health effects (fatalities)	16.4	0.8	0.9	0.9	4.0	3.9	6.6	13	13.6	53	52.4	50	51	53.0	NA

Note: NA = not applicable.

[a] Alternative definitions are summarized in Section E.2.2 and provided in detail in Chapter 3 of the PEIS.

[b] Onsite impacts are calculated for the Hanford Site.

[c] Cargo-related impacts are impacts attributable to the radioactive nature of the waste material.

[d] Dose risk is a societal risk and is the product of accident probability and accident consequence.

[e] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public (ICRP, 1991).

[f] Vehicle-related impacts are impacts independent of the cargo in the shipment.

Table E–16. Total Population Impacts of Transportation of Current LLW Inventories Plus 20 Years of LLW Generation: Rail Mode

Impact	Alternative[a]														
	No Action	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Regionalized 4	Regionalized 5	Regionalized 6	Regionalized 7	Centralized 1	Centralized 2	Centralized 3	Centralized 4	Centralized 5	Onsite[b]
Shipment summary															
Shipments	33,420	9,210	9,740	9,900	31,850	33,460	35,430	66,040	71,480	91,440	96,880	96,710	102,100	90,980	4,360
Mileage (10^6 mi)	69.9	3.50	3.74	3.78	17.2	16.6	25.3	51.4	54.4	224	219	218	212	223	0.122
Population impacts															
Cargo-related[c]															
Dose risk (person-rem)															
Routine crew[d]	388	41.1	43.7	44.2	163	166	208	405	433	1,190	1,190	1,190	1,180	1,190	1.38
Routine public	849	128	135	136	408	368	470	820	845	2,340	2,340	2,310	2,310	2,330	0
Accident[e]	1.03	0.0859	0.162	0.162	0.626	0.886	23.9	44.0	25.0	114	90.9	114	91.6	113	NA
Latent cancer fatalities[f]															
Crew fatalities	0.15	0.016	0.02	0.02	0.07	0.067	0.08	0.16	0.17	0.48	0.47	0.48	0.47	0.47	5.52×10^{-4}
Public fatalities	0.43	0.064	0.07	0.07	0.21	0.18	0.23	0.43	0.42	1.2	1.20	1.1	1.2	1.20	0
Vehicle-related[g]															
Emission fatalities	0.78	0.12	0.13	0.13	0.32	0.23	0.35	0.47	0.47	1.8	1.8	1.7	1.8	1.8	NA
Accident fatalities	0.15	0.0073	0.0078	0.0079	0.036	0.035	0.053	0.11	0.11	0.47	0.46	0.46	0.45	0.47	NA
Total population health effects (fatalities)	1.5	0.21	0.23	0.23	0.64	0.51	0.71	1.2	1.2	4.0	3.9	3.7	3.9	3.9	NA

Note: NA = not applicable.

[a] Alternative definitions are summarized in Section E.2.2 and provided in detail in Chapter 3 of the PEIS.

[b] Onsite impacts are calculated for the Hanford Site.

[c] Cargo-related impacts are impacts attributable to the radioactive nature of the waste material.

[d] Rail crew values are expected to range from impacts listed in this table (for dedicated shipments) to slightly higher than the truck crew impacts identified in the previous table. See Section E.7 for a more detailed explanation.

[e] Dose risk is a societal risk and is the product of accident probability and accident consequence.

[f] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public (ICRP, 1991).

[g] Vehicle-related impacts are impacts independent of the cargo in the shipment.

For truck transportation, the total estimated number of fatalities from radiological causes ranges from approximately 0.3 to 16. For rail transportation, fatalities from radiological causes range from 0.08 to 1.7. Shipment by rail results in lower doses to crew members and the public, primarily because of the reduced number of shipments involved. In general, for LLW shipments, the vehicle-related risks are greater than the associated cargo-related risks.

E.7.2.3 Maximally Exposed Individual Assessment

The estimated doses during routine transportation for each of the individual receptors considered (see Section E.6.9 for exposure assumptions) are presented in Table E–17 on a per-event basis. The total dose for repeated exposures can be estimated by multiplying the per-event dose by the number of exposures.

As noted previously for HLW shipments, the potential exists for significant individual exposures if multiple exposure-causing events occur during LLW shipments; for instance, the dose to a person caught in a traffic jam for 30 minutes next to a shipment is estimated to be 0.5 mrem. If the exposure is longer, the dose would rise proportionally. Therefore, it is conceivable that a person could receive a dose of between 2 to

Table E–17. Estimated Routine Doses and Lifetime Risk of Fatal Cancer to MEIs From Shipments of LLW (per Exposure Event)[a]

Receptor[b]	Dose (rem)		Lifetime Risk[c]	
	Truck	Rail	Truck	Rail
Workers				
Crew member	d	d	d	d
Inspector	1.5E-04	1.5E-04	6.0E-08	6.0E-08
Rail-yard crew member	NA	7.9E-05	NA	3.0E-08
Public				
Resident	1.6E-08	1.6E-08	8.0E-12	8.0E-12
Person in traffic jam	5.0E-04	5.0E-04	3.0E-07	3.0E-07
Person at service station	2.1E-05	NA	1.0E-08	NA
Resident near rail stop	NA	1.1E-06	NA	6.0E-10

Note: NA = not applicable.
[a] The external dose rate is assumed to be 1 mrem/h at 1 m (3.3 ft) for all shipments.
[b] Receptor assumptions are described in Section E.6.9.
[c] Lifetime risk of fatal cancer based on ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.
[d] The DOE administrative control level limits doses to DOE workers to 2 rem/yr.

10 mrem while stopped in traffic next to an LLW shipment. In addition, a person working at a truck service station could receive an increased dose if trucks were to use the same stops repeatedly. If a truck-stop worker is present for 100 shipment stops (at the distance and duration given previously), the estimated dose is approximately 2 mrem. Administrative controls could be instituted to control the location and duration of truck stops if multiple exposures were to happen routinely. The probability of multiple exposures increases as the amount of waste transportation increases.

The potential cumulative dose to a resident living along a site entrance route is summarized in Table E-18 for the LLW alternatives. Doses were calculated for all DOE sites in each case; however, only the five sites sending or receiving the most shipments have been included in Table E-18. The cumulative doses assume that a resident is present for every shipment entering and exiting a site and is unshielded at a distance of 30 m (98 ft) from the roadway. The maximum cumulative dose would occur near centralized facilities because of the large number of shipments entering a single site; for instance, for the Centralized 2 Alternative, the maximum dose to a resident living near the NTS would be approximately 4 mrem for the all-truck case and 2 mrem for the all-rail case. The annual dose can be estimated by assuming that shipments would occur over a 20-year period for the No Action Alternative and over a 10-year period for all other cases. The estimated annual dose to a resident would be well below the annual limit of 100 mrem specified for members of the public (DOE, 1990b).

E.7.2.4 Accident Consequence Assessment

For the accident consequence assessment, the waste characteristics for each site were screened to determine the waste with the highest potential radiological consequences if a release were to occur. The LLW from the Argonne National Laboratory-West (ANL-W) site results in the highest transportation accident doses. The doses were highest primarily because the LLW from ANL-W contains a significant amount of cobalt-60, nearly 7,000 Ci per shipment. To comply with regulations in 10 CFR 71 for Type A packagings, the material would have to be shipped in many packages. In practice, such quantities likely would be shipped in Type B packages; however, for purposes of assessment, the ANL-W source term was used to conservatively estimate the impacts of potential LLW accidents.

As stated previously, the accident consequences were calculated for transportation-related accidents that result in the maximum release of radioactive material (accident severity Category VIII). The accident consequence results are presented in Table E-19. The population doses are for a uniform population

Table E–18. Cumulative Dose and Lifetime Risk to an MEI Living Along a Site Entrance Route for Shipments of LLW (Current Inventories Plus 20 Years of Generation)[a]

Alternative and Site[b]	All Truck			All Rail		
	Total Shipments	Dose (rem)	Lifetime Risk[c]	Total Shipments	Dose (rem)	Lifetime Risk[c]
No Action						
NTS	69,960	1.1E-03	6.0E-07	26,740	4.3E-04	2.0E-07
PORTS	33,440	5.4E-04	3.0E-07	12,740	2.1E-04	1.0E-07
Hanford	17,340	2.8E-04	1.0E-07	6,640	1.1E-04	6.0E-08
Pantex	13,740	2.2E-04	1.0E-07	5,440	8.8E-05	4.0E-08
RMI	7,300	1.2E-04	6.0E-08	2,740	4.4E-05	2.0E-08
Decentralized						
PORTS	23,320	3.7E-04	2.0E-07	8,760	1.4E-04	7.0E-08
RMI	7,680	1.2E-04	6.0E-08	2,870	4.6E-05	2.0E-08
KAPL-S	6,780	1.1E-04	6.0E-08	2,570	4.1E-05	2.0E-08
Mound	5,120	8.2E-05	4.0E-08	1,900	3.1E-05	2.0E-08
Bettis	3,730	6.0E-05	3.0E-08	1,410	2.3E-05	1.0E-08
Regionalized 1						
PORTS	24,820	4.0E-04	2.0E-07	9,330	1.5E-04	8.0E-08
RMI	7,680	1.2E-04	6.0E-08	2,870	4.6E-05	2.0E-08
KAPL-S	6,780	1.1E-04	6.0E-08	2,570	4.1E-05	2.0E-08
Mound	5,120	8.2E-05	4.0E-08	1,900	3.1E-05	2.0E-08
Bettis	3,730	6.0E-05	3.0E-08	1,410	2.3E-05	1.0E-08
Regionalized 2						
PORTS	24,380	3.9E-04	2.0E-07	9,260	1.5E-04	8.0E-08
RMI	7,610	1.2E-04	6.0E-08	2,850	4.6E-05	2.0E-08
KAPL-S	6,670	1.1E-04	5.0E-08	2,560	4.1E-05	2.0E-08
Mound	5,080	8.2E-05	4.0E-08	1,910	3.1E-05	2.0E-08
Bettis	3,660	5.9E-05	3.0E-08	1,400	2.3E-05	1.0E-08
Regionalized 3						
ORR	64,590	1.0E-03	5.0E-07	24,470	3.9E-04	2.0E-07
PORTS	33,440	5.4E-04	3.0E-07	12,740	2.1E-04	1.0E-07
LANL	18,400	3.0E-04	2.0E-07	6,910	1.1E-04	6.0E-08
Pantex	14,500	2.3E-04	1.0E-07	5,440	8.8E-05	4.0E-08
RMI	7,680	1.2E-04	6.0E-08	2,870	4.6E-05	2.0E-08
Regionalized 4						
ORR	58,210	9.4E-04	5.0E-07	22,310	3.6E-04	2.0E-07
PORTS	47,610	7.7E-04	4.0E-07	18,410	3.0E-04	2.0E-07
LANL	17,860	2.9E-04	1.0E-07	6,740	1.1E-04	5.0E-08
Pantex	14,180	2.3E-04	1.0E-07	5,370	8.6E-05	4.0E-08
RMI	7,520	1.2E-04	6.0E-08	2,860	4.6E-05	2.0E-08

Table E-18. Cumulative Dose and Lifetime Risk to an MEI Living Along a Site Entrance Route for Shipments of LLW (Current Inventories Plus 20 Years of Generation)[a]—Continued

Alternative and Site[b]	All Truck			All Rail		
	Total Shipments	Dose (rem)	Lifetime Risk[c]	Total Shipments	Dose (rem)	Lifetime Risk[c]
Regionalized 5						
ORR	63,430	1.0E-03	5.0E-07	24,170	3.9E-04	2.0E-07
PORTS	32,500	5.2E-04	3.0E-07	12,500	2.0E-04	1.0E-07
INEL	25,620	4.1E-04	2.0E-07	10,020	1.6E-04	8.0E-08
Pantex	13,830	2.2E-04	1.0E-07	5,380	8.7E-05	4.0E-08
LANL	11,750	1.9E-04	1.0E-07	4,640	7.5E-05	4.0E-08
Regionalized 6						
SRS	130,030	2.1E-03	1.0E-06	49,340	7.9E-04	4.0E-07
ORR	65,420	1.1E-03	5.0E-07	24,860	4.0E-04	2.0E-07
Hanford	44,360	7.1E-04	4.0E-07	16,700	2.7E-04	1.0E-07
PORTS	33,440	5.4E-04	3.0E-07	12,740	2.1E-04	1.0E-07
Pantex	14,500	2.3E-04	1.0E-07	5,440	8.8E-05	4.0E-08
Regionalized 7						
SRS	130,030	2.1E-03	1.0E-06	49,340	7.9E-04	4.0E-07
ORR	65,420	1.1E-03	5.0E-07	24,860	4.0E-04	2.0E-07
NTS	58,900	9.5E-04	5.0E-07	22,140	3.6E-04	2.0E-07
PORTS	33,440	5.4E-04	3.0E-07	12,740	2.1E-04	1.0E-07
Hanford	14,540	2.3E-04	1.0E-07	5,440	8.8E-05	4.0E-08
Centralized 1						
Hanford	242,730	3.9E-03	2.0E-06	91,440	1.5E-03	7.0E-07
SRS	68,340	1.1E-03	6.0E-07	25,400	4.1E-04	2.0E-07
ORR	65,420	1.1E-03	5.0E-07	24,860	4.0E-04	2.0E-07
PORTS	33,440	5.4E-04	3.0E-07	12,740	2.1E-04	1.0E-07
Pantex	14,500	2.3E-04	1.0E-07	5,440	8.8E-05	4.0E-08
Centralized 2						
NTS	257,270	4.1E-03	2.0E-06	96,880	1.6E-03	8.0E-07
SRS	68,340	1.1E-03	6.0E-07	25,400	4.1E-04	2.0E-07
ORR	65,420	1.1E-03	5.0E-07	24,860	4.0E-04	2.0E-07
PORTS	33,440	5.4E-04	3.0E-07	12,740	2.1E-04	1.0E-07
Hanford	14,540	2.3E-04	1.0E-07	5,440	8.8E-05	4.0E-08
Centralized 3						
Hanford	225,660	3.6E-03	2.0E-06	87,240	1.4E-03	7.0E-07
SRS	67,520	1.1E-03	5.0E-07	25,230	4.1E-04	2.0E-07
ORR	61,250	9.9E-04	5.0E-07	24,470	3.9E-04	2.0E-07
PORTS	47,440	7.6E-04	4.0E-07	18,350	3.0E-04	2.0E-07
LANL	36,640	5.9E-04	3.0E-07	14,400	2.3E-04	1.0E-07

Table E-18. Cumulative Dose and Lifetime Risk to an MEI Living Along a Site Entrance Route for Shipments of LLW (Current Inventories Plus 20 Years of Generation)[a]—Continued

Alternative and Site[b]	All Truck			All Rail		
	Total Shipments	Dose (rem)	Lifetime Risk[c]	Total Shipments	Dose (rem)	Lifetime Risk[c]
Centralized 4						
NTS	239,350	3.9E-03	2.0E-06	92,470	1.5E-03	7.0E-07
SRS	67,520	1.1E-03	5.0E-07	25,230	4.1E-04	2.0E-07
ORR	61,250	9.9E-04	5.0E-07	24,470	3.9E-04	2.0E-07
PORTS	47,440	7.6E-04	4.0E-07	18,350	3.0E-04	2.0E-07
LANL	36,640	5.9E-04	3.0E-07	14,400	2.3E-04	1.0E-07
Centralized 5						
Hanford	241,540	3.9E-03	2.0E-06	90,980	1.5E-03	7.0E-07
SRS	68,540	1.1E-03	6.0E-07	25,320	4.1E-04	2.0E-07
ORR	65,840	1.1E-03	5.0E-07	24,890	4.0E-04	2.0E-07
PORTS	32,500	5.2E-04	3.0E-07	12,500	2.0E-04	1.0E-07
Pantex	14,180	2.3E-04	1.0E-07	5,370	8.6E-05	4.0E-08

[a] The external dose rate is assumed to be 1 mrem/h at 1 m (3.3 ft) for all shipments. The resident is assumed to be present for all shipments that either enter or exit the site. Shipments are assumed to pass at a distance of 30 m (98 ft) and an average speed of 24 km/h (15 mi/h).
[b] For each alternative, only the five sites sending or receiving the most shipments are reported. All other sites have MEI doses less than those presented here.
[c] Lifetime risk of fatal cancer based on ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.

density. The location of the MEI after an accident is determined on the basis of atmospheric conditions and buoyant characteristics of the released plume. The locations of maximum exposure from the accident site are 160 m (525 ft) for neutral conditions and 400 m (1,312 ft) for stable conditions.

The dose to the MEI is independent of the accident location. The maximum dose to an individual (approximately 7 rem for a rail accident under unfavorable weather conditions) has a potential lifetime fatal cancer risk of 4×10^{-3}.

The accident consequence results for LLW from ANL-W should be considered extremely conservative for most LLW shipments for a number of reasons. First, the LLW from ANL-W represents less than 1% by volume of the total LLW generated annually within DOE. Only about two truck shipments would be required each year to transport ANL-W waste to an offsite facility for treatment, storage, or disposal. Therefore, it is unlikely that a severe LLW accident would involve the LLW from ANL-W. Second, the

Table E-19. Estimated Consequences for the Most Severe Accidents Involving Shipments of LLW [a,b]

Mode and Accident Location	Neutral Conditions[c]				Stable Conditions[d]			
	Population[e]		MEI[f]		Population[e]		MEI[f]	
	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatality)	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatality)
Truck								
Urban	8.3E+03	4.2E+00	7.7E-01	3.9E-04	6.7E+04	3.4E+01	2.6E+00	1.3E-03
Suburban	1.6E+03	8.0E-01	7.7E-01	3.9E-04	1.2E+04	6.0E+00	2.6E+00	1.3E-03
Rural	1.5E-01	8.0E-03	7.7E-01	3.9E-04	1.2E+02	6.0E-02	2.6E+00	1.3E-03
Rail								
Urban	2.2E+04	1.1E+01	2.1E+00	1.3E-03	1.8E+05	9.0E+01	7.0E+00	3.5E-03
Suburban	4.2E+03	2.1E+00	2.1E+00	1.3E-03	3.3E+04	1.7E+01	7.0E+00	3.5E-03
Rural	4.1E+01	2.0E-02	2.1E+00	1.3E-03	3.2E+02	1.6E-01	7.0E+00	3.5E-03

[a] The most severe accidents correspond to the highest NUREG-0170 accident severity category (Category VIII) (NRC, 1977a). Results are reported for LLW from ANL-W, which was found to result in the highest potential accident doses.
[b] Buoyant plume rise resulting from fire for a severe accident was included in the exposure model.
[c] Neutral weather conditions result in moderate dispersion and dilution of the released plume. Neutral conditions were taken to be Pasquill Stability Class D with a windspeed of 4 m/s (9 mi/h). Neutral conditions occur approximately 50% of the time in the United States.
[d] Stable weather conditions result in minimal dispersion and dilution of the released plume and are thus unfavorable. Stable conditions were taken to be Pasquill Stability Class F with a windspeed of 1 m/s (2.2 mi/h). Stable conditions occur approximately one-third of the time in the United States.
[e] Populations extend at a uniform population density to a radius of 80 km (50 mi) from the accident site. Population exposure pathways include acute inhalation; acute cloudshine; groundshine; resuspended inhalation; resuspended cloudshine; and ingestion of food, including initially contaminated food (rural only). No decontamination or mitigative actions are taken.
[f] The MEI is assumed to be at the location of maximum exposure. The locations of maximum exposure would be 160 m (525 ft) and 400 m (1,312 ft) from the accident site under neutral and stable atmospheric conditions, respectively. Individual exposure pathways include acute inhalation, acute cloudshine, and groundshine during passage of the plume. No ingested dose is considered.

accident dose results for LLW from ANL-W are at least a factor of 10 greater than those for LLW from other sites, primarily because of the cobalt-60 content of the ANL-W waste. The "average" accident consequences would be much less than those presented here.

E.7.2.5 Onsite Assessment Results

The onsite risks for LLW transportation at the Hanford Site are summarized in Table E-15 for truck transportation and in Table E-16 for rail transportation. The risks presented for the transportation crew include the dose to workers in areas along the shipping route. The total dose to workers close to the route

is generally much less than the dose to the actual crew members involved in transporting the waste. Risks calculated for the public include persons sharing the transportation route with waste shipments. The MEI for routine conditions, besides crew members, was considered to be a guard at a facility gate or checkpoint along the route who is exposed to each shipment for 1 minute at a distance of 5 m (16.4 ft). The total dose to the guard for all shipments is estimated to be 30 mrem. Overall, the routine onsite shipment risks are much less than the offsite shipment risks for all cases considered.

In addition, the consequences of an onsite accident at the Hanford Site are summarized in Table E–20. For the accident consequence assessment, the characteristics of LLW from the Hanford Site were used. The

Table E–20. Results of Onsite Accident Consequence Assessment for the Hanford Site

	Onsite Population		Offsite Population		MEI	
Waste and Transport Mode	**Neutral Conditions**	**Stable Conditions**	**Neutral Conditions**	**Stable Conditions**	**Neutral Conditions**	**Stable Conditions**
Dose (person-rem)						
LLW						
Truck	7.6E-02	2.6E-01	9.0E-01	7.7E+00	7.7E-03	2.6E-02
Rail	2.0E-01	6.9E-01	2.4E+00	2.1E+01	2.1E-02	7.0E-02
CH-TRUW						
Truck	1.0E+01	3.6E+01	6.0E+00	5.2E+01	2.5E-01	8.4E-01
Rail	2.1E+01	7.0E+01	1.2E+01	1.0E+02	5.0E-01	1.7E+00
RH-TRUW						
Truck	2.1E+00	7.1E+00	1.2E+00	1.1E+01	5.0E-02	1.7E-01
Rail	4.1E+00	1.4E+01	2.4E+00	2.1E+01	1.0E-01	3.4E-01
LLMW						
Truck	4.5E+00	1.6E+01	8.1E+00	6.9E+01	1.1E-01	3.6E-01
Rail	1.2E+01	4.0E+01	2.1E+01	1.8E+02	2.8E-01	9.3E-01
Risk (latent cancer fatalities)						
LLW						
Truck	3.0E-05	1.0E-04	4.5E-04	3.8E-03	3.9E-06	1.3E-05
Rail	8.1E-05	2.8E-04	1.2E-03	1.0E-02	1.0E-05	3.5E-05
CH-TRUW						
Truck	4.2E-03	1.4E-02	3.0E-03	2.6E-02	1.3E-04	4.2E-04
Rail	8.2E-03	2.8E-02	5.9E-03	5.2E-02	2.5E-04	8.3E-04
RH-TRUW						
Truck	8.2E-04	2.8E-03	6.0E-04	5.3E-03	2.5E-05	8.4E-05
Rail	1.6E-03	5.6E-03	1.2E-03	1.1E-02	5.0E-05	1.7E-04
LLMW						
Truck	1.8E-03	6.2E-03	4.0E-03	3.5E-02	5.3E-05	1.8E-04
Rail	4.7E-03	1.6E-02	1.1E-02	9.0E-02	1.4E-04	4.6E-04

MEI is located at the position where maximum impacts would occur, similar to the offsite accident consequence assessment. An exposure of 2 hours was assumed for the population of onsite workers after an accident. The impacts on the offsite population were calculated by using the population distribution in the vicinity of the Hanford Site and by assuming a 1-year exposure duration.

E.7.3 TRANSURANIC WASTE

The projected rate for TRUW generation for each site, the waste characteristics, the potential treatments, and the cases considered in the PEIS are described in detail in the TRUW technical report (ANL, 1996i). Transportation risks have been calculated for five TRUW alternative cases summarized in Section E.2.2 (1 of the 6 alternatives does not involve waste transportation). The alternatives range from decentralized to centralized approaches to treatment and storage before final geologic disposal. The No Action Alternative does not involve transport of waste. The other alternatives each have CH-TRUW and RH-TRUW components. The transportation assessment assumes that all TRUW will ultimately be shipped to WIPP for disposal. The WM PEIS considers current inventories of TRUW plus 20 years of TRUW generation for all DOE sites. All impacts are calculated as totals for the entire waste inventory under consideration. The average annual risk can be estimated by dividing the summarized results by the duration of the shipping campaigns. For purposes of the PEIS, to estimate the sizes of potential facilities needed for treatment, the assumption has been made that waste would be shipped over a 10-year period. Previous assessments have assumed that TRUW would be shipped to WIPP over a 20-year period (DOE, 1990b). Transportation of TRUW for treatment, storage, and disposal is also analyzed in the DOE'S *Draft WIPP Disposal Phase Supplemental Environmental Impact Statement.*

E.7.3.1 Shipment Summary

The total number of shipments and the mileage for loaded shipments for each TRUW alternative are summarized in Table E–21 for truck shipments and Table E–22 for rail shipments. The total truck shipments range from approximately 18,640 to 23,900. For rail transportation, the corresponding numbers range from 9,360 to 12,010 shipments. The total distance for loaded shipments ranges from 55 to 69 million km (34 to 43 million mi) for truck transportation and from 26 to 34 million km (16 to 21 million mi) for rail transportation. The average annual number of shipments and mileage can be estimated by dividing the total results by a shipping duration of either 10 or 20 years.

Table E-21. Total Population Impacts of Transportation of Current TRUW Inventories Plus 20 Years of TRUW Generation: Truck Mode

Impact	Alternative[a]						
	No Action	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Centralized	Onsite[b]
Shipment summary							
Shipments	0	23,900	21,680	18,640	20,600	21,640	206
Mileage (10^6 mi)	--	42.4	38.3	34.0	37.2	38.7	0.0047
Population impacts							
Cargo-related[c]							
Dose risk (person-rem)							
Routine crew	--	3,650	3,270	2,890	3,160	3,310	11
Routine public	--	3,870	3,360	2,940	3,310	3,490	0.56
Accident[d]	--	9.80	8.98	8.98	11.8	8.93	NA
Latent cancer fatalities[e]							
Crew fatalities	--	1.5	1.3	1.2	1.3	1.3	0.0044
Public fatalities	--	1.9	1.7	1.5	1.7	1.7	0.00028
Vehicle-related[f]							
Emission fatalities	--	0.22	0.19	0.18	0.19	0.20	NA
Accident fatalities	--	3.0	2.7	2.4	2.6	2.7	NA
Total population health effects (fatalities)	--	6.6	5.9	5.2	5.7	6.0	NA

Note: NA = not applicable.
[a] Alternative definitions are summarized in Section E.2.2 and provided in detail in Chapter 3 of the PEIS.
[b] Onsite impacts are calculated for the Hanford Site.
[c] Cargo-related impacts are impacts attributable to the radioactive nature of the waste material.
[d] Dose risk is a societal risk and is the product of accident probability and accident consequence.
[e] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.
[f] Vehicle-related impacts are independent of the shipment's cargo.

For comparison, within the United States for the years 1986 to 1988, the average annual reported mileage for interstate truck shipments of all commodities was approximately 45 billion km (28 billion mi), and for rail shipments approximately 48.8 billion railcar-km (30.3 billion railcar-mi) (Saricks and Kvitek, 1994). The maximum estimated annual TRUW shipments would represent much less than 0.1% of the annual truck and rail transportation activity within the United States.

Table E–22. Total Population Impacts of Transportation of Current TRUW Inventories Plus 20 Years of TRUW Generation: Rail Mode

Impact	Alternative[a]						
	No Action	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Centralized	Onsite[b]
Shipment summary							
Shipments	0	12,010	10,890	9,360	10,340	10,870	104
Mileage (10^6 mi)	--	20.3	18.2	15.8	17.4	18.4	0.0029
Population impacts							
Cargo-related[c]							
Dose risk (person-rem)							
Routine crew[d]	--	836	756	656	718	759	4.8
Routine public	--	1,130	978	821	907	1,010	0
Accident[e]	--	0.777	0.770	0.773	0.844	0.768	NA
Latent cancer fatalities[f]							
Crew fatalities	--	0.33	0.30	0.26	0.28	0.30	0.0019
Public fatalities	--	0.57	0.49	0.41	0.46	0.51	0
Vehicle-related[g]							
Emission fatalities	--	0.10	0.091	0.073	0.079	0.091	NA
Accident fatalities	--	0.043	0.037	0.033	0.036	0.039	NA
Total population health effects (fatalities)	--	1.0	0.92	0.78	0.86	0.94	NA

Note: NA = not applicable.
[a] Alternative definitions are summarized in Section E.2.2 and provided in detail in Chapter 3 of the PEIS.
[b] Onsite impacts are calculated for the Hanford Site.
[c] Cargo-related impacts are impacts attributable to the radioactive nature of the waste material.
[d] Rail crew values are expected to range from impacts listed in this table (for dedicated shipments) to slightly higher than the truck crew impacts identified in the previous table. See Section E.7 for a more detailed explanation.
[e] Dose risk is a societal risk and is the product of accident probability and accident consequence.
[f] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.
[g] Vehicle-related impacts are independent of the shipment's cargo.

E.7.3.2 Collective Population Risk Results

The results for collective risk assessment for the TRUW alternatives are also summarized in Table E–21 for truck shipments and Table E–22 for rail shipments. The collective risk results are presented for shipment of the current TRUW inventories plus the estimated generation of TRUW for a period of 20 years.

Examination of the results of the transportation risk assessment shows that differences in population risk among the various cases are dependent primarily on total shipping distances. The total shipping distance

for each alternative is determined by the definition of the case (shipment origin and destination sites), site-specific waste inventories (specifically waste volume and mass, which directly determine the total number of shipments), packaging assumptions, and the route distances among all pairs of origin-and-destination sites.

The total estimated number of fatalities from radiological causes ranges from approximately 2.7 to 3.4 for truck shipments. For rail transportation, fatalities from radiological causes range from 0.67 to 0.90. Shipment by the rail mode results in lower doses to crew members and the public, primarily because of the reduced number of shipments involved. In general, for TRUW shipments, the vehicle-related risks are comparable to the associated cargo-related risks.

E.7.3.3 Maximally Exposed Individual Assessment

The estimated doses during routine transportation for each individual receptor considered (see Section E.6.9 for exposure assumptions) are presented in Table E–23 for CH-TRUW, and in Table E–24 for RH-TRUW. The total dose for repeated exposures can be estimated by multiplying the per-event dose by the number of exposures.

Except for doses to crew members, all doses are presented for single exposures. Note that the potential exists for significant individual exposures if multiple exposure-causing events occur. For example, the dose to a person stopped in traffic next to a truck shipment of CH-TRUW for 30 minutes is estimated to be 5 mrem; if the exposure duration were longer, the dose would rise proportionally. Therefore, it is conceivable that a person could receive a dose of approximately 10 to 20 mrem while stopped in traffic next to a TRUW shipment. In addition, a person working at a truck service station could receive an increased dose if trucks used the same stops repeatedly. If a truck stop worker were present for 100 CH-TRUW shipment stops (at the distance and duration given previously), the estimated dose would be approximately 20 mrem. Administrative controls could be instituted to control the location and duration of truck stops if multiple exposures were to happen routinely. The probability of multiple exposures increases as the amount of waste transportation increases.

The cumulative dose to a resident living along a site entrance route is summarized in Table E–25 for each TRUW alternative. Note that each alternative involves both contact- and remote-handled shipments. Although doses were calculated for all DOE sites storing or generating TRUW, only data for the five sites

Table E-23. Estimated Routine Doses and Lifetime Risk of Fatal Cancer to MEIs From Shipments of CH-TRUW (per Exposure Event)[a]

Receptor[b]	Dose (rem)		Lifetime Risk[c]	
	Truck	Rail	Truck	Rail
Workers				
Crew member	d	d	d	d
Inspector	1.4E-03	1.4E-03	6.0E-07	6.0E-07
Rail-yard crew member	NA	1.5E-03	NA	6.0E-07
Public				
Resident	1.5E-07	3.0E-07	8.0E-11	2.0E-10
Person in traffic jam	4.7E-03	9.3E-03	2.0E-06	5.0E-06
Person at service station	1.9E-04	NA	1.0E-07	NA
Resident near rail stop	NA	2.1E-05	NA	1.0E-08

Note: NA = not applicable.
[a] The dose rate is assumed to be 3 mrem/h at 1 m (3.3 ft) from each package.
[b] Receptor assumptions are described in Section E.6.9.
[c] Lifetime risk of fatal cancer based on ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.
[d] The DOE administrative control level limits doses to DOE workers to 2 rem/yr.

Table E-24. Estimated Routine Doses and Lifetime Risk of Fatal Cancer to MEIs From Shipments of RH-TRUW (per Exposure Event)[a]

Receptor[b]	Dose (rem)		Lifetime Risk[c]	
	Truck	Rail	Truck	Rail
Workers				
Crew member	d	d	d	d
Inspector	1.0E-03	1.0E-03	4.0E-07	4.0E-07
Rail-yard crew member	NA	1.1E-03	NA	4.0E-07
Public				
Resident	1.1E-07	2.3E-07	6.0E-11	1.0E-10
Person in traffic jam	3.6E-03	7.1E-03	2.0E-06	4.0E-06
Person at service station	1.5E-04	NA	8.0E-08	NA
Resident near rail stop	NA	1.5E-05	NA	8.0E-09

Note: NA = not applicable.
[a] Dose rate is assumed to be 7 mrem/h at 1 m (3.3 ft) from each package.
[b] Receptor assumptions are described in Section E.6.9.
[c] Lifetime risk of fatal cancer based on ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public.
[d] The DOE administrative control level limits doses to DOE workers to 2 rem/yr.

Table E-25. Cumulative Dose and Lifetime Risk to an MEI Living Along a Site Entrance Route for Shipments of TRUW (Current Inventories Plus 20 Years of Generation)[a]

Alternative and Site[b]	All Truck			All Rail		
	Total Shipments	Dose (rem)	Lifetime Risk[c]	Total Shipments	Dose (rem)	Lifetime Risk[c]
Decentralized						
WIPP	23,860	3.1E-03	2.0E-06	11,970	3.1E-03	2.0E-06
Hanford	10,260	1.2E-03	6.0E-07	5,140	1.2E-03	6.0E-07
INEL	5,970	8.7E-04	4.0E-07	2,990	8.7E-04	4.0E-07
SRS	2,370	3.6E-04	2.0E-07	1,190	3.6E-04	2.0E-07
ORR	1,910	2.1E-04	1.0E-07	970	2.2E-04	1.0E-07
Regionalized 1						
WIPP	20,080	2.5E-03	1.0E-06	10,060	2.6E-03	1.0E-06
Hanford	11,920	1.4E-03	7.0E-07	5,970	1.4E-03	7.0E-07
INEL	4,900	7.1E-04	4.0E-07	2,460	7.1E-04	4.0E-07
ORR	2,440	2.7E-04	1.0E-07	1,230	2.8E-04	1.0E-07
LANL	1,320	1.9E-04	1.0E-07	670	2.0E-04	1.0E-07
Regionalized 2						
WIPP	17,040	2.1E-03	1.0E-06	8,530	2.2E-03	1.0E-06
Hanford	11,830	1.3E-03	7.0E-07	5,930	1.4E-03	7.0E-07
INEL	4,250	6.1E-04	3.0E-07	2,130	6.1E-04	3.0E-07
LANL	1,030	1.5E-04	8.0E-08	520	1.5E-04	8.0E-08
ORR	990	1.1E-04	5.0E-08	500	1.1E-04	6.0E-08
Regionalized 3						
WIPP	17,030	2.1E-03	1.0E-06	8,520	2.2E-03	1.0E-06
Hanford	11,830	1.3E-03	7.0E-07	5,930	1.4E-03	7.0E-07
INEL	7,610	1.1E-03	6.0E-07	3,820	1.1E-03	6.0E-07
LANL	1,350	2.0E-04	1.0E-07	680	2.0E-04	1.0E-07
ORR	990	1.1E-04	5.0E-08	500	1.1E-04	6.0E-08
Centralized						
WIPP	20,500	2.6E-03	1.0E-06	10,290	2.7E-03	1.0E-06
Hanford	11,610	1.3E-03	7.0E-07	5,820	1.4E-03	7.0E-07
INEL	5,180	7.5E-04	4.0E-07	2,600	7.6E-04	4.0E-07
SRS	2,080	3.1E-04	2.0E-07	1,040	3.1E-04	2.0E-07
LANL	1,350	2.0E-04	1.0E-07	680	2.0E-04	1.0E-07

[a] The external dose rates are assumed to be 3 mrem/h at 1 m (3.3 ft) for CH-TRUW, and 7 mrem/h for RH-TRUW shipments. The resident is assumed to be present for all shipments that enter or exit the site. Shipments are assumed to pass at a distance of 30 m (98 ft) and an average speed of 24 km/h (15 mi/h).

[b] For each alternative, only the five sites sending or receiving the most shipments are reported. All other sites have MEI doses less than those presented here.

[c] Lifetime risk of fatal cancer based on ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public.

sending or receiving the most shipments have been provided for each case in Table E–25. The cumulative doses assume that an unshielded resident is present at a distance of 30 m (98 ft) from the roadway for every shipment entering or exiting a site. In almost all cases, the maximum cumulative dose would occur near the WIPP disposal site. If all CH-TRUW and RH-TRUW were shipped to WIPP, the maximum dose to a resident would be less than 4 mrem for both truck and rail cases. The truck and rail doses are similar because the same number of packages would be shipped for each mode. The annual dose can be estimated by assuming that shipments would occur over either a 10- or 20-year period. The annual dose to a resident would be well below the annual limit of 100 mrem specified for members of the public through DOE orders (DOE, 1990b), as well as comparable NRC limits (10 CFR 20).

E.7.3.4 Accident Consequence Assessment

For the accident consequence assessment, the characteristics of contact- and remote-handled waste for each site were screened to determine the waste with the highest potential radiological consequences if a release were to occur during an accident. For CH-TRUW, waste shipments from LANL were found to result in the highest potential transportation accident doses. For RH-TRUW, shipments from the Hanford Site were found to result in the highest potential accident doses. The accident consequence results are presented in Table E–26 for contact-handled shipments and Table E–27 for remote-handled shipments. The population doses are for a uniform population density within an 80-km (50-mi) radius of accidents occurring in rural, suburban, and urban population density zones.

The location of the MEI after an accident is determined on the basis of atmospheric conditions and buoyant characteristics of the released plume. The locations of maximum exposure are 160 m (525 ft) from the accident site for neutral conditions, and 400 m (1,312 ft) from the accident site for stable conditions. The dose to the MEI is independent of the accident location. The maximum dose to an individual (approximately 34 rem for a RH-TRUW rail accident under unfavorable weather conditions) corresponds to a potential lifetime fatal cancer risk of 2×10^{-2}.

E.7.3.5 Onsite Assessment Results

The onsite risks for TRUW transportation at the Hanford Site are summarized in Table E–21 for trucks and Table E–22 for rail. The risks presented for the transportation crew include the dose to workers in areas

Table E-26. Estimated Consequences for the Most Severe Accidents Involving Shipments of CH-TRUW [a,b]

Mode and Accident Location	Neutral Conditions[c]				Stable Conditions[d]			
	Population[e]		MEI[f]		Population[e]		MEI[f]	
	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatality)	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatality)
Truck								
Urban	4.0E+03	2.0E+00	3.5E+00	1.8E-03	3.2E+04	1.6E+01	1.2E+01	6.0E-03
Suburban	7.4E+02	3.7E-01	3.5E+00	1.8E-03	5.9E+03	3.0E+00	1.2E+01	6.0E-03
Rural	6.5E+00	3.0E-03	3.5E+00	1.8E-03	5.2E+01	3.0E-02	1.2E+01	6.0E-03
Rail								
Urban	7.9E+02	4.0E+00	7.1E+00	3.6E-03	6.3E+04	3.2E+01	2.4E+01	1.2E-02
Suburban	1.5E+02	7.5E-01	7.1E+00	3.6E-03	1.2E+04	6.0E+00	2.4E+01	1.2E-02
Rural	1.3E+01	7.0E-03	7.1E+00	3.6E-03	1.0E+02	5.0E-02	2.4E+01	1.2E-02

[a] The most severe accidents correspond to the highest NUREG-0170 accident severity category (Category VIII) (NRC, 1977a). Results are reported for CH-TRUW from LANL.
[b] Buoyant plume rise resulting from fire for a severe accident was included in the exposure model. Three TRUPACT-IIs are assumed to be breached in a truck accident; six TRUPACT-IIs are assumed to be equally breached in a rail accident.
[c] Neutral weather conditions result in moderate dispersion and dilution of the released plume. Neutral conditions were taken to be Pasquill Stability Class D with a windspeed of 4 m/s (9 mi/h). Neutral conditions occur approximately 50% of the time in the United States.
[d] Stable weather conditions result in minimal dispersion and dilution of the released plume and are thus unfavorable. Stable conditions were taken to be Pasquill Stability Class F with a windspeed of 1 m/s (2.2 mi/h). Stable conditions occur approximately one-third of the time in the United States.
[e] Populations extend at a uniform population density to a radius of 80 km (50 mi) from the accident site. Population exposure pathways include acute inhalation; acute cloudshine; groundshine; resuspended inhalation; resuspended cloudshine; and ingestion of food, including initially contaminated food (rural only). No decontamination or mitigative actions are taken.
[f] The MEI is assumed to be at the location of maximum exposure. The locations of maximum exposure would be 160 m (525 ft) from the accident site under neutral atmospheric conditions, and 400 m (1,312 ft) for stable atmospheric conditions. Individual exposure pathways include acute inhalation, acute cloudshine, and groundshine during passage of the plume. No ingested dose is considered.

along the shipping route. The total dose to workers adjacent to the route is generally much less than the dose to the crew members involved in transporting the waste. Risks calculated for the public include persons sharing the transportation route with waste shipments. The MEI for routine conditions, besides crew members, was considered to be a guard at a facility gate or checkpoint along the route exposed to each shipment for 1 minute at a distance of 5 m (16.4 ft). The total dose to the guard from all shipments is estimated to be 61 mrem. Overall, the routine onsite shipment risks are much lower than the offsite shipment risks for all cases considered.

Table E-27. Estimated Consequences for the Most Severe Accidents Involving Shipments of RH-TRUW [a,b]

Mode and Accident Location	Neutral Conditions[c]				Stable Conditions[d]			
	Population[e]		MEI[f]		Population[e]		MEI[f]	
	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatality)	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatality)
Truck								
Urban	6.0E+01	3.0E-02	5.1E-02	2.6E-05	4.8E+02	2.4E-01	1.7E+01	8.5E-03
Suburban	1.1E+01	5.5E-03	5.1E-02	2.6E-05	8.9E+01	4.5E-02	1.7E+01	8.5E-03
Rural	1.0E-01	5.0E-03	5.1E-02	2.6E-05	8.3E+01	4.2E-04	1.7E+01	8.5E-03
Rail								
Urban	1.2E+02	6.0E-02	1.0E-01	5.0E-05	9.5E+02	4.8E-01	3.4E+01	1.7E-02
Suburban	2.2E+01	1.1E-02	1.0E-01	5.0E-05	1.8E+02	9.0E-02	3.4E+01	1.7E-02
Rural	2.1E-01	1.1E-04	1.0E-01	5.0E-05	1.7E+00	8.5E-04	3.4E+01	1.7E-02

[a] The most severe accidents correspond to the highest NUREG-0170 accident severity category (Category VIII) (NRC, 1977a). Results are reported for RH-TRUW from the Hanford Site.
[b] Buoyant plume rise resulting from fire for a severe accident was included in the exposure model. One RH-72B is assumed to be breached in a truck accident; two RH-72Bs are assumed to be equally breached in a rail accident.
[c] Neutral weather conditions result in moderate dispersion and dilution of the released plume. Neutral conditions were taken to be Pasquill Stability Class D with a windspeed of 4 m/s (9 mi/h). Neutral conditions occur approximately 50% of the time in the United States.
[d] Stable weather conditions result in minimal dispersion and dilution of the released plume and are thus unfavorable. Stable conditions were taken to be Pasquill Stability Class F with a windspeed of 1 m/s (2.2 mi/h). Stable conditions occur approximately one-third of the time in the United States.
[e] Populations extend at a uniform population density to a radius of 80 km (50 mi) from the accident site. Population exposure pathways include acute inhalation; acute cloudshine; groundshine; resuspended inhalation; resuspended cloudshine; and ingestion of food, including initially contaminated food (rural only). No decontamination or mitigative actions are taken.
[f] The MEI is assumed to be at the location of maximum exposure. The locations of maximum exposure would be 160 m (525 ft) and from the accident site under neutral atmospheric conditions, and 400 m (1,312 ft) for stable atmospheric conditions. Individual exposure pathways include acute inhalation, acute cloudshine, and groundshine during passage of the plume. No ingested dose is considered.

The consequences of an onsite accident at the Hanford Site are summarized in Table E-20. For the accident consequence assessment, characteristics of CH-TRUW and RH-TRUW from the Hanford Site were used. The MEI is located at the position where maximum impacts would occur, similar to the offsite accident consequence assessment. An exposure of 2 hours was assumed for the population of onsite workers after an accident. Impacts on the offsite population were calculated by using the population distribution near the Hanford Site and by assuming a 1-year exposure duration.

E.7.4 LOW-LEVEL MIXED WASTE

The projected rate of LLMW generation for each site, the waste characteristics, the potential treatments, and the cases considered in the PEIS are described in detail in ANL (1996k). Transportation risks have been calculated for the LLMW alternatives summarized in Section E.2.2 (the No Action Alternative does not involve transportation of LLMW). The cases range from decentralized to centralized approaches to TSD. The number of disposal sites varies from 16 sites for decentralized disposal to 1 site for centralized disposal. Options for treatment also vary from decentralized to centralized approaches.

The PEIS considers current inventories of LLMW plus 20 years of generation for all DOE sites. All impacts are calculated as totals for the entire inventory of waste under consideration. The average annual risk can be estimated by dividing the summarized results by the duration of the shipping campaigns. For all alternatives, shipments would occur uniformly over a 10-year period, with the assumption of a 10-year period to build TSD facilities. These timeframes are consistent with the assumptions used in the facility assessments for estimating throughputs.

E.7.4.1 Shipment Summary

The total number of shipments and the mileage for loaded shipments for each LLMW alternative are summarized in Table E-28 for truck shipments, and Table E-29 for rail shipments. The estimated number of shipments and the total mileage for the various cases span a wide range. The total number of truck shipments ranges from approximately 490 for the Decentralized Alternative to about 11,000 shipments for the Regionalized 3 Alternative. For rail transportation, the corresponding numbers of shipments range from 360 to 4,540. The total mileage for loaded shipments ranges from 0.37 to 24 million km (0.23 to 15 million mi) for truck transportation and from 0.34 to 11 million km (0.21 to 6.8 million mi) for rail transportation. The average annual number of shipments and mileage can be estimated by dividing the total results by the shipping duration which is assumed to be 10 years in the WM PEIS.

For comparison, within the United States for the years 1986 to 1988, the average annual reported mileage for interstate truck shipments of all commodities was approximately 45 billion km (28 billion mi), and for train shipments approximately 48.8 billion railcar-km (30.3 billion railcar-mi) (Saricks and Kvitek, 1994). The estimated annual LLMW shipments for the maximum transportation alternative would represent less than 0.1% of the annual truck and rail transportation activity within the United States.

Table E-28. Total Population Impacts of Transportation of Current LLMW Inventories Plus 20 Years of LLMW Generation: Truck Mode

Impact	Alternative[a]						
	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Regionalized 4	Centralized	Onsite[b]
Shipment summary							
Shipments	480	1,820	5,560	10,990	4,250	7,520	1,720
Mileage (10^6 mi)	0.25	0.59	2.57	14.9	2.89	13.5	0.051
Population impacts							
Cargo-related[c]							
Dose risk (person-rem)							
Routine crew	8.22	20.4	80.3	429	84.1	374	1.49
Routine public	9.72	23.1	92.6	513	98.6	447	0.033
Accident[d]	1.09	2.23	15.4	26	15.9	148	NA
Latent cancer fatalities[e]							
Crew fatalities	0.0033	0.0083	0.032	0.17	0.033	0.15	0.00060
Public fatalities	0.0055	0.013	0.053	0.27	0.049	0.29	1.72×10^{-5}
Vehicle-related[f]							
Emission fatalities	0.0046	0.0085	0.024	0.10	0.015	0.054	NA
Accident fatalities	0.018	0.038	0.19	1.0	0.19	0.83	NA
Total fatalities	0.031	0.068	0.30	1.5	0.29	1.3	NA

Note: NA = not applicable.
[a] Alternative definitions are summarized in Section E.2.2 and provided in detail in Chapter 3 of the PEIS.
[b] Onsite impacts are calculated for the Hanford Site.
[c] Cargo-related impacts are impacts attributable to the radioactive nature of the waste material.
[d] Dose risk is a societal risk and is the product of accident probability and accident consequence.
[e] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public (ICRP, 1991).
[f] Vehicle-related impacts are impacts independent of the cargo in the shipment.

E.7.4.2 Collective Population Risk Results

The results for the collective risk assessment for the LLMW alternatives are also summarized in Table E-28 for truck shipments, and Table E-29 for rail shipments. The results for collective risk are presented for shipment of the current inventories plus the estimated generation of LLMW for a period of 20 years.

Examination of the results of the transportation risk assessment shows that differences in population risk among the various cases are primarily dependent on total shipping distances. Thus, in general, centralized options predictably show larger transportation risks than regionalized or decentralized approaches because the centralized options involve greater transportation distances. The total shipping distance for each alternative is determined by the definition of the case (shipment origin and destination sites), site-specific

Table E-29. Total Population Impacts of Transportation of Current LLMW Inventories Plus 20 Years of LLMW Generation: Rail Mode

Impact	Alternative[a]						
	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Regionalized 4	Centralized	Onsite[b]
Shipment summary							
Shipments	350	1,030	2,490	4,540	2,050	3,340	660
Mileage (10^6 mi)	0.23	0.48	1.37	6.76	1.57	6.46	0.026
Population impacts							
Cargo-related[c]							
Dose risk (person-rem)							
Routine crew[d]	1.97	4.98	12.9	41.3	12.5	36.6	0.206
Routine public	5.75	13.7	29.1	75.8	28.2	69.3	0.0024
Accident[e]	0.311	0.596	2.18	4.61	2.60	27.6	NA
Latent cancer fatalities[f]							
Crew fatalities	0.00081	0.0020	0.0052	0.017	0.0050	0.015	8.3×10^{-5}
Public fatalities	0.0031	0.0072	0.015	0.040	0.015	0.049	9.6×10^{-7}
Vehicle-related[g]							
Emission fatalities	0.0057	0.013	0.023	0.055	0.024	0.053	NA
Accident fatalities	0.00050	0.0010	0.0028	0.014	0.0032	0.014	NA
Total fatalities	0.010	0.023	0.046	0.13	0.047	0.13	NA

Note: NA = not applicable.
[a] Alternative definitions are summarized in Section E.2.2 and provided in detail in Chapter 3 of the PEIS.
[b] Onsite impacts are calculated for the Hanford Site.
[c] Cargo-related impacts are impacts attributable to the radioactive nature of the waste material.
[d] Rail crew values are expected to range from impacts listed in this table (for dedicated shipments) to slightly higher than the truck crew impacts identified in the previous table. See Section E.7
[e] Dose risk is a societal risk and is the product of accident probability and accident consequence.
[f] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP, 1991).
[g] Vehicle-related impacts are impacts independent of the cargo in the shipment.

waste inventories (specifically waste volume and mass, which directly determine the total number of shipments), packaging assumptions, and route distances among all pairs of origin and destination sites.

For truck transportation, the total estimated number of fatalities from radiological causes ranges from approximately 0.009 to 0.5. For rail transportation, fatalities from radiological causes range from 0.004 to 0.06. Shipment by rail results in lower doses to crew members and the public, primarily because of the reduced number of shipments involved. In general, for LLMW shipments, the vehicle-related risks are greater than the associated cargo-related risks.

E.7.4.3 Maximally Exposed Individual Assessment

The estimated doses during routine transportation for each of the individual receptors considered (see Section E.6.9 for exposure assumptions) are presented in Table E–30 on a per-event basis. The total dose for repeated exposures can be estimated by multiplying the per-event dose by the number of exposures.

As noted previously for HLW and LLW shipments, the potential exists for significant individual exposures if multiple exposure-causing events occur during LLMW shipments; for instance, the dose to a person caught in a traffic jam for 30 minutes next to a shipment is estimated to be 0.5 mrem. If the exposure is longer, the dose would rise proportionally. Therefore, it is conceivable that a person could receive a dose of between 2 to 10 mrem while stopped in traffic next to an LLMW shipment. In addition, a person working at a truck service station could receive an increased dose if trucks were to use the same stops repeatedly. If a truck-stop worker is present for 100 shipment stops (at the distance and duration given previously), the estimated dose is approximately 2 mrem. Administrative controls could be instituted to control the location and duration of truck stops if multiple exposures were to happen routinely. The probability of multiple exposures increases as the amount of waste transportation increases.

Table E–30. Estimated Routine Doses and Lifetime Risk of Fatal Cancer to MEIs From Shipments of LLMW (per Exposure Event)[a]

Receptor[b]	Dose (rem)		Lifetime Risk[c]	
	Truck	Rail	Truck	Rail
Workers				
Crew member	d	d	d	d
Inspector	1.5E-04	1.5E-04	6.0E-08	6.0E-08
Rail-yard crew member	NA	7.9E-05	NA	3.0E-08
Public				
Resident	1.6E-08	1.6E-08	8.0E-12	8.0E-12
Person in traffic jam	5.0E-04	5.0E-04	3.0E-07	3.0E-07
Person at service station	2.1E-05	NA	1.0E-08	NA
Resident near rail stop	NA	1.1E-06	NA	6.0E-10

Note: NA = not applicable.
[a] Dose rate is assumed to be 1 mrem/h at 1 m (3.3 ft) from an LLMW shipment.
[b] Receptor assumptions are described in Section E.6.9.
[c] Lifetime risk of fatal cancer based on ICRP Publication 60 (ICRP, 1991) health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public.
[d] The DOE administrative control level limits doses to DOE workers to 2 rem/yr.

The potential cumulative dose to a resident living along a site entrance route is summarized in Table E-31 for the LLMW alternatives. Doses were calculated for all DOE sites for each case; however, only the five sites sending or receiving the most shipments have been included in Table E-31. The cumulative doses assume that a resident is present for every shipment entering and exiting a site and is unshielded at a distance of 30 m (98 ft) from the roadway. The maximum cumulative dose would occur near regionalized or centralized facilities because of the large number of shipments entering a small number of sites; for instance, for the Regionalized 3 Alternative, the maximum dose to a resident living near the NTS would be approximately 0.2 mrem for the all-truck case and 0.06 mrem for the all-rail case. The annual dose can be estimated by assuming that shipments would occur over a 10-year period for all alternatives. The estimated annual dose to a resident would be well below the annual limit of 100 mrem specified for members of the public through DOE Orders (DOE, 1990b), as well as comparable NRC limits (10 CFR 20).

E.7.4.4 Accident Consequence Assessment

As stated previously, the accident consequences were calculated for transportation-related accidents that result in the maximum release of radioactive material (accident severity Category VIII). For these accidents, the assumptions were that all of the material in the shipment would be released from its packaging, that 10% would be entrained as an aerosol, and that 5% of the aerosol would be respirable.

During screening, the LLMW from the Paducah Gaseous Diffusion Plant (PGDP) was found to result in the highest transportation accident doses for the most severe accidents. The accident consequence results from RISKIND for LLMW shipments are presented in Table E-32. The population doses are for a uniform population density within an 80-km (50-mi) radius of accidents occurring in rural, suburban, and urban population density zones. The location of the MEI after an accident is determined on the basis of atmospheric conditions and the buoyant characteristics of the released plume. The locations of maximum exposure are approximately 160 m (525 ft) and 400 m (1,312 ft) from the accident site for neutral and stable weather conditions, respectively. The dose to the MEI is independent of the location of the accident. The maximum dose to an individual (approximately 5 rem for a rail accident under unfavorable weather conditions) has a potential lifetime fatal-cancer risk of 2.0E-03.

Table E-31. Cumulative Dose and Lifetime Risk to MEI Living Along a Site Entrance Route for WM LLMW Shipments (Current Inventories plus 20 Years of Generation)[a]

Alternatives and Site[b]	All Truck			All Rail		
	Total Shipments	Dose (rem)	Risk (Fatal Cancer)[c]	Total Shipments	Dose (rem)	Risk (Fatal Cancer)[c]
Decentralized						
LLNL	250	4.0E-06	2.0E-09	120	1.9E-06	1.0E-09
ETEC	110	1.8E-06	9.0E-10	40	6.4E-07	3.0E-10
NTS	100	1.6E-06	8.0E-10	40	6.4E-07	3.0E-10
SRS	90	1.4E-06	7.0E-10	90	1.4E-06	7.0E-10
PORTS	90	1.4E-06	7.0E-10	90	1.4E-06	7.0E-10
Regionalized 1						
FEMP	1,060	1.7E-05	9.0E-09	410	6.6E-06	3.0E-09
PORTS	820	1.3E-05	7.0E-09	440	7.1E-06	4.0E-09
ANL-E	450	7.2E-06	4.0E-09	180	2.9E-06	1.0E-09
LLNL	310	5.0E-06	3.0E-09	180	2.9E-06	1.0E-09
NTS	120	1.9E-06	1.0E-09	60	9.7E-07	5.0E-10
Regionalized 2						
LANL	2,610	4.2E-05	2.0E-08	1,020	1.6E-05	8.0E-09
RFETS	2,560	4.1E-05	2.0E-08	980	1.6E-05	8.0E-09
PORTS	2,260	3.6E-05	2.0E-08	960	1.5E-05	8.0E-09
ORR	1,660	2.7E-05	1.0E-08	650	1.0E-05	5.0E-09
ANL-E	450	7.2E-06	4.0E-09	180	2.9E-06	1.0E-09
Regionalized 3						
NTS	9,650	1.6E-04	8.0E-08	3,700	6.0E-05	3.0E-08
RFETS	2,560	4.1E-05	2.0E-08	980	1.6E-05	8.0E-09
PORTS	2,260	3.6E-05	2.0E-08	960	1.5E-05	8.0E-09
ORR	2,100	3.4E-05	2.0E-08	790	1.3E-05	6.0E-09
Hanford	1,690	2.7E-05	1.0E-08	710	1.1E-05	6.0E-09
Regionalized 4						
INEL	2,450	3.9E-05	2.0E-08	1,040	1.7E-05	8.0E-09
RFETS	1,990	3.2E-05	2.0E-08	740	1.2E-05	6.0E-09
ORR	1,480	2.4E-05	1.0E-08	740	1.2E-05	6.0E-09
PORTS	650	1.0E-05	5.0E-09	260	4.2E-06	2.0E-09
ANL-E	450	7.2E-06	4.0E-09	180	2.9E-06	1.0E-09
Centralized						
Hanford	7,520	1.2E-04	6.0E-08	3,340	5.4E-05	3.0E-08
RFETS	1,990	3.2E-05	2.0E-08	740	1.2E-05	6.0E-09
ORR	1,970	3.2E-05	2.0E-08	740	1.2E-05	6.0E-09
INEL	700	1.1E-05	6.0E-09	290	4.7E-06	2.0E-09
PORTS	650	1.0E-05	5.0E-09	260	4.2E-06	2.0E-09

[a] The external dose rate is assumed to be 1 mrem/h at 1 m (3.3 ft) for all shipments. The resident is assumed to be present for all shipments that enter or exit the site. Shipments are assumed to pass at a distance of 30 m (98 ft) and an average speed of 24 km/h (15 mi/h).

[b] For each alternative, only the five sites sending or receiving the most shipments are reported. All other sites have MEI doses less than those presented here.

[c] The risk of fatal cancer is calculated by using the ICRP Publication 60 (ICRP, 1991) health risk conversion factor of 5.0E-04 fatal cancers per person-rem for members of the public.

Table E–32. Estimated Consequences for the Most Severe Accidents Involving Shipments of WM LLMW[a,b]

Mode and Accident Location	Neutral Conditions[c]				Stable Conditions[d]			
	Population[e]		MEI[f]		Population[e]		MEI[f]	
	Dose (person-rem)	Risk (Cancer Fatalities)	Dose (rem)	Risk (Cancer Fatality)	Dose (person-rem)	Risk (Cancer Fatalities)	Dose (rem)	Risk (Cancer Fatality)
Truck								
Urban	6.0E+02	3.0E-01	5.3E-01	2.7E-04	4.75E+03	2.0E+00	1.8E+00	9.0E-04
Suburban	1.1E+02	6.0E-02	5.3E-01	2.7E-04	8.85E+02	4.0E-01	1.8E+00	9.0E-04
Rural	1.0E+00	5.0E-04	5.3E-01	2.7E-04	7.5E+00	4.0E-03	1.8E+00	9.0E-04
Rail								
Urban	1.62E+03	8.0E-01	1.4E+00	7.0E-04	1.283E+04	6.0E+00	4.8E+00	2.4E-03
Suburban	3.0E+02	2.0E-01	1.4E+00	7.0E-04	2.4E+03	1.0E+00	4.8E+00	2.4E-03
Rural	2.7E+00	1.0E-03	1.4E+00	7.0E-04	2.0E+01	1.0E-02	4.8E+00	2.4E-03

[a] The most severe accidents correspond to the highest NUREG-0170 accident severity category (Category VIII) (NRC, 1977a). Results are reported for WM LLMW from PGDP, which was found to result in the highest potential accident doses. The assumptions were that 100% of the radioactive material would be released from its packaging in an accident, that 10% of the release would be entrained in an aerosol, and that 5% of the aerosolized release would be respirable.

[b] Buoyant plume rise resulting from fire for a severe accident was included in the exposure model.

[c] Neutral weather conditions result in moderate dispersion and dilution of the released plume. Neutral conditions were taken to be Pasquill Stability Class D with a wind speed of 4 m/s (9 mi/h). Neutral conditions occur approximately 50% of the time in the United States.

[d] Stable weather conditions result in minimal dispersion and dilution of the released plume and are thus unfavorable. Stable conditions were taken to be Pasquill Stability Class F with a wind speed of 1 m/s (2.2 mi/h). Stable conditions occur approximately one-third of the time in the United States.

[e] Populations extend at a uniform population density to a radius of 80 km (50 mi) from the accident site. Population exposure pathways include acute inhalation; acute cloudshine; groundshine; resuspended inhalation; resuspended cloudshine; and ingestion of food, including initially contaminated food (rural only). No decontamination or mitigative actions are taken.

[f] The MEI is assumed to be at the location of maximum exposure. The locations of maximum exposure would be 160 m (525 ft) and 400 m (1,312 ft) from the accident site under neutral and stable atmospheric conditions, respectively. Individual exposure pathways include acute inhalation, acute cloudshine, and groundshine during passage of the plume. No ingested dose is considered.

E.7.4.5 Onsite Assessment Results

The onsite risks for LLMW transportation at the Hanford Site are summarized in Table E–28 for truck transportation and in Table E–29 for rail transportation. The risks presented for the transportation crew include the dose to workers in areas along the shipping route. The total dose to workers close to the route is generally much less than the dose to the actual crew members involved in transporting the waste. Risks calculated for the public include persons sharing the transportation route with waste shipments. The MEI for routine conditions, besides crew members, was considered to be a guard at a facility gate or checkpoint along the route who is exposed to each shipment for 1 minute at a distance of 5 m (16.4 ft). The total dose to the guard for all shipments is estimated to be 16 mrem. Overall, the routine onsite shipment risks are much less than the offsite shipment risks for all cases considered.

In addition, the consequences of an onsite accident at the Hanford Site are summarized in Table E–20. For the accident consequence assessment, the characteristics of LLMW from the Hanford Site were used. The MEI is located at the position where maximum impacts would occur, similar to the offsite accident consequence assessment. An exposure of 2 hours was assumed for the population of onsite workers after an accident. The impacts on the offsite population were calculated by using the population distribution in the vicinity of the Hanford Site and by assuming a 1-year exposure duration.

E.8 Uncertainties and Conservatism in Estimated Impacts

The sequence of analyses performed to generate estimates of radiological risk for transporting radioactive waste includes (1) determining waste inventory and characteristics at each site, (2) estimating shipment requirements, (3) determining route characteristics, (4) calculating radiation doses to exposed individuals (including estimating of environmental transport and uptake of radionuclides), and (5) estimating health effects. Uncertainties are associated with each step. Uncertainties exist in the way that the physical systems being analyzed are represented by the computational models; in the data required to apply the models (because of measurement errors, sampling errors, natural variability, or unknowns caused simply by the future nature of the actions being analyzed); and in the calculations themselves (for example, the approximation algorithms used by the computers).

In principle, one can estimate the uncertainty associated with each input or computational source and predict the resultant uncertainty in each subsequent set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final, or absolute, result.

However, conducting such a full-scale quantitative uncertainty analysis is often impractical and sometimes impossible, especially for actions to be initiated at an unspecified time in the future. Instead, the risk analysis is designed to ensure—through uniform and judicious selection of scenarios, models, and input parameters—that relative comparisons of risk among the various alternatives are meaningful. In the transportation risk assessment, this design is accomplished by uniformly applying input parameters and assumptions to all alternatives for each waste type. Therefore, although considerable uncertainty is inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

In the following sections, areas of uncertainty are discussed for each assessment step enumerated previously, with the exception of health effects. Special emphasis is placed on identifying whether the uncertainties affect relative or absolute measures of risk. Where practical, the parameters that most significantly affect the risk assessment results are identified, and quantitative estimates of uncertainty are provided. The uncertainties involved in estimating health effects from radiological doses are discussed in Appendix D.

E.8.1 Uncertainties in Waste Inventory and Characterization

The site-specific waste inventories and the physical and radiological waste characteristics are important input parameters for the transportation risk assessment. The potential amount of transportation for any alternative is determined primarily by the projected waste inventory at each site and assumptions about shipment configurations (packaging and shipment capacities). The physical and radiological waste characteristics are important in determining the amount of waste released during accidents and the subsequent doses to exposed individuals through multiple environmental exposure pathways.

The development of projected site-specific inventory and waste characterization data, including identification of uncertainties, is discussed in the reports prepared for each waste type. In general, the uncertainties in the data specific to the site and to the waste type may potentially affect the relative and absolute measures of transportation risk and are difficult to quantify. Precisely defining the impact of these uncertainties on the transportation risk analysis is difficult because of the large number of sites and alternatives and because of the inability to accurately quantify the uncertainty in waste characterization at each site.

The uncertainties in the waste characterization data will be reflected to some degree in the transportation risk results. If the waste inventories are consistently overestimated (or underestimated), the resulting transportation risk estimates will also be overestimated (or underestimated) by roughly the same factor. In terms of relative risk comparisons, if the uncertainty in one site inventory is large as compared with other site inventories, then the uncertainties may not be comparable among different alternatives, and meaningful relative risk comparisons are difficult. For example, if the inventory at Site A is overestimated as compared with other sites, the risk transportation assessment results will be unduly biased toward those alternatives that do not involve shipping Site A waste; however, the waste characterization data have been carefully developed by uniformly applying consistent methodologies and assumptions to the best available information. This approach is expected to limit the overall uncertainty in the data and the likelihood that the level of uncertainty varies significantly among sites. For comparative purposes among alternatives, the observed differences in transportation risks are believed to represent unbiased, reasonably accurate estimates from current information.

E.8.2 Uncertainties in Shipment Configurations

As stated previously, the amount of transportation required for each alternative is partly based on assumptions about the packaging and shipment configurations for each waste type. Representative shipment configurations have been defined for each waste type on the basis of either historical or probable future shipment capacities (for example, all truck shipments of LLW are assumed to be at the regulatory weight limit). In reality, the actual shipment capacities may differ from the predicted capacities so that the projected number of shipments and, consequently, the total transportation risk would change; however, although the predicted transportation risks would increase or decrease accordingly, the relative differences in risks among consolidation alternatives would generally remain unchanged.

E.8.3 Uncertainties in Route Determination

Conceptual routes have been determined between all pairs of origin and destination sites considered by the alternatives. The routes have been determined consistent with current guidelines, regulations, and practices but may not be the actual routes that will be used in the future. In reality, the actual routes may differ from the conceptual ones in terms of distances and total population along the routes. Moreover, because the assessment considers wastes generated over the next 20 to 30 years, the highway and rail infrastructures and the demographics along routes may change as a function of time. Although these effects have not been

accounted for in the transportation assessment, it is not anticipated that these changes would significantly affect relative comparisons of risk among alternatives considered in the PEIS.

E.8.4 UNCERTAINTIES IN THE CALCULATION OF RADIATION DOSES

The models used to calculate radiation doses from transportation activities introduce additional uncertainty into the risk assessment process. Estimating the accuracy, or absolute uncertainty, of the risk assessment results is generally difficult. The accuracy of the calculated results is closely related to the limitations of the computational models and to the uncertainties in each of the input parameters that the model requires. The single greatest limitation facing users of RADTRAN, or any computer code of this type, is the scarcity of data for certain input parameters.

Uncertainties associated with the computational models are minimized by using state-of-the-art computer codes that have been extensively reviewed. However, because numerous uncertainties are recognized but are difficult to quantify, assumptions are made at each step of the risk assessment process that are intended to produce conservative results (that is, overestimate the calculated dose and radiological risk). Because parameters and assumptions are applied equally to all alternatives for a waste type, this model bias is not expected to affect the meaningfulness of relative comparisons of risk; however, the results may not represent risks in an absolute sense.

To understand the most important uncertainties and conservatisms in the transportation risk assessment, the results for all cases were examined to identify the largest contributors to the collective population risk. The results of this examination are discussed briefly in the following paragraphs.

For truck shipments, the largest contributors to the collective population dose were found to be, in decreasing order of importance: (1) incident-free dose to members of the public at stops; (2) incident-free dose to transportation crew members; (3) incident-free dose to members of the public sharing the route (on-link dose); (4) incident-free dose to members of the public living along the route (off-link dose); and (5) accident dose risk to members of the public. Approximately 80% of the estimated public dose was incurred at stops; 15% was incurred by the on-link population; and 5% was incurred by the off-link population. In general, the accident contribution to the total risk was negligible as compared with the incident-free risk.

For rail shipments, the largest contributors to the collective population dose were found to be the following (in decreasing order of importance): (1) incident-free dose to transportation crew members; (2) incident-free dose to members of the public living along the route (off-link dose); (3) incident-free dose to members of the public at stops; (4) incident-free dose to members of the public sharing the route (on-link dose); and (5) accident dose risk to members of the public. Approximately 70% of the estimated public dose was incurred by the off-link population; 25% was incurred by the population at stops; and 5% was incurred by the on-link population. As with truck shipments, the accident contribution to the total risk in general was negligible as compared with the incident-free risk.

As shown previously, incident-free transportation risks are the dominant component of the total transportation risk for both truck and rail modes. The most important parameter in calculating incident-free doses is the shipment external dose rate (incident-free doses are directly proportional to the shipment external dose rate). For calculational purposes, representative dose rates have been applied to each waste type because information is not available to predict shipment dose rates accurately on a site-by-site basis. The representative dose rates are based on historical shipments or waste type-specific data when possible and were selected to reflect the probable average dose rates of future shipments. In practice, the external dose rates will vary not only from site to site and waste type to waste type, but also from shipment to shipment at a given site; and the rates will range above and below the levels assumed for this assessment.

Finally, the single largest contributor to the collective population doses calculated with RADTRAN was found to be the dose to members of the public at truck stops. RADTRAN uses a simple point source approximation for truck stop exposures and assumes that the total stop time for a shipment is proportional to the shipment distance. The parameters used in the stop model were based on a survey of a very limited number of radioactive material shipments that examined various shipment types in different areas of the country (Madson and Wilmot, 1982). The assumption was made that stops occur as a function of distance, with a rate of 0.011 h/km; thus, for a 1,000-km (621-mi) trip, the total would be 11 hours of stops. The further assumption was made that an average of 25 people are exposed at a distance of 20 m (66 ft) at each stop. The population dose is directly proportional to the external shipment dose rate and the number of people exposed (25) and is inversely proportional to the square of the distance ($20 \times 20 = 400$). Based on the limited data available, the parameter values used in the assessment appear to be conservative; however, data do not exist to qualitatively assess the degree of conservatism in the stop dose model. As a practical matter, DOE could conceivably take steps to control the location, frequency, and duration of truck stops, if necessary to assure that the local population does not receive excessive exposure to radiation.

E.8.5 UNCERTAINTIES IN THE COMPARISON OF TRUCK AND RAIL TRANSPORTATION MODES

The transportation risk assessment results presented in the WM PEIS indicate that rail transportation poses a lower overall risk to workers and the public as compared with truck transportation of the same quantity of waste. However, it is important to recognize that although rail shipments were found to result in a smaller number of expected fatalities compared with truck shipments, in general the risks from transportation operations are small for both modes. Moreover, comparisons between truck and rail shipment risks need to consider the uncertainties inherent in the risk assessment process. As discussed above, in most cases the calculational uncertainties are difficult to quantify and, in fact, may not be the same between the truck and rail assessment assumptions. Some important issues that should be considered while comparing truck and rail shipment risks are discussed below.

In the WM PEIS, transportation risks were estimated for the shipment of all waste by (a) 100% truck and (b) 100% rail for each alternative and waste type. The intent of this approach was to bound the transportation impacts for any possible mix of truck and rail shipments, recognizing that both will likely take place in the future. Therefore, all facilities were assumed to have rail access. A review of the transportation capabilities at 35 major DOE sites indicated that 15 have direct rail access onsite, an additional 12 have access within 10 miles, and 8 more have access between 10 and 100 miles. For those sites lacking direct rail access, the risks associated with shipping waste by truck to a rail siding were not considered in detail in the WM PEIS assessment, although preliminary evaluations indicated that these activities are generally a small contributor to the overall transportation risk.

Although subject to calculational uncertainties, a number of factors contribute to the assessment results, indicating that rail shipments have lower impacts than truck shipments for the same alternative. These include:

- Rail shipments are larger than truck shipments (about three times larger) and thus require fewer total shipments. Consequently, impacts tend to be lower for rail because overall transportation impacts tend to be proportional to shipment mileage.
- On a per-shipment basis, rail shipments have lower radiological impacts than truck shipments. The radiological impacts from rail shipments tend to be lower than truck shipments because fewer members of the public are exposed during rail transport (primarily fewer people at stops and sharing the routes). In addition, crew members tend to be much farther from the radioactive material packages. However, the differences in radiological risk between the two modes for all

alternatives lies within the uncertainty from the estimates for the number and location of exposed persons in both cases.

Although rail impacts were found to be lower than truck impacts, a number of considerations were not specifically addressed in the representative assessment conducted for the purposes of the WM PEIS. First, rail shipments may require additional handling and preparation, especially for sites lacking rail access, which will contribute to the overall rail shipment risk. Second, rail shipments generally require a large inventory of waste to be cost-effective, and thus may not be a cost-effective option at smaller generating sites. Finally, rail operations in general are not as flexible and responsive to individual site needs and capabilities as truck operations.

E.9 Mitigative Measures

The DOE is committed to conducting all transportation-related activities in a manner protective of human health and safety. The hazards of transporting radioactive materials under both incident-free conditions and accidents are minimized by existing regulations. All activities related to transporting radioactive waste would be conducted according to applicable health-and-safety requirements of the Federal Government, States, and local jurisdictions, including requirements promulgated by DOT in 49 CFR.

Transportation planning integrates a wide range of expertise and requirements, including program engagement, material handling and packaging, transportation operations (traffic management), key governmental involvement, public information, environmental safety and health, and emergency preparedness. Where necessary, planning would be clarified in a Transportation Plan that would document the planned logistics for a shipping campaign. The focus of this plan would be operational; e.g., the handling, packaging, and transport of the waste through sequential steps resulting in the safe transport to a site. The plan would include organizational responsibilities of DOE, the shipper, corridor jurisdictions, and other Federal agencies. It would contain shipment schedules, transport mode, shipment route, emergency plan and contacts, and communication strategies.

Although detailed plans about waste transportation will not be prepared for major shipping campaigns until some future time, safety plans have been prepared for a program involving the transportation of TRUW

to WIPP. The plans for WIPP can be considered as representative of those for future major DOE programs for waste transportation. The WIPP plans (DOE, 1990a) include provisions for the following:

- Vehicles and equipment with the best available mechanical safeguards, including personal protective equipment and speed limiters
- A facility for maintaining and inspecting equipment
- A safety program, including personnel training in safe work practices
- Stringent driver-training program and penalty provisions
- Accident and emergency training
- Constant-surveillance service for all loaded shipments
- Communications equipment and services

In reviewing the WIPP program activities, the National Academy of Sciences concluded that the "system proposed for transportation of TRUW waste to the WIPP is safer than that employed for any other hazardous material in the United States today and will reduce risk to very low levels" (DOE, 1990a).

In addition to these policies, DOE may impose administrative measures to control accumulated doses during specific circumstances. Examples of administrative controls would include requiring temporary lead shielding between loaded casks and service personnel, controlling the location and duration of service stops, and prohibiting transportation during inclement weather. These measures would ensure that all exposures are maintained below the regulatory dose limits specified in DOE Orders 5400.5 and 5480.11 (DOE, 1988c, 1990b), as well as comparable NRC limits (10 CFR 20) for members of the public and for workers.

For accidents, DOE has issued a series of orders specifying the requirements for emergency preparedness, including DOE Orders 5500.10, 5500.2B, 5500.3A, and 5500.4A (DOE, 1991a–c, 1992a). Each DOE site has also established an emergency management program, such as the one at the Hanford Site (WHC, 1994). Procedures and agreements among DOE, other Federal agencies, and State agencies are in place to allow for effective response by all appropriate parties if a severe accident should occur.

State and local police and fire departments have primary responsibility for responding to events that could endanger the health and welfare of their citizens. Most States maintain specialized teams capable of responding to hazardous materials incidents. Through the capabilities these teams currently possess for dealing with potential accidents involving other hazardous materials (e.g., hazardous chemicals), they should already have the capability to deal with most plausible accidents involving LLW and LLMW. Thus, additional training for LLW and LLMW would most likely be minimal. However, some states would

require additional training to respond to potential radioactive hazards resulting from TRUW or HLW transportation accidents. Currently, to assist in planning and preparedness for an unlikely, but theoretically possible transportation emergency involving TRUW or HLW radioactive shipments, DOE does offer a variety of radiological emergency response resources and information to complement existing emergency preparedness programs, and will continue to maintain a comprehensive emergency management system, particularly for radiological emergencies. The emergency management system includes training courses, Regional Coordinating Offices, and DOE Radiological Assistance Program teams.

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APPENDIX E—PART II
Hazardous Waste Transportation Risk Assessment

E.11 Introduction

Part II of this appendix considers risk from hazardous waste (HW) transportation and from the hazardous waste components of low-level mixed waste (LLMW) and transuranic waste (TRUW). These wastes are regulated under the Resource Conservation and Recovery Act (RCRA). Some waste types not covered by RCRA but regulated by the States or under the Toxic Substances Control Act (TSCA: 7 United States Code [USC] 136) are also included. The transportation of each waste type for treatment and ultimate disposal is an integral component of the alternatives being considered in the U.S. Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS).

This appendix should be read in conjunction with the technical reports for HW, LLMW, and TRUW (ANL, 1996a-c), which present inventory characterization and waste load data for each major generator within the DOE complex. These data are used for the transportation risk assessment.

Section E.12 discusses the scope of the transportation risk assessment for HW and HW components of LLMW and TRUW. Section E.13 describes packaging requirements and the distinctions between requirements for HW and those for radioactive waste. Section E.14 describes the method for selecting the most likely transportation routes for use in the risk assessment. Section E.15 describes the analytical approach used for the transportation risk assessment. Modeling input parameters and assumptions are provided in Section E.16. Section E.17 presents the results of the transportation risk assessment for HW, LLMW, and TRUW. Section E.18 discusses sources of uncertainty in the assessment, focusing on areas that might affect comparisons among alternatives. Finally, Section E.19 suggests mitigative measures that could be implemented to reduce the risk of transporting HW and HW components of LLMW and TRUW.

E.12 Scope of Assessment

This section describes the scope of the PEIS transportation risk assessment, including the treatment, storage, and disposal (TSD) alternatives; transportation-related activities; onsite versus offsite assessments; potential

vehicle- and cargo-related impacts; receptors; and transportation modes are considered. Subsequent sections provide additional details about the assessment.

E.12.1 ALTERNATIVES

HW. The HW transportation risk analysis is intended to provide input for decisions about the extent to which DOE should continue to rely on commercial facilities for treating and disposing of the nonaqueous portion of the hazardous waste stream. Four alternatives are considered: (1) No Action, (2) Decentralized, (3) Regionalized 1 (five TSD sites), and (4) Regionalized 2 (two TSD sites). The specific DOE and TSD sites associated with these alternatives are discussed in Section E.17. The HW technical report (ANL, 1996a) contains details about TSD technologies, HW inventory and generation, existing and planned capabilities for treating and storing HW, and waste loads by alternative.

TRUW. For TRUW, six alternatives are considered: (1) No Action, (2) Decentralized, (3) Regionalized 1, (4) Regionalized 2, (5) Regionalized 3, and (6) Centralized. See Section E.2.2.3 for detailed descriptions of these alternatives.

LLMW. For LLMW, seven alternatives are considered: (1) No Action, (2) Decentralized, (3) Regionalized 1, (4) Regionalized 2, (5) Regionalized 3, (6) Regionalized 4, and (7) Centralized. See Section E.2.2.4 for detailed descriptions of these alternatives.

E.12.2 DESCRIPTION OF TRANSPORTATION ACTIVITIES

As in Part I of this appendix, the radioactive waste transportation risk assessment, these HW assessments for HW and HW components of TRUW and LLMW are limited to estimating the human health risks during waste transport. The risks during waste loading, unloading, and handling before or after shipment are not included; nor do these assessments address possible impacts from increased transportation levels on local traffic flow, noise levels, logistics, or infrastructure.

E.12.3 ONSITE VERSUS OFFSITE TRANSPORTATION

The HW transportation risk assessment includes onsite and offsite transportation. These transportation types are as defined in Section E.2.1. To estimate onsite transportation risks, site-specific values are used (when available). Models that rely on simplifying assumptions and average values for many parameters, such as road dimensions, weather conditions, and population densities, are used to estimate risk from offsite shipments. As in the radiological transportation risk assessment, the Hanford Site (Hanford) was selected as representative of conservatively estimated impacts for onsite transportation risks and is used for comparison with offsite transportation risks. On-site analyses were not conducted for TRUW and LLMW. For both of these waste types, the low risks estimated for offsite transportation indicated that risks from onsite transportation would be negligible.

E.12.4 CARGO-RELATED IMPACTS (HAZARDOUS CHEMICAL WASTES)

Cargo-related impacts to human health during HW, TRUW and LLMW transportation come from exposure resulting from container failure and chemical release during an accident (a collision with another vehicle or road obstacle). Containers used for shipping HW have been specified by the U.S. Department of Transportation (DOT) and have been assumed to preclude any significant exposure of workers or the public during routine HW transport. Type A packaging for LLMW is also designed and maintained to ensure the containers will contain and shield their contents during normal transport. TRUW is packaged in TRUPACT-II containers (i.e., external containers into which 55-gal drums are placed for transportation), decreasing further the likelihood of release under routine conditions. Accordingly, no cargo-related impacts are associated with HW transport under routine (incident-free) conditions.

The risks from HW and HW component exposure during transportation accidents can be either acute (resulting in immediate injury or fatality) or latent (resulting in cancer that becomes evident after a latency period of several years). Population risks and risks to the maximally exposed individual (MEI) have been evaluated for transportation accidents. Two acute health endpoints—potential life-threatening effects and potential adverse effects—have been evaluated for assessing cargo-related population impacts from transportation accidents. The identification of chemicals in HW, TRUW, and LLMW with potential life-threatening effects was made by comparison with gaseous and liquid substances designated "poison inhalation hazard" (PIH) chemicals by DOT. Chemicals selected for the potential adverse effects analysis

included PIHs and gaseous or liquid chemicals with inhalation toxicity values (reference concentrations) established by the U.S. Environmental Protection Agency (EPA, 1993a-b).

The acute effects evaluated are assumed to exhibit a threshold, nonlinear relationship with exposure; that is, some low level of exposure can be tolerated without inducing a health effect. Chemical-specific values for the potential life-threatening concentration (PLC) and potential adverse effect concentration (PAEC) were developed to estimate risks. All individuals exposed at these levels or higher are included in HW transportation risk estimates. Use of this type of population risk descriptor, which involves estimating the number of persons exposed above a specified conservatively estimated level, is recommended under EPA guidance (EPA, 1992). Figure E-6 presents a conceptual diagram of how PLC and PAEC values were derived. Additionally, to address MEIs, locations of maximum HW concentration were identified for shipments with the largest potential releases of individual HW components.

A latent health endpoint—"increased cancer risk"—has also been used to assess the cargo-related population impacts from accidents involving carcinogen releases. Traditionally, risk assessment for chemical carcinogens characterizes risk to the MEI (EPA, 1989a). The MEI assessment is included in this HW

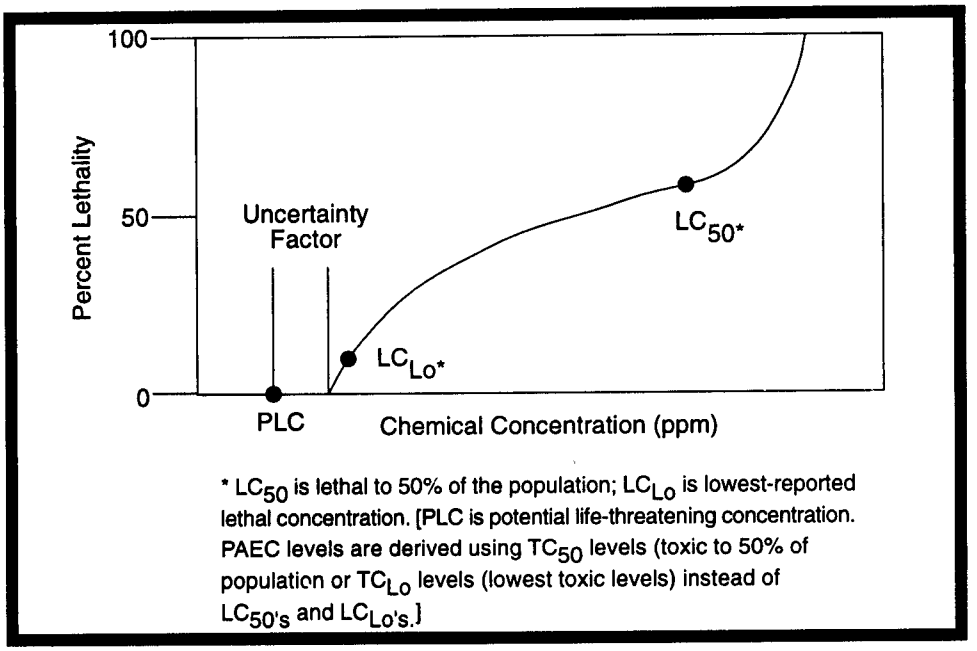

Figure E-6. Conceptualization of Threshold Health Effects.

transportation risk analysis (Section E.17.1.3). Additionally, for assessing risk to the general population, increased carcinogenic risk has been expressed as the number of individuals in the general population with an increased lifetime cancer risk of one in one million or greater, as recommended under EPA guidance for characterization of population risks (EPA, 1992). Cancer risks greater than one in one million have been designated as *increased cancer risk concentrations (ICRC) levels*. Overall population risk (in terms of number of excess cancers expected in the population) has not been calculated for HW as it was for radioactive waste because this calculation would require an estimate of average exposure levels in the population, while standardized cancer risk assessment methods address only MEIs. Therefore, characterizing population cancer risks associated with HW transportation as the number of individuals experiencing an increased risk of one in one million was deemed preferable. Cargo-related population cancer risks presented in this assessment cannot be directly compared with cancer risks for individuals.

Inhalation is the primary exposure route of concern for accidental release of HW, TRUW, and LLMW. Direct exposure to hazardous materials by other pathways, such as ingestion or dermal absorption, is possible, but these routes are expected to result in much lower exposure than the inhalation pathway doses. The likelihood of acute effects, such as those evaluated by using PLC and PAEC values, is much lower for the ingestion and dermal pathways than for inhalation. For HW, this assessment addresses inhalation of organic vapors and gases only: the potential for the public's exposure by inhalation of particulates is considered to be much lower than that for inhalation of vapors or gases because (1) DOE transports limited quantities of solids prone to particulate formation (for example, powders), so releases would be relatively small and would result only in small particulate clouds; (2) because particulates settle rapidly, exposure of the general population located 30 m (100 ft) farther from the release site would be minor because of low particulate concentrations; and (3) acute toxicity of inhaled particulates is lower than for vapors or gases in the DOE shipments for the same quantity released. Although some particulates are carcinogens (for example, cadmium salts), low exposure dose and duration make risks low compared with risks from vapors and gases. For LLMW, two types of exposures from solid wastes are also evaluated to maintain consistency with the radiological assessment. These are (1) volatile organic vapor emissions from contaminated spoils piles (i.e., solid waste spill on the ground); and (2) respirable aerosol fraction of organic substances from a solids spill direct to the atmosphere. Inorganic substances in LLMW were not assessed for the same reasons given above for HW. Evaluation of releases from solids was not conducted for TRUW because the bounding risk from release of organic liquids was minimal.

E.12.5 VEHICLE-RELATED IMPACTS

For HW, vehicle-related risks (independent of a shipment's chemicals) are assessed for the same transportation routes as cargo-related impacts, for routine and accident conditions. Vehicle-related risks under routine conditions are the result of exposure to vehicle-exhaust emissions; risks are primarily associated with exposure in urban environments. Vehicle-related accident risks are fatalities and injuries resulting from direct physical trauma during an accident (not from exposure to released cargo). Fatality and injury rates specific to HW transportation are used in this assessment. For TRUW and LLMW, vehicle-related risks are presented in Part 1 of this appendix.

E.12.6 TRANSPORTATION MODE

HW. The transportation risk assessment is based on shipping HW by truck from generators to TSD facilities. Shipments by rail, barge, and aircraft, although possible, have not been considered because none of these shipment modes were identified in the baseline case data. In addition, waste volumes accumulated at a site are generally small (onsite storage at DOE sites is generally limited to 90 days under RCRA, unless a Part B permit is obtained); the volume to be transported is not large enough to warrant rail or barge transportation.

TRUW and LLMW. Both truck and rail transport were assessed for TRUW and LLMW. The assessments for truck and rail shipments used the same methods and accident statistics as were used for the radiological assessment.

E.12.7 RECEPTORS

In general, risks from HW, TRUW, and LLMW transportation are calculated for members of the public. Risks to the MEI are also presented. Potential risks are estimated for the collective populations of exposed people, as well as for MEIs. The collective population risk is a measure of the radiological risk posed to society by the alternative being considered, and it is the primary means of comparing various alternatives.

E.13 Waste Packaging

Regulations that govern the transportation of hazardous materials are designed to protect the public from the potential dispersal of hazardous materials. The specification of standards for packaging hazardous materials is the primary regulatory approach for ensuring the public's safety.

The packaging requirements for a specific hazardous material are determined by the level of hazard the material would present as a result of an accidental release. In the "Hazardous Materials Table" (Title 49, Part 172.01, of the *Code of Federal Regulations* [CFR]), which lists more than 4,000 chemicals in alphabetical order by proper shipping name, column 8 supplies a reference number to a part of 49 CFR 173. The part specified describes shipping requirements for a particular chemical.

Container acceptability is determined by performance-based tests (e.g., drop strength, leak resistance, hydrostatic pressure, stacking, and vibration) (49 CFR 173). A wide range of performance levels is required because of the broad spectrum of hazard levels presented by different hazardous materials.

Radioactive waste types generally have more rigorous containment requirements than HW. Most low-level waste (LLW) and LLMW can be shipped in Type A containers, typically 0.21-m^3 (55-gal) drums. The DOT and U.S. Nuclear Regulatory Commission (NRC) performance specifications for Type A radioactive waste containers are comparable to the DOT requirements for HW containers. Most other radioactive wastes considered in this PEIS (HLW and TRUW) require Type B containers, which are subject to far more rigorous requirements than Type A containers. Examples of testing include a 9-m (30-ft) drop test (regardless of size and weight of container), a 15-m (50-ft) water immersion over an 8-hour period, and a 30-minute exposure to a radiation environment at or above 802°C (1,475°F) and emissivity coefficient of at least 0.9.

The NRC data summarized in Section E.6.5 (Tables E-6 and E-7) and DOT-reported data on release probability during an accident (Harwood and Russell, 1990) can be used to compare the containment performance differences between Type B containers and typical containers used for HW. The data show that the probability of a release from a Type B container resulting from an accident would be less than 9% and that, if a release occurs, less than 1% of the total shipment quantity would be released. These estimates are considered to be extremely conservative (i.e., overestimates of potential release amounts). The DOT data, based on 1985–86 data involving liquid hazardous material spills from truck accidents in the State of Missouri, show that the probability of a liquid hazardous material in bulk containment being released as the

result of an accident is estimated to be 18.7% and that, if a release occurred, the average percentage of total cargo released would exceed 16%.

E.14 Routing Analysis

The HIGHWAY 3.1 computer program (described in Section E.4.2.1.1) was used for predicting the most likely truck route for each shipment of HW assessed. The HIGHWAY model provides the number of miles each route passes through various population density areas and provides estimates of population densities along each segment of routes of interest. In generating estimates of risk, the midpoint of the population density given by the HIGHWAY code for each route segment was used.

For the potential life-threatening endpoint under the No Action Alternative, transporters were contacted to determine the actual routes for each shipment. For the potential adverse effect and increased carcinogenic risk endpoints and for all four alternatives, HIGHWAY was used to determine the most likely route by constraining the routing to maximize interstate highway use. The INTERLINE 5.0 model was used for determining rail routes for LLMW and TRUW (see Section E.4.2.1.2 for details).

E.15 Methods for Computing Transportation Risk

This section describes methods for computing risks associated with two types of transportation conditions—routine operations and accident conditions—involving the vehicle and its cargo. The routine risk estimated is solely the vehicle-related risk from inhalation of vehicle emissions; no cargo-related risk would exist because of the assumption that potential seepage would be contained. The accident risks include cargo-related risks from inhalation of a hazardous chemical (in the case of a ruptured waste container) and vehicle-related risks from the physical trauma of a traffic accident. The risk computation for routine operating conditions involves only two parameters: a risk factor for urban vehicle exhaust exposure and the distance transported in an urban area. In addition to risks to the general population, risks to the MEI from the most hazardous chemical shipment are also assessed for accident conditions. A technical support document by ANL (1996d) contains a more detailed discussion of this method.

The cargo-related health risk to the public (expressed as the number of individuals likely to experience an adverse health effect) from transporting a specific HW is computed for each segment of the rural, urban,

or suburban population zone associated with a specific shipment route. The total risk is obtained by summing the risks for each shipment over a period of interest. This approach for determining risk from transporting HW and HW components of TRUW and LLMW is similar to the procedure for performing radiological transportation risk calculations described in Part I of this appendix. The differences in approach are principally the applied consequence assessment models and model input assumptions, and the health criteria used to compute the hazard zones (population areas at risk). These differences and the principal areas of similarity are highlighted in the following sections for the offsite and onsite risk assessment methodologies.

E.15.1 OFFSITE TRANSPORTATION

The offsite transportation risk assessment approach for routine operations and accident conditions is summarized in Figure E–7 and discussed in detail in the following sections. Section E.16.5 describes the development of health risk criteria used in this assessment.

E.15.1.1 Routine Risk Assessment Method (Vehicle-Related Risks)

The HW assessment calculates only vehicle-related routine risk, because no significant health concerns can be identified for cargo-related routine operations. The estimation of routine risks from vehicle exhausts is based on an empirical correlation linking latent inhalation mortality risk to vehicle mileage (the methods are the same as those described in Section E.5.1.1.3 of the radiological assessment).

Risks from routine transportation may be calculated by multiplying the number of kilometers traveled in urban areas by the appropriate risk factor for each HW shipment. This calculation enables the comparison of total risk of routine transport for the baseline case and the various alternatives. Routine risk for HW is presented in Section E.17, whereas routine risks for TRUW and LLMW are presented in Part I of this appendix.

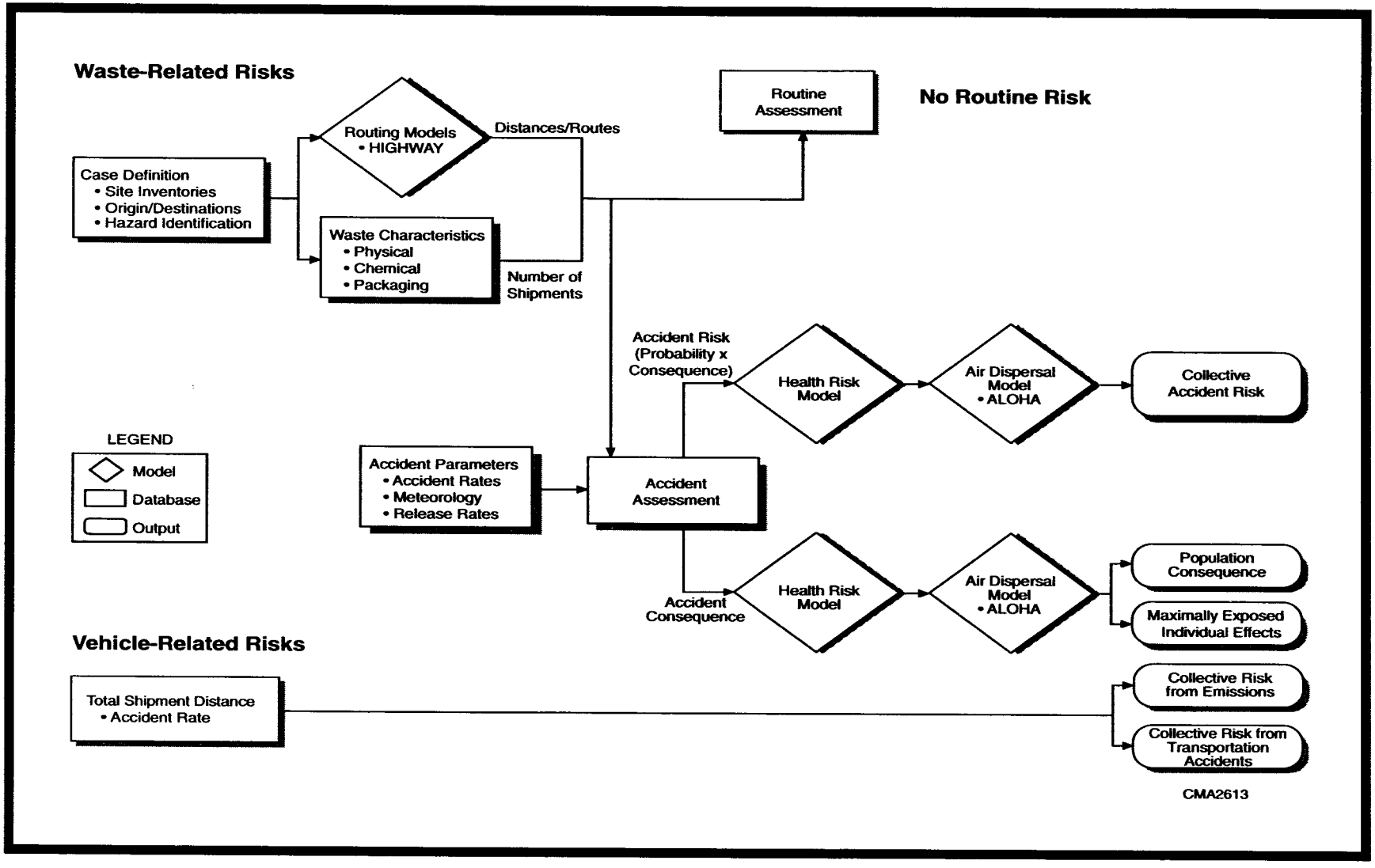

Figure E–7. Components of the Transportation Risk Assessment Method for HW and HW Components of TRUW and LLMW.

E.15.1.2 Accident Risk Assessment Method

E.15.1.2.1 *Cargo-Related Risks*

HW. The risk assessment for HW transportation accidents considers historical hazardous material truck traffic data, including accident probabilities, cargo release likelihoods given an accident, and consequences of a range of possible transportation accidents. These accidents include low-probability accidents with high consequences and high-probability accidents with low consequences. The need to evaluate the consequences from the most severe hypothetically postulated HW transportation accident (instantaneous release of entire cargo contents), consistent with the assumptions used for the most severe radioactive accidental release, is considered. As discussed in Section E.5.1, the consequence assessment for routine and accident radioactive waste transportation conditions are computed with the RADTRAN 4 (collective populations risks) and RISKIND (individual or population subgroup risks) models (Neuhauser and Kanipe, 1993; Yuan et al., 1993). Hazardous waste transportation accident consequence assessment relies on the Areal Locations of Hazardous Atmospheres ALOHA™ model (version 5.1) (Reynolds, 1992) for the collective population and individuals. The model is a widely applied code EPA often used to help emergency field personnel implement emergency response measures.

The main differences between the ALOHA™ and the RADTRAN 4/RISKIND computer models are in the approaches for determining the source-term (chemical or radionuclide release rate or fraction), transport and dispersion, and exposure duration. The ALOHA™ model has a built-in source-term algorithm for computing the rate, quantity, and type of atmospheric release of a hazardous air pollutant, including pool evaporation from a volatile organic liquid spill. The model can handle computations for frequently encountered accidental releases from ruptured tanks, drums, and pipes. ALOHA™ incorporates a chemical data library of physical and chemical properties (such as vapor pressure, boiling point, and molecular weight) for several hundred chemical compounds. These properties, along with container content input, such as the container geometry and rupture characteristics (hole size, for example), are used by ALOHA™ to compute chemical release rate and duration. Radionuclide release quantities for RADTRAN 4 and RISKIND are not computed by the models but are specified as release fraction input parameters. With these models, release fractions (defined as the fraction of material in a package that could be released in an accident) are assigned to each accident severity category according to the waste material's physical and chemical form. Both models assume instantaneous releases.

All three models assume that plume transport and diffusion approximate Gaussian distribution in the atmosphere. The ALOHA™ model simulates atmospheric transport and dispersion of the released substance as either a neutrally buoyant (or passive) plume or a slumping dense gas plume. In the ALOHA™ model, the selection of plume type (passive or heavy gas) from a near-surface release depends primarily on the relative density of the released toxic vapor (vapor or gas density to atmospheric density) and the ambient windspeed. Either continuous or intermittent releases and dispersion in rural or urban atmospheres can be simulated. The RADTRAN 4 and RISKIND models are limited to passive plume dispersion from instantaneous releases; these models are not designed to simulate transport and dispersion from dense gas releases commonly associated with HW chemicals. The ALOHA™ model does not account for the thermal buoyancy generated from fire plumes. Because severe accidents routinely involve fires, the RISKIND model was designed to take into account physical phenomena from the fire, such as buoyant plume rise. The risks associated with HW transportation accidents involving fire and water immersion are now being assessed with models or approaches appropriate to these conditions. These assessments will address risk associated with fire combustion products and water reaction chemistry.

Once the release and plume characteristics are computed, ALOHA™ establishes the plume hazard area or "footprint" (ground areal plume coverage with chemical concentrations greater than or equal to health criteria concentrations). Health criteria values are concentrations in air corresponding to the potential life-threatening effect, increased cancer risk, and any adverse health effect endpoints. This footprint is used to estimate the consequences of population exposure along the transportation route. No consequences are assumed within 30 m (98 ft) of the accident because homes are not likely to be located less than 30 m (100 ft) from the center of the highway. The ALOHA™-computed hazard areas, along with the chemical-specific health criteria concentration values and estimated exposure durations, are used to estimate acute and latent health effects from inhalation. In comparison, the consequences estimated by RADTRAN 4 or RISKIND, along with health risk conversion factors, are used to compute latent cancer fatalities, cancer incidence, and serious genetic effects from inhalation and ingestion by exposed populations. The supporting technical report by ANL (1996a) provides further description of the ALOHA™ model and modeling assumptions.

TRUW. Since only liquid or gaseous hazardous components of TRUW required evaluation, the methods used to calculate cargo-related risks were identical to those used for HW.

LLMW. The LLMW consequence assessment for HW assumes organic liquid spills and particulate releases are instantaneous as liquid and solid (as respirable fraction) aerosols. The methods used to calculate cargo-

related risks for the liquid or gaseous hazardous components of LLMW were identical to those used for HW. For particulates, release fractions are estimated with the approach used for radionuclide releases (described in Section E.6.6). One additional source term is estimated for contaminated solids (containing volatile organic compounds) spilled on the ground. The emission rate is calculated with a standard evaporative gaseous emissions model (EPA, 1988). The emission rates are used in the ALOHA™ code to provide hazard zones ("footprints"). Details are provided in the Supplemental Information document for LLMW (ANL, 1996e).

E.15.1.2.2 *Vehicle-Related Risks*

The risk assessment also provides an estimate of injury or fatality to truck crew members and the public as a result of physical trauma from vehicle collisions. This risk is assessed by combining data on U.S. annual deaths and injuries occurring from hazardous materials transportation accidents with total miles traveled by hazardous materials transport vehicles (DOC, 1987). The death and injury rates (unit risks) derived from these data are 9.56×10^{-9} fatalities/km (1.53×10^{-8}/mi) traveled and 6.25×10^{-8} injuries/km (1.0×10^{-7}/mi) traveled.

The risk of collision death or injury from transporting HW for each route segment is calculated as the product of the number of kilometers traveled and the unit risk factors. Risks are summed over the entire route and over all shipments for each alternative. Vehicle-related risks for TRUW and LLMW are presented in Part I of this appendix.

E.15.2 ONSITE TRANSPORTATION

The approach used for offsite HW transportation risk calculations was also used to estimate onsite accident risks to collective populations and the MEI. The Hanford Site was selected as a large representative DOE site for estimating the magnitude of the onsite transportation risk for hazardous and radioactive waste. The assessment requires extensive use of site-specific routing and worker population data. Sitewide characteristics such as meteorologic data and building-specific worker population densities are variable input parameters. In addition, receptor characteristics such as intake rate and location relative to the shipment route can be specified.

The three groups of receptors considered for the onsite routine risk assessment are as follows:

- Workers near the transport route (worker population dose)
- Guards at the gates of individual facilities or at checkpoints along the route
- General public near a gate (offsite collective population)

For each shipment, onsite transport HW accident consequences and the attendant health risks were calculated. The same accident and release probabilities used for the offsite risk calculations were used for the onsite risk estimates at the Hanford Site.

Based on results of the off-site analysis for TRUW and LLMW, risks from on-site transportation for these waste types would likely be very small, and were therefore not quantified.

E.16 Input Parameters and Assumptions

E.16.1 Waste Inventory and Characterization Data

HW. The HW risk assessment modeling (HaWRAM) database was developed to support the WM PEIS transportation and technology analysis (Lazaro et al., 1994). The database was developed primarily as a tool to provide the modeling parameters identified below:

- Chemical name, its United Nations or North American identification number, and classification; that is, whether the chemical is a PLC, PAEC, or ICRC chemical
- Physical-chemical state (liquid, solid, or gas/vapor) of waste container contents
- Chemical composition and physical-chemical characteristics
- Container type (metal or fabric drum)
- Container size (0.21-m^3, 0.11-m^3, or 19-L [55-, 30-, or 5-gal] drum), number of containers in shipment, and total quantity of waste in containers shipped
- Shipment date and EPA and State manifest numbers
- Generator name, EPA identification number, and location
- TSD facility name, EPA identification number, and location

The HaWRAM database contains waste inventory and characterization data for each DOE site, operations data for the facilities used for TSD of the wastes, and definitions of the various alternatives. The development of the HaWRAM database is described by ANL (1996a,c).

The HaWRAM database was designed to provide the following:

- Quantities of offsite HW shipments, key physical-chemical HW characteristics, and treatment technologies commercial TSD facilities used
- Data, such as chemical name, container size, chemical state, and chemical hazard designation, required to carry out a transportation risk assessment under current as well as future conditions
- Data for determining the degree and type of onsite versus offsite treatment at commercial facilities
- Data on "as-generated" or "operational" HW from industrial-type processes or laboratory research versus "remediation" HW from decommissioning or Superfund cleanup

Hazardous waste is defined under RCRA as waste either exhibiting certain standard characteristics (ignitability, corrosivity, reactivity, or toxicity) or listed under RCRA Subpart D (40 CFR 261.31). Subpart D lists approximately 800 waste categories and several hundred individual constituents as hazardous waste; however, many of these wastes are solids or nonvolatile liquids whose potential to become airborne under accident conditions is insufficient for significant exposure of the general public. Therefore, the substances evaluated for the WM PEIS transportation risk assessment were limited to those appropriate for the health endpoint being assessed, as detailed below.

For accident conditions, three health endpoints were evaluated: potential for life-threatening effects, potential for any adverse effects, and increased cancer risk. For evaluation of the potential life-threatening effects endpoint, analyses were conducted for shipments containing substances designated by DOT as PIH chemicals (criteria for PIH designation are detailed in Section E.16.5.1). Potential life-threatening concentration values were developed for estimating the risks for this endpoint. In the evaluation of potential for any adverse effects, both PIH substances and substances that may result in less severe adverse health effects on exposure were evaluated. Potential adverse effect concentration values were developed for estimating the risks for this endpoint. Increased cancer risks concentration values were developed to assess risks from substances for which sufficient evidence of carcinogenicity exists in humans or animals. Increased cancer risk concentration values were expressed as the concentrations associated with an increased lifetime cancer risk of one in one million for members of the public.

For fiscal year (FY) 1992, the HaWRAM database identifies the shipment by DOE of 48 substances to be evaluated under the potential life-threatening effects endpoint, 85 substances evaluated under the potential for any adverse effects endpoint, and 32 substances evaluated under the increased cancer risk endpoint. This constituted cargo-related risk evaluations of approximately 285 of the 1,712 shipments; however, evaluation of these shipments for the three stated health endpoints was considered to adequately represent inhalation hazards associated with collisions, because releases of less hazardous substances from other shipments are unlikely to result in a health risk to the general population. The potentially lethal concentrations (PLC), potentially adverse effects concentration (PAEC), and increased cancer incidence effects (ICRC) values were developed for the WM PEIS risk assessment (Hartman et al., 1994). These values were derived by using toxicologic data and risk evaluation methods for emergency planning available from the EPA and other sources (EPA, 1986; EPA et al., 1987; DOT, 1993b; National Research Council, 1993).

TRUW and LLMW. Reports have been prepared describing the TRUW and LLMW inventories and characteristics at each DOE site (ANL, 1996b,c). These reports were used as the primary source of information for the transportation assessment. The majority of information on the hazardous-chemical compositions is derived from site-specific (process) operational knowledge. All TRUW is assumed to be radioactive material mixed with other chemical substances and divided into a number of waste-stream categories (e.g., aqueous wastes, organic liquids, contaminated soils). Concentrations of hazardous chemical constituents for each of these categories were estimated (ANL, 1996b). For LLMW, classification into waste-stream categories was also conducted to facilitate the assessment (e.g., aqueous liquids, organic liquids, solid process residues; ANL, 1996b).

Organic liquid and solid hazardous waste components with significant volatilization potential and inhalation toxicity values (i.e., slope factors or reference concentrations) available from the EPA were evaluated. The same health risk endpoints as for HW were considered, although for some health endpoints, zero risk was calculated (e.g., the potential for life-threatening effects endpoint for both TRUW and LLMW was zero, because no substances in the respective inventories were identified as PIH chemicals.)

E.16.2 Population Density Zones

The same three population density zones (rural, suburban, and urban) used in the radiological risk assessment (Section E.6.3) were used for the offsite population risk assessments. As for the radiological

risk assessment, the onsite analysis used population densities for the Hanford Site and the town of Richland, Washington.

E.16.3 TRUCK ACCIDENT AND RELEASE PROBABILITIES

A cross-classification study conducted in California (Graf and Archuleta, 1985) and cited in a Midwest Research Institute document (Harwood and Russell, 1990) provided the only data available on accident rates by highway type (rural freeway, rural nonfreeway, or urban freeway) and truck configuration (single unit, single combination, or double combination). Because HWs in the DOE complex are shipped mainly by 0.21-m^3 (55-gal) drum or smaller containers, single-unit trucks will likely be the predominant truck type used; therefore, accident rates for single-unit trucks were used in this assessment. Also, because an accident rate for suburban freeways was required, the average of the rural and urban freeway rates was used. Rates used in the analysis (per million kilometers of truck travel) were as follows: rural freeway, 0.35; rural nonfreeway, 0.42; suburban freeway, 0.49; and urban freeway, 0.63 (0.56, 0.68, 0.79, and 1.01, respectively, per million miles). Rural nonfreeway rates were used for the small route segments from facilities to freeways.

Some states maintain more comprehensive and better monitored hazardous materials incident data than can be found in corresponding national data from DOT sources; for example, the State of Missouri's highway patrol accident reports contain data identifying whether each vehicle involved in an accident was carrying hazardous materials, what type or types of materials were carried, and whether a toxic substance was released. This format permits accurate classification of accidents by hazardous material cargo type. Missouri is one of only three states to incorporate all of these items in their reports. Because Missouri was considered the most representative (nearest the midpoint of the Nation), the data from Missouri, as cited in Harwood and Russell (1990), were used as the basis for estimating the probability of a toxic substance release after an accident. The probabilities used were 0.072 for gases in bulk and 0.187 for liquids in bulk.

In addition to these accident and release probabilities, an estimate is needed of the likely number of containers and the quantity of chemicals to spill from them as the result of a vehicle accident. An algorithm was developed to account for multiple chemicals in containers, percentage of containers in a shipment expected to be breached in an accident, and average quantity released per container. This algorithm provided the estimate of the amount spilled from the total quantity reported on HW manifest sheets (an HW tracking form mandated by Federal and, in most cases, State law for all offsite shipments of HW). The

quantity of the chemical of interest per container was assumed to be equal to the total quantity in each container divided by the number of chemicals in the container (specific concentration levels were generally unavailable). This quantity was multiplied by the appropriate assumption for percent spilled and by the number of containers assumed to be breached. Data on percent spilled and number of containers breached were specific to container type (metal, plastic, glass, pressurized, or other) and size and were based on statistics from the Hazardous Materials Incident Reporting System (HMIRS) database (DOT, 1993a).

E.16.4 ATMOSPHERIC CONDITIONS

The meteorologic input to the ALOHA™ model assumes neutral stability (Pasquill Stability Class D, daytime) with moderate to overcast solar insolation, ambient temperature of 35°C (95°F), and a windspeed of 4 m/s (13.12 ft/s). Because neutral meteorologic conditions are the most frequently occurring atmospheric stability conditions in the United States, these conditions are most likely to prevail in the event of a transportation spill of a hazardous chemical or radioactive waste shipment (Part I, Section E.6.7, contains assumptions for radioactive waste exposure modeling). On the basis of observations from National Weather Service surface meteorologic stations at more than 300 locations in the United States, on an annual average, neutral conditions occur about 50% of the time, while stable conditions (represented by Pasquill Stability Classes E and F) occur about 33% of the time, and unstable conditions (represented by Pasquill Stability Classes A and B) occur about 17% of the time (NOAA, 1976). Regionally, neutral conditions are less prevalent in the arid Southwest and most prevalent in the Midwest and Northeast. The neutral category predominates in all seasons, but most frequently in the winter (nearly 60% of the observations). Neutral stability is conservative for the daytime, when most accidents occur. In its *1993 Emergency Response Guidebook* (DOT, 1993b), DOT employs neutral stability and 4.5-m/s (14.76-ft/s) windspeed for the meteorology for all transportation accidents. Although most conservative meteorological conditions, such as Class F stability and windspeed of 1.5 m/s (4.92 ft/s), should be conservative for both day and night, DOT's position when developing the Initial Isolation and Protective Action Distances was to avoid multiplying conservative assumptions. This position was also adopted for modeling chemical exposure in this assessment.

E.16.5 HEALTH RISK CRITERIA

For predicting inhalation hazards associated with accidental releases, the ALOHA™ model can be applied to calculate the health consequence area by predicting the HW plume area resulting from an accident. Plume

concentrations corresponding to appropriate health endpoints are required. Human health risk endpoints addressed in this assessment include the potential for life-threatening effects (evaluated using PLC values), potential for reversible or irreversible adverse effects (evaluated using PAEC values), and potential for increased cancer incidence effects (evaluated using ICRC values). The calculated risks correspond to the endpoint being assessed.

The goal of identifying PLC, PAEC, and ICRC values is to estimate the minimum concentration that could induce an adverse health effect. This minimum level is used in the ALOHA™ model to estimate the plume area with an air concentration at that level or higher. The total population exposed is assumed to be at risk for the health effect. Of the population at risk (the population within the plume), those exposed to the highest concentrations will be most likely to experience the health effect. The collective population risk calculations identify the number of individuals in the population at risk but do not differentiate the risk for individuals within the plume area. The analysis for MEI receptors addresses the highest estimated exposure levels.

E.16.5.1 Potential Life-Threatening Concentration Values

The potential for life-threatening health effects is assessed for specific HW components designated as PIHs by DOT (49 CFR 173.115, 173.132-133). These substances are assigned protective action distances in the DOT *1993 Emergency Response Guidebook* commonly used by hazardous materials incident response personnel (DOT, 1993a). Only liquids and gases are designated as PIH substances. Two criteria must be met for designation as a PIH: (1) high toxicity, based on the concentration of a chemical gas or vapor at which 50% of the test animals die, known as LC_{50}; and (2) for liquids, medium to high volatility. Potential life-threatening concentration values were derived for all PIH substances in the HW FY 1992 shipment inventory considered the baseline case for the No Action Alternative. These resulted in PLC values for approximately 50 chemicals. No PIH chemicals were identified in the TRUW or LLMW inventories.

Potential life-threatening concentration values are air concentrations of HW above which exposed persons are at risk for potential life-threatening health effects when exposed for the associated exposure duration. Potential life-threatening concentration values are input to the ALOHA™ code to estimate "PLC-areas at risk" (areas that equal or exceed the PLC air concentration). In deriving PLC values, three main issues must be addressed: (1) selection of toxicity values, (2) selection of appropriate uncertainty factors, and

(3) exposure duration adjustment. These issues are discussed in detail in the technical support document (ANL, 1996a) and are summarized below.

E.16.5.1.1 *Toxicity Value Selection*

Toxicity data were obtained from one of two sources: (1) the Registry of Toxic Effects of Chemical Substances (RTECS) database (NIOSH, 1992), or (2) *Dangerous Properties of Industrial Materials* (Lewis and Sax, 1992). Two possible toxicity values for estimating potential human life-threatening health effects are the LC_{50}, defined above, and the human LC_{LO} defined as the lowest reported concentration of gas or vapor that has caused death in humans.

In this assessment, the lower of either (a) the lowest available human LC_{LO} value divided by an uncertainty factor of 3 or (b) the LC_{50} value for the most sensitive tested mammalian species divided by an uncertainty factor of 10 was selected as the primary toxicity value for deriving PLCs. For substances with no available LC_{50} or human LC_{LO} value, the lowest mammalian LC_{LO} value was substituted for the LC_{50} value. In the absence of either value, a short-term exposure level (STEL) for occupational exposures was multiplied by 15 to derive the PLC value, based on methods similar to those used to derive "Level of Concern" values (EPA et al., 1987). The toxicity value selection was restricted to data with associated experimental exposure times between 5 minutes and 6 hours. Experimental data with exposure times less than 5 minutes are difficult to reproduce, and data with exposure times greater than 6 hours would be inappropriate for evaluating acute health effects.

E.16.5.1.2 *Uncertainty Factor Selection*

The EPA uses uncertainty factors to allow for imprecision in deriving reference doses (RfDs) for hazardous chemical substances (EPA, 1989a). For this assessment, an uncertainty factor of 3 (approximate logarithmic mean of 1 and 10) was selected on the basis of limited EPA guidance (EPA, 1980; 1989a). To correct for variations in susceptibility among individuals in the human population, LC_{LO} values were reduced by an uncertainty factor of 3. Values for LC_{50} or mammalian LC_{LO} were reduced by an uncertainty factor of 10 (3 to correct for interspecies extrapolation and 3 to account for variations in human susceptibility—rounded from 9 to 10 for simplicity).

E.16.5.1.3 *Exposure Duration Adjustment*

The ALOHA™ code used to estimate the PLC areas at risk for transportation accidents also computes estimates of release duration. These estimates range from 1 to 60 minutes. Longer duration releases are reported as "greater than 60 minutes." The ALOHA™ model limits the puff release (forcible emission) duration to periods of 1 hour or less.

Reported LC_{LO} and LC_{50} values are associated with experimental exposure times. The estimated duration of releases computed with the ALOHA™ code are used to scale LC_{LO} or LC_{50} values in the literature from experimental exposure times to the estimated duration of exposures. Either a linear or exponential function can be assumed in scaling literature-reported toxicity values to the appropriate exposure duration. The scaling assumption resulting in the lowest PLC value was used in this assessment.

In calculating accident risks for the potential life-threatening endpoint, the assumption is that the entire population living within the PLC area at risk could experience life-threatening health effects from the exposure. This assumption is conservative because the PLC values have incorporated uncertainty factors to account for sensitive human subpopulations. Greater detail on the derivation of PLC values, the PLC values for all PIH substances contained in the HW shipping inventory, and comparisons with other available emergency planning criteria, are included in the technical support document (ANL, 1996d). Potential life-threatening concentration values and supporting information for some representative high-risk substances are presented in Table E–33.

E.16.5.2 Potential Adverse Effect Concentration Values

To estimate the occurrence probability of less severe effects, values were also developed to estimate air concentrations of HW components above which exposed persons are at risk of any adverse effect (PAEC values). Any-adverse-effect concentration values were derived for all PIH substances shipped by DOE waste generators in FY 1992 and for other substances (in either HW, LLMW, or TRUW shipment inventories) with inhalation RfDs available from the EPA (approximately 90 substances). As in the derivation of PLC values, the derivation of PAEC values requires selection of toxicity values, selection of uncertainty factors, and exposure duration adjustment, which are discussed below.

Table E-33. Values for PLC, PAEC, and ICRC for Representative Substances

Substance	Toxicity Value (ppm)	Time/Species/ Effect/Reference[a]	Inhalation RfD (mg/kg/d)[b]	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	VSD (mg/m^3)	Health Risk Criterion (ppm) (15 min)	Health Risk Criterion (ppm) (30 min)	Health Risk Criterion (ppm) (60 min)
PLC Values								
Arsine[c]	1.3E+02	30 min/rat	NA	NA	NA	1.9E+01	1.3E+01	6.6E+00
Chlorine	1.4E+02	1 h/mouse	NA	NA	NA	2.7E+01	1.9E+01	1.4E+01
Hydrogen fluoride[c]	5.0E+01	30 min/human/ LC_{LO}/Lewis & Sax	NA	NA	NA	2.4E+01	1.7E+01	8.3E+00
Hydrogen selenide	6.1E+00	1 h/rat/LC_{LO}	NA	NA	NA	1.2E+00	8.6E-01	6.1E-01
Nitrogen dioxide	3.0E+01	1 h/guinea pig	NA	NA	NA	6.0E+00	4.2E+00	3.0E+00
PAEC Values								
Acrolein[d]	8.7E-06	2 wk-7 yr/ human/RfC/IRIS or HEAST	5.71E-06	NA	NA	1.5E-03	7.4E-04	3.7E-04
Hydrogen chloride[d]	4.7E-03	2 wk-7 yr/ human/RfC/IRIS or HEAST	2.00E-03	NA	NA	8.0E-01	4.0E-01	2.0E-01
Hydrogen fluoride	1.2E+02	1 min/human TC_{LO}/cough, irritation	NA	NA	NA	8.2E-01	4.1E-01	2.0E-01
Hydrogen selenide	6.1E+00	1 h/rat/LC_{LO}	NA	NA	NA	1.2E-02	9.0E-03	6.0E-03
Phosgene	4.4E+02	10 min/mouse/ LC_{50}	NA	NA	NA	3.0E-01	1.5E-01	7.0E-02
1,1,1-Trichloroethane[d]	1.8E-01	2 wk-7 yr/ human/RfC/IRIS or HEAST	NA	NA	NA	3.1E+01	1.6E+01	7.8E+00
ICRC Values[e]								
Chloroform	NA	NA	NA	2.3E-05	4.3E-05	NA	NA	5.5E+00
Dichloroethylene	NA	NA	NA	5.0E-05	2.0E-05	NA	NA	3.1E+00
Dichloromethane	NA	NA	NA	4.7E-07	2.1E-03	NA	NA	3.8E+02

Notes: NA = not applicable; $(\mu g/m^3)^{-1}$ = reciprocal micrograms per cubic meter; VSD = virtually safe dose = 10^{-6} (inhalation unit risk $\times 1{,}000$ $\mu g/mg$).
[a] For PLC derivation, toxicity value is LC50 unless otherwise noted. For PAEC derivation, toxicity value is RfC obtained from EPA's IRIS database (EPA, 1993b) or EPA's HEAST (EPA, 1993a). Other toxicity values were obtained from the RTECS database (NIOSH, 1992), except when Lewis and Sax (Lewis and Sax, 1992) are listed.
[b] Inhalation RfD (in milligrams per kilogram per day) = [(toxicity value $\times$ molecular weight) /24.5] $\times$ (20 m^3/d $\div$ 70 kg).
[c] Exponential scaling used for 15-min PAEC; linear scaling used for 60-min PAEC.
[d] Indicates that chronic RfC was adopted as subchronic RfC; value may be conservative.
[e] ICRC value = VSD $\times$ 24 h/d $\times$ 365 d/yr $\times$ 70 yr $\times$ 24.5/molecular weight (per National Research Council, 1986, 1993).

E.16.5.2.1 *Toxicity Value Selection*

Inhalation RfDs and reference concentrations (RfCs) developed by EPA were selected as the most applicable toxicity values for deriving PAEC values. An inhalation RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of continuous exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects (EPA, 1989b). Subchronic RfC

values, applicable to exposure durations of 2 weeks to 7 years, are used when available. Otherwise, chronic RfC values are used; these values are most likely conservative, tending to overestimate risk. The RfD in milligrams per kilogram per day is derived from the RfC in milligrams per cubic meter. The EPA Integrated Risk Information System (IRIS) database and Health Effects Assessment Summary Tables (HEAST) have been used to obtain current RfC values (EPA, 1993a,b).

Many PIH substances did not have available RfC values. For these substances, toxicity data, such as values for the lowest toxic concentration (TC_{LO}), were obtained from either NIOSH (1992) or Lewis and Sax (1992). Toxicity values were selected in a hierarchical fashion analogous to that used to estimate PLC values. In the absence of an RfC, the lowest human TC_{LO} value, or the lowest concentration causing any adverse effect, was selected as the most appropriate toxicity value for PAEC derivation. When human TC_{LO} values were unavailable, the following toxicity values from the literature were used (in decreasing order of preference): (1) lowest mammalian TC_{LO} values, (2) lowest human LC_{LO} values, (3) lowest LC_{50} values, (4) lowest mammalian LC_{LO} values, and (5) the STEL value. As with the PLC data, the toxicity value selection for PAEC values was restricted to data with associated experimental exposure times of between 5 minutes and 6 hours.

E.16.5.2.2 *Uncertainty Factor Selection*

For substances with available RfC values, application of uncertainty factors was unnecessary because the appropriate factors are already incorporated into the RfC value (EPA, 1993a,b). Where use of other toxicity values was necessary, uncertainty factors were selected following the rationale EPA used in deriving RfC values (EPA, 1989a): (1) human TC_{LO} divided by 10 (for sensitive subpopulations); (2) mammalian TC_{LO} divided by 100 (10 for sensitive subpopulations and 10 for extrapolation from animal data to humans); (3) human LC_{LO} divided by 100 (10 for sensitive human subpopulations and 10 for extrapolation of lethality data to estimate sublethal effects); (4) LC_{50} or mammalian LC_{LO} divided by 1,000 (10 for sensitive human subpopulations, 10 for extrapolation from animal data to humans, and 10 for extrapolation of lethality data to estimate sublethal effects); and (5) the STEL value divided by 3 (for sensitive human subpopulations).

E.16.5.2.3 *Exposure Duration Adjustments*

For substances for which RfC values are available, the equation used to estimate PAEC values was based on EPA methods for estimating inhalation exposures and acceptable air concentrations of noncarcinogenic contaminants (EPA, 1989a, 1991). Details about the parameter values chosen are given in supporting documentation (ANL, 1996a).

For substances for which no RfC values are available, the exposure duration adjustment is identical to that used in generating PLC values: the exposure duration adjustment (linear or exponential) resulting in the lowest PAEC value was used in modifying toxicity values to derive PAECs.

In calculating accident risks for the endpoint presented as any adverse effect, the assumption is that the entire population living within the PAEC area at risk would experience some adverse effect from the exposure. Again, this assumption is conservative because the PAEC values have incorporated uncertainty factors to account for sensitive human subpopulations. The equation used to estimate PAECs and the computed PAEC values, along with comparisons with other available emergency planning criteria, are discussed in the technical support document (ANL, 1996d). The PAEC values and supporting information for some representative high-risk substances are presented in Table E–33.

E.16.5.3 Increased Cancer Risk Concentration Values

Hazardous chemical waste transported from DOE facilities may also be evaluated for possible increased cancer risk in exposed individuals. Values were developed to estimate the air concentrations of carcinogenic HW components above which exposed persons have an increased carcinogenic risk of one in one million or higher. These values were termed ICRC values. The risk level of one in one million was selected to represent the level below which increased risk is considered negligible.

An ICRC value was derived for each HW, TRUW, LLMW substance that met the following criteria: (1) the substance is classified as a known, probable, or possible human carcinogen (EPA, 1993a,b); (2) the substance has an EPA inhalation unit-risk value; and (3) the substance is volatile enough to present significant potential for exposure of the public. Increased cancer risk concentration values were derived for approximately 25 carcinogens. Several inorganic and organic substances were not evaluated because they

are solids under ambient conditions or because the potential to volatize is minimal (for example, lindane, arsenic, beryllium, and cadmium).

The method used to generate ICRC values is that recommended by the National Research Council (1986, 1993). Because the estimation of increased cancer risk for exposure periods of less than 1 hour is highly uncertain, ICRC values were generated only for an assumed 1-hour exposure. Exposures were averaged over a 70-year lifetime. In calculating risks for individual accidents, the assumption was made that the entire population living within the ICRC area at risk would experience an increased cancer risk of one in one million or higher. The equation used to estimate ICRCs and the computed ICRC values are discussed in the technical support documents (ANL, 1996c-e). Table E-33 presents increased cancer risk concentration values and supporting information for some representative high-risk substances.

Population at Risk. The cargo-related population risk is calculated by estimating the minimum concentration level that could induce the adverse health effect of interest for each endpoint (potential life-threatening effects, any adverse effects, or increased cancer risk). This minimum level is used in the ALOHA™ model to estimate the plume area with an air concentration at that level or higher. The HIGHWAY 3.1 and INTERLINE 5.0 models then provides population density estimates for the plume areas in rural, suburban, or urban areas. Of the population at risk, those exposed to the highest concentrations would be most likely to experience the health effect, but the method does not differentiate the risk for individuals within the plume area. The evaluation of MEIs is intended to address the question of what maximum exposure levels could be and what health effects could be associated with those levels. To evaluate the MEI for each health endpoint, the primary factors considered were a combination of chemical potency, quantity released, and dispersion, as reflected by the exposed areas output from the ALOHA™ model (Section E.17.1.3 provides details). The MEI was considered to be located at the point of highest chemical concentration accessible to the public. This location was modeled to be 30 m (100 ft) from the release point (the assumed closest distance of a residence from the middle of the roadway). Although for each endpoint, many shipments of each chemical may be included in the database, only the shipment resulting in the highest chemical concentration is evaluated for the MEI.

E.17 Risk Assessment Results

E.17.1 HAZARDOUS WASTE

E.17.1.1 Hazardous Waste Alternatives

Transportation impacts associated with the four HW alternatives are analyzed to provide input for decisions about the extent to which DOE should continue to rely on commercial facilities for treating and disposing of the nonaqueous part of the hazardous waste stream. The analyzed HW alternatives are (1) No Action; (2) Decentralized (optimize commercial facility selection for 11 DOE sites, and use the limited existing and approved treatment capacity at three to five sites); (3) Regionalized 1 (five DOE TSD sites, including three TSD hubs or host sites); and (4) Regionalized 2 (two DOE TSD hubs or host sites). Hazardous waste from 11 DOE sites representing approximately 90% of the HW generation in the DOE complex was analyzed. The HW inventories and the HW alternatives for these facilities are described further in ANL (1996a).

Hazardous waste management under the *No Action Alternative (current baseline conditions)* would continue to use existing and approved TSD facilities (for example, primarily wastewater treatment) at the DOE sites, while most of the nonaqueous (nonwastewater) waste stream would be shipped offsite to permitted commercial facilities.

Under the *Decentralized Alternative (optimal conditions)* the no action activities would continue with an "optimized" use of DOE facilities and commercial vendors. This optimization would occur through eliminating brokering (consolidating HW with a broker from more than one generator before shipment for TSD) and by strategically selecting commercial TSD facilities by waste treatment group capability and proximity to the largest generators. These actions would limit the number of commercial facilities storing, brokering, treating, and disposing DOE HW and would select commercial TSDs as close to the principal generators as practical. Hazardous waste brokering, sometimes at several broker locations, can significantly increase the transportation miles of the original HW, depending on when and where consolidation occurs. Figure E–8 illustrates shipment routes for the Decentralized Alternative. Except for wastes to be incinerated (approximately 15% of the total generated organic HW) and destroyed through use as a fuel-waste (approximately 12% of the total organic generated HW) at Idaho National Engineering Laboratory (INEL),

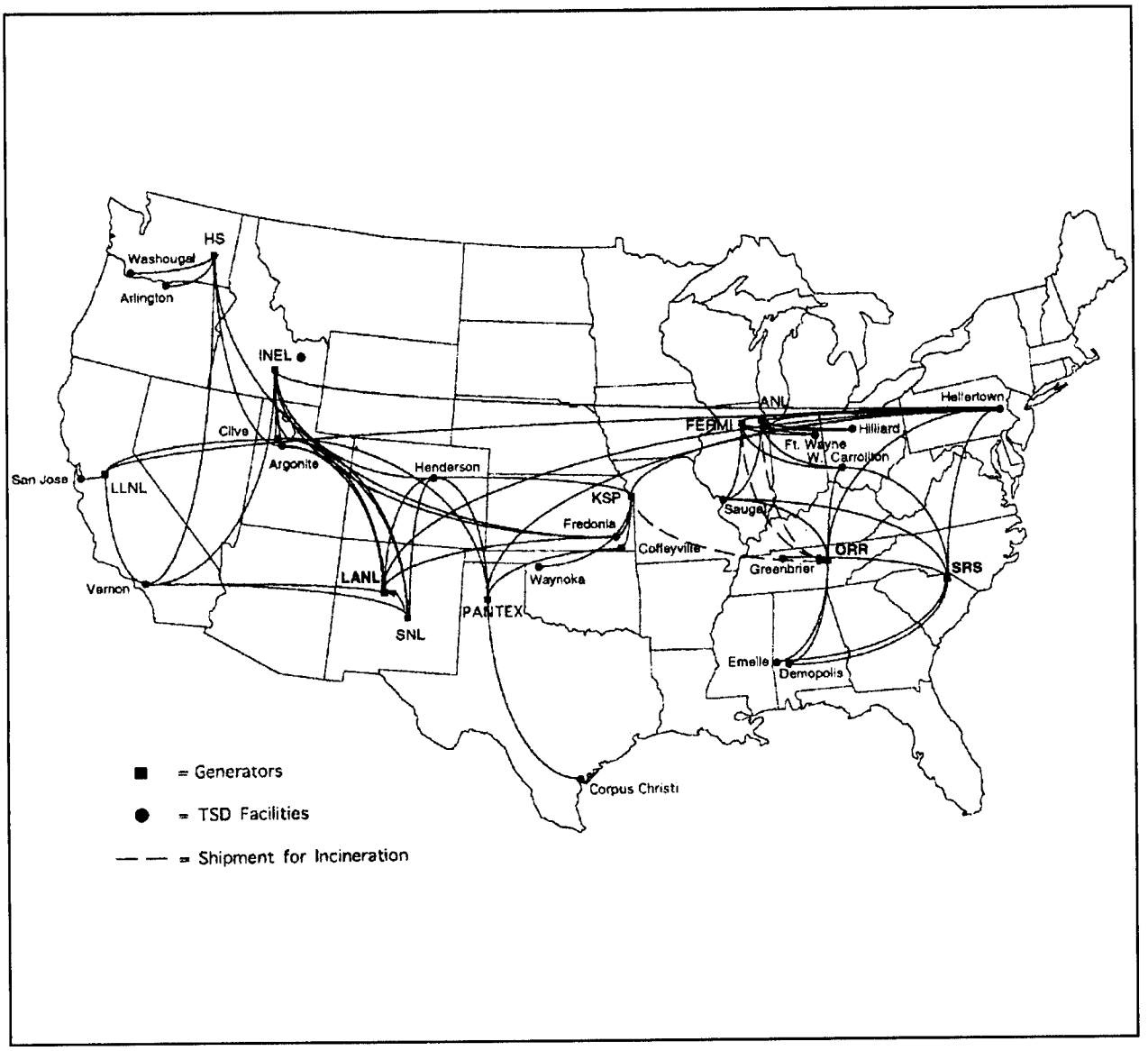

Figure E–8. Decentralization Alternative—Offsite HW Shipments From DOE Sites to Commercial TSD Facilities and to LANL and ORR for Limited Incineration.

Oak Ridge Reservation (ORR), and the Savannah River Site (SRS), most of the HW generated by the other eight DOE sites included in this analysis would be sent to commercial TSD facilities.

The *Regionalized 1 Alternative* would continue no action, except that approximately 50% of nonaqueous HW generated by the core sites would be treated at five treatment hubs or home facilities—Hanford, INEL, LANL, ORR, and SRS. Hazardous waste not treated at these sites and the residual treated waste from these sites would be sent to commercially licensed facilities for treatment and disposal. Under this alternative,

HW shipments would occur as follows: Pantex and Sandia National Laboratories (SNL) to the LANL hub; Lawrence Livermore National Laboratory (LLNL) to the Hanford Site hub; and the Kansas City Plant (KCP), Argonne National Laboratory-East (ANL-E), and Fermi National Accelerator Laboratory (FERMI) to the ORR hub. INEL and SRS would serve as home TSDs only for their own generated HW. The remaining smaller generators would ship to permitted commercial TSD facilities. Figure E-9 shows the transportation routes computed for the Regionalized 1 Alternative.

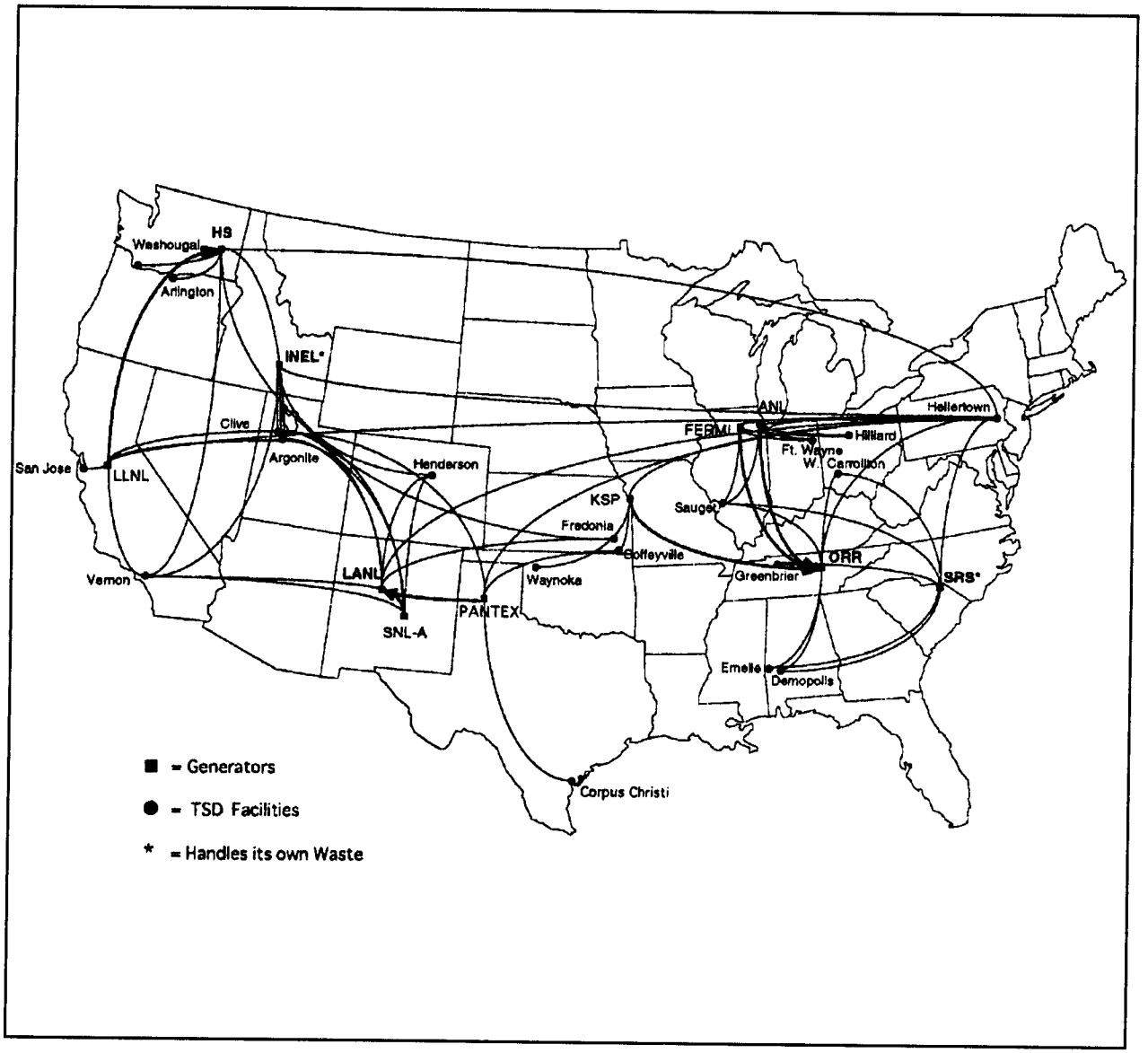

Figure E-9. Regionalized 1 Alternative—Offsite HW Shipments From DOE Sites to Three DOE Treatment Hubs (Hanford, LANL, and ORR) and to Commercial TSD Facilities.

The *Regionalized 2 Alternative* would continue no action, except that approximately 90% of the total nonwastewater HW generated by core sites (including all organic HW) would be treated at two treatment hubs (INEL and ORR). All remaining HW would be packed and shipped to a limited number of permitted commercial TSD facilities. Under this alternative, shipments of HW would be as follows: Hanford, LANL, Pantex, SNL, and LLNL to the INEL hub; and KCP, ANL-E, Fermi, and SRS to the ORR hub. Figure E-10 illustrates the transportation routes computed for the Regionalized 2 Alternative.

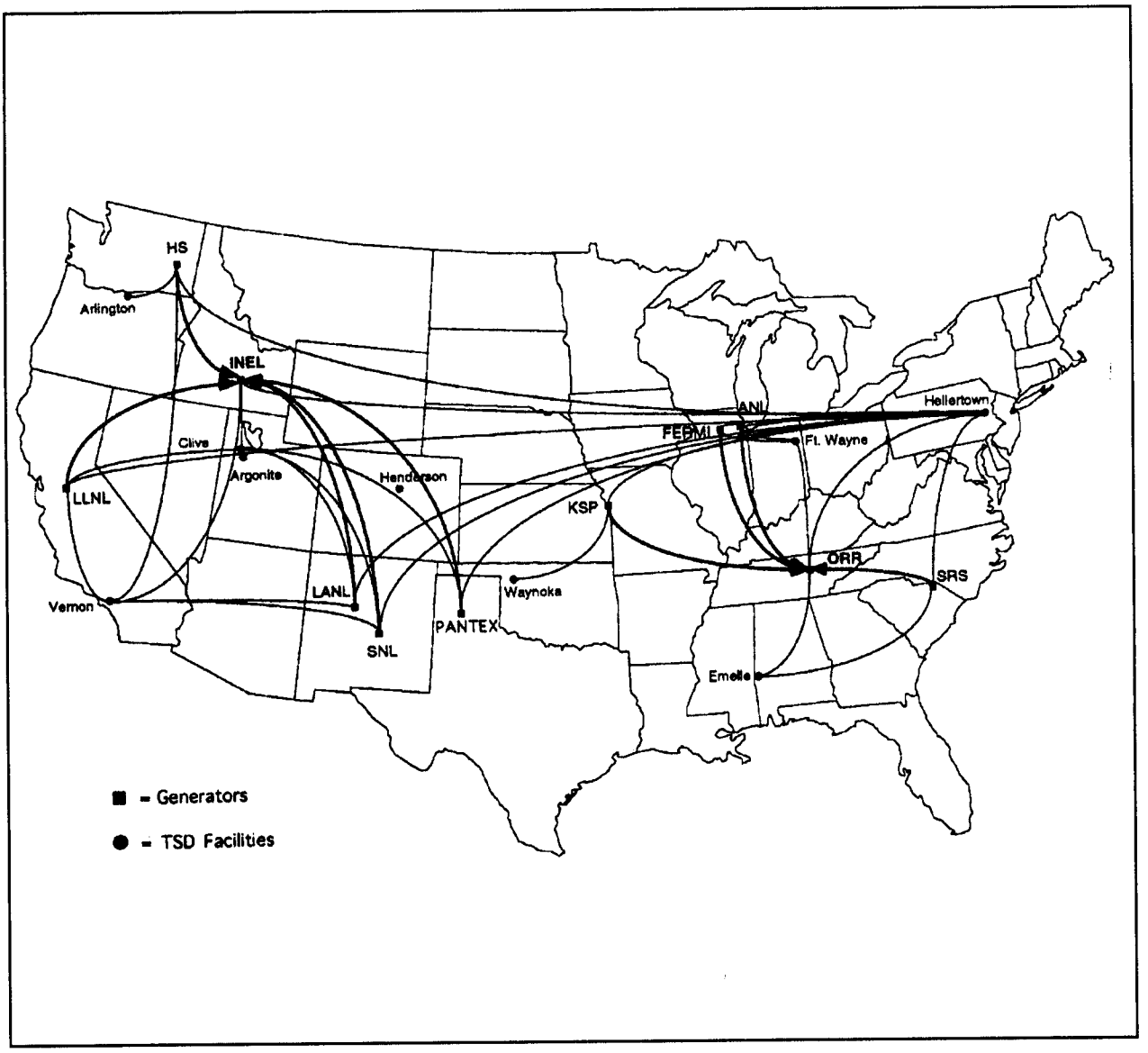

Figure E-10. Regionalized 2 Alternative—Offsite HW Shipments From DOE Sites to Two Treatment Hubs (INEL and ORR) and to Commercial TSD Facilities.

For each alternative, vehicle-related and cargo-related risks are calculated for onsite and offsite transportation of HW. Cargo-related risks from accident conditions are computed for chemical exposure of onsite and offsite populations and for the MEI. Vehicle-related risks are quantified for death and injury from collisions and for latent cancer mortality caused by inhalation of vehicle exhausts. The collective risk for each alternative is computed and reported below on an annual basis for the respective estimated HW shipment inventories. Shipments of HW to commercial and DOE hub TSD facilities are assumed to occur over 20 years. The average shipment period duration risk can therefore be calculated by dividing the results provided in the following tables by 20.

E.17.1.2 Cargo-Related Accident Transportation Risks (Chemical Dose Through Inhalation)

The assessment of transportation accident impacts associated with exposures to chemical releases are quantified in terms of risks to onsite and offsite populations for the three health endpoints described in Section E.16.5. Inhalation exposure risks from chemical releases in onsite and offsite HW transportation accidents are quantified for the four HW alternatives. The risks are expressed as the potential number of expected adverse health effects (such as fatalities, reversible or irreversible organ or tissue damage, and individuals with an increased cancer risk of one in one million or higher) for each alternative and as a relative risk as compared with the No Action Alternative. A detailed description of the HW shipment inventory for each alternative is in ANL (1996a).

The collective annual population risks to the general public and onsite workers for onsite and offsite HW transportation, under each alternative, are presented in Table E-34. The approximate shipping routes are shown in Figures E-8 through E-10. The technical support document (ANL, 1996a) should be consulted for more detailed information (such as risks by generator, by shipment, and by chemical). Under the current system (No Action Alternative), HW is often brokered. Brokering is not assumed to occur under any but the No Action Alternative. Data on final destination of brokered HW were generally unavailable for the assessment of shipments evaluated for the potential adverse effects and cancer endpoints. Brokering data were incorporated only for shipments evaluated for the potential lethality endpoint.

Table E-34. Population Impacts Summary for Each HW Alternative for a 20-Year Period[a]

Shipment Data and Population Risks	Alternatives			
	No Action	Decentralized	Regionalized	Regionalized 2
Shipment Summary				
Number of shipments				
PIH cargo	1,000	1,000	2,000	1,000
Carcinogenic waste	3,000	4,000	5,000	3,000
Adverse effect waste	6,000	7,000	8,000	6,000
Other waste[b]	34,000	41,000	50,000	34,000
All waste categories[c]	34,000	41,000	50,000	34,000
Distance ($km \times 10^6$)[d]				
Other waste[b]	31.5	31.3	55.7	30.0
PIH cargo	2.3	1.3	0.8	1.6
Carcinogenic waste	6.3	3.9	7.3	5.6
Adverse effect waste	13.00	8.9	16.5	11.8
All waste categories[c]	31.5	31.3	55.7	30.0
Population Risks[e] (number of individuals potentially affected)				
Cargo-related[f]				
Potential life-threatening health effects	0.146	0.057	0.056	0.076
Concerns for potential cancer incidents	2.2	1.2	2.5	2.1
Potential adverse health effects	78	49	86	60
Vehicle-related				
Physical trauma impacts[g]				
Accident fatalities	0.302	0.274	0.533	0.287
Accident injuries	1.972	1.793	3.480	1.874
Vehicle exhaust-related fatalities[h]	0.117	0.102	0.180	0.102

[a] Risks, number of shipments, and travel distances are for the total shipment duration (20 years). To obtain the annual values, divide risks, shipments, and distances by 20.
[b] Other waste is RCRA waste that did not meet the toxicity criteria for evaluation in this assessment (Section E.16.5).
[c] Total shipments and distances are less than the sum of the shipments and distances by cargo type because several waste types are generally shipped together.
[d] Distances reflect nonempty truck shipment distance multiplied by 2 to account for return of trucks with empty cargo. As a result, distance may be overestimated.
[e] Cargo-related and vehicle-related risks cannot be added because of the disparity in calculation methods and meaning of endpoints.
[f] Cargo-related risks refer to the number of people affected, computed from the product of the probability of accidental release times the number of people exposed to the health criteria concentration.
[g] Physical trauma impacts are based on total distance traveled carrying DOE HW.
[h] Vehicle exhaust impacts are based on total urban kilometers traveled by trucks carrying DOE HW in all four categories.

E.17.1.2.1 *Potential Life-Threatening Effects*

The data in Table E-34 show the relative risk of potential life-threatening effects among alternatives from transporting HW involving a PIH chemical spill. This table indicates that, among the alternatives evaluated, the No Action Alternative tends to indicate a higher risk of 45 to 50%. Risks under the Decentralized and Regionalized Alternatives are lowest, approximately 40% of those under the No Action Alternative.

The risk of life-threatening effects from offsite HW shipments under the No Action Alternative is generally approximately two or more times greater than the risks for other alternatives. The average shipment distances for containers with PIH chemicals for each alternative are approximately 2,380 km (1,480 mi) for No Action, 1,320 km (820 mi) for Decentralization, 400 km (250 mi) for Regionalized 1, and 1,600 km (994 mi) for Regionalized 2. More than 50% of the potential life-threatening effects risk under the No Action Alternative is contributed by about 8% of the HW shipments that contain PIH chemicals (5 of 63 PIH shipments). This same relationship is also true for the other three alternatives. The reduced risk under these alternatives is a direct result of shortening the shipment transportation distances. The specific chemicals in the five waste truckloads that contribute to most of the chemical inhalation risk are two shipments of arsine (0.03 m^3 [8 gal]), two shipments of hydrogen fluoride (0.06 m^3 [17 gal]), and one shipment of hydrogen selenide (3.8 L [1 gal]). The atmospheric transport and dispersion from the release of all five truckloads of these three chemicals was modeled as a negatively buoyant heavy or dense vapor plume. As the analysis indicates, these chemicals could present a significant but relatively small risk over the 20-year shipment duration.

E.17.1.2.2 *Any Adverse Effects*

For the any-adverse-effects endpoint, risks are highest under the No Action and Regionalized Alternatives; these risks are about 60 to 80% greater than risks under the Decentralized and Regionalized 2 Alternatives (Table E-34). The average transportation distances for shipments containing compounds with PAEC values are approximately 2,166 km (1,346 mi) for No Action, 1,271 km (790 mi) for the Decentralized Alternative, 2,062 km (1,282 mi) for Regionalized 1, and 1,967 km (1,222 mi) for Regionalized 2. More than 50% of the any-adverse-effects risk under the No Action Alternative is contributed by less than 13% of the shipments involving any-adverse-effect chemicals (36 of 285 shipments). This relationship also holds approximately true for the other three alternatives. The specific chemicals in these waste shipments that contribute most of the any-adverse-effect risk are 26 shipments of hydrogen chloride (30 containers;

3.05 m^3 [800 gal]), 8 shipments of hydrogen fluoride (9 containers; 0.81 m^3 [215 gal]), 1 shipment of acrolein (1 container; 3.8 L [1 gal]), 1 shipment of hydrogen selenide (1 container; 3.8 L [1 gal]), and 1 shipment of phosgene (1 container; 3.8 L [1 gal]). Atmospheric transport and dispersion were modeled as a negatively buoyant heavy or dense vapor plume for all but the acrolein shipment. The acrolein spill was modeled as a passive neutrally buoyant vapor plume. As the analysis indicates, these chemicals are substances that could present a significant risk of adverse effects if an accidental release occurred during truck transportation.

E.17.1.2.3 *Increased Carcinogenic Risk*

The average distance of waste container shipments with carcinogenic chemicals (or compounds with an ICRC value) for each alternative is approximately 2,100 km (1,305 mi) for No Action, 975 km (606 mi) for the Decentralized Alternative, 1,460 km (907 mi) for Regionalized 1, and 1,867 km (1,160 mi) for Regionalized 2. More than 50% of the carcinogenic risk under the No Action Alternative is contributed by less than 7% of the shipments of HW containing carcinogenic chemicals (7 of the 169 shipments). This relationship also holds approximately for the other three alternatives. The reduced cancer risk under the Decentralized Alternative is a direct result of lessening the shipment transportation distance. The specific chemicals in the seven waste shipments that contribute to most of the total risk are five shipments of dichloroethylene (six containers; 363.4 L [96 gal]) and two tanker shipments of chloroform 27.8 m^3 [7,342 gal]). The atmospheric transport and dispersion of these chemicals were modeled as passive, neutrally buoyant vapor plumes. As the analysis indicates, these chemicals could present an increased cancer risk of one in one million or higher to the general population if an accidental release occurred during truck transportation.

E.17.1.2.4 *Discussion*

As indicated in Table E–34, with respect to potential life-threatening health effects, the No Action Alternative results in the greatest number of kilometers traveled and, thus, the highest cargo-related population risk. For the other health endpoints, the No Action Alternative does not result in the highest number of miles traveled or the highest risks; however, the mileage estimates under the No Action

Alternative for the increased-cancer-risk and any-adverse-effects endpoints may be underestimated, because information on brokering was unavailable for shipments evaluated for those endpoints.

The Regionalized 2 Alternative results in higher potential life-threatening risks than the Regionalized 1 Alternative; however, with respect to the increased-cancer-risk and any-adverse-health-effects endpoints, the Regionalized 1 Alternative has greater risk. In all cases, the higher risks are associated with a greater number of kilometers traveled. The Regionalized 1 Alternative has five DOE treatment sites and nine supporting commercial sites (five west and four east of the Mississippi River). The Regionalized 2 Alternative includes two DOE sites and 21 commercial sites; however, the key factor here is that approximately 50% of the HW for the Regionalized 1 Alternative would be treated at commercial sites and 50% at DOE sites. For the Regionalized 2 Alternative, 90% of the waste is to go to only two sites (the DOE locations); the remaining 10% of the waste is to be sent, as needed, to the commercial sites.

The explanation for why risk is greater under the Regionalized 1 Alternative than under the Regionalized 2 Alternative (for carcinogenic and any-adverse-health-effects endpoints) lies in the distance trucks travel and how full they would be with DOE waste. In the analysis, more trucks are needed to ship HW under the Regionalized 1 Alternative because the waste typically must be split between commercial and DOE treatment. A shipment was considered a DOE shipment even if the truck was only partially loaded with DOE waste; however, for the Regionalized 2 Alternative, trucks can be loaded closer to capacity, reducing the number of shipments and transportation distance because so much of the waste is going to the same place (to either of the two DOE Regionalized 2 treatment hubs). The 90-day maximum on storage at DOE sites is the reason that full truckloads of waste are unlikely to leave DOE sites for treatment. Once the 90-day period is over, the waste must be moved offsite for treatment. Full trucks are more the exception than the rule, considering the various treatments possible for that waste. The exception is for the PIH chemicals. Although fewer shipments are required under the Regionalized 2 Alternative for PIH chemicals, the greater distance to centralized hubs is likely the cause of higher risks.

Current practice is for a DOE site to be one of a number of loading stops for a commercial transporter. The use of fully loaded, dedicated trucks going to a centralized location is an expensive alternative not considered realistic. This usage is certainly not common practice for DOE at this time. In addition, the requirement that a waste container not be stored for more than 90 days also argues for the current commercial pickup procedure, which allows for a larger number of shipments spread out over the year and avoids waste accumulation. If DOE-dedicated trucks were used for the Regionalized 1 and Regionalized 2

Alternatives, the total truck distance traveled would likely be lower for the Regionalized 1 Alternative because travel distance would be less for most shipments.

E.17.1.3 Cargo-Related Accident Transportation Risks (Chemical Dose Through Inhalation) for the MEI

E.17.1.3.1 *Potential Life-Threatening Effects*

The ALOHA™-computed hazard zones for PIH chemicals are given in Table E-35. A hazard zone is the distance from the release point within which life-threatening health effects may occur. Hazard zones are presented for PIH chemicals shipped by DOE with ALOHA™-modeled releases that would result in potentially lethal plumes. Poison inhalation hazard chemicals shipped in small quantities and for which spills would not result in a potentially lethal plume are not listed.

Table E-35. Hazard Zones for Potential Life-Threatening Risks to an MEI

Chemical Name	Hazard Zone[a] (m)	Number of Annual Shipments	Chemical Name	Hazard Zone[a] (m)	Number of Annual Shipments
Ammonia	93	5	Nitric acid, fuming	67	2
Arsine	719	4	Nitric oxide	137	1
Boron trifluoride	238	1	Phosgene	39	2
Bromine	39	2	Phosphine	203	2
Carbon monoxide	76	4	Sulfur dioxide	122	1
Chlorine	305	10	Titanium tetrachloride	40	1
Hydrogen fluoride	626	5			
Hydrogen sulfide	207	8	Nickel carbonyl	227	2

[a] Hazard zone indicates the distance from the release point within which life-threatening health effects may occur.

E.17.1.3.2 *Any Adverse Effects*

Poison inhalation hazard chemicals were not included in the exposure assessment of the MEI for the potential adverse effects endpoint because the appropriate endpoint for MEI receptors is potential lethality, which was addressed under Section E.17.1.3. ALOHA™ was used to estimate the chemical concentration and exposure duration for the MEI for the non-PIH chemicals. A standard risk equation was used (EPA, 1989b). Consistent with the chemical-specific accident risks for the public for this endpoint, parameters for a 6-year-old child were used: body weight of 21 kg (46.3 lb) and moderate activity inhalation rate of 0.033 m^3/min (EPA, 1989a). These values were compared with EPA RfD values by generating a hazard quotient (HQ) (daily intake/RfD) for each chemical. An HQ greater than 1 indicates that an adverse effect for the MEI is likely. Note that the level of concern associated with exposure to these compounds does not increase linearly as HQ values exceed 1. In other words, HQ values do not represent a probability or a percentage. One may conclude that, as the HQ value above 1 increases, greater concern exists about potential adverse effects; however, assuming that an HQ value of 10 indicates that adverse health effects are 10 times more likely to occur than for an HQ value of 1 is incorrect.

Results are shown in Table E–36. Only the HQ for trichlorofluoromethane is less than 1. The other HQs range from 1.9 (for dichlorodifluoromethane) to about 29,000 (for mercury). Thus, an accidental release of any of these substances would potentially result in adverse effects for receptors at the MEI location. Because of uncertainties and conservatism associated with using EPA RfD values to evaluate single, brief exposures, the assumption may be made that the risk of adverse effects is minimal for substances with HQ values between 1 and 10. Therefore, the greatest potential for adverse effects to the MEI is associated with accidental release of the following substances: 1,1,1-trichloroethane, acrylonitrile, carbon disulfide, carbon tetrachloride, chloroform, epichlorohydrin, hexane, mercury, methylene chloride, methyl isobutyl ketone, propylene oxide, toluene, triethylamine, and vinyl acetate.

E.17.1.3.3 *Increased Carcinogenic Risk*

For the 10 carcinogens of greatest concern, risks to the MEI were calculated on the basis of potency, quantity released, and dispersivity, as reflected by exposed areas output from the ALOHA™ model. Of the carcinogens DOE shipped under the No Action Alternative, only two (benzene and vinyl chloride) are

Table E-36. Any Adverse Effects Risk to an MEI

Chemical	Concentration at MEI Location (ppm)	Exposure Time (min)	Intake (mg/kg/d)	RfD (mg/kg/d)	HQ
Acetonitrile	3.0E+02	25	1.4E+00	1.4E-01	1.0E+01
Acrylonitrile	2.6E+02	20	1.3E+00	5.7E-04	2.3E+03
Acrylic acid	2.5E+01	60	5.0E-03	8.6E-04	5.8E+00
Aniline	9.0E+01	60	2.3E-02	2.9E-03	7.9E+00
Carbon disulfide	2.5E+02	10	8.7E-01	2.9E-03	3.0E+02
Carbon tetrachloride	1.4E+02	20	2.0E+00	1.7E-02	1.2E+02
Chloroform	7.0E+03	20	7.7E+01	1.1E-02	7.0E+03
Chloromethane	1.2E+04	2	5.3E+00	2.6E+00	2.0E+00
Dichlorodifluoro-methane	1.0E+03	2	1.1E+00	5.7E-01	1.9E+00
Epichlorohydrin	8.0E+00	60	2.0E-01	2.9E-03	6.9E+01
Hexane	1.8E+02	10	6.9E-01	5.7E-02	1.2E+01
Mercury	4.5E+01	60	2.5E+00	8.6E-05	2.9E+04
Methylene chloride	2.0E+04	10	7.8E+01	8.6E-01	9.1E+01
Methyl ethyl ketone	1.2E+03	25	9.9E+00	2.9E+00	3.4E+01
Methyl isobutyl ketone	5.5E+02	60	1.5E+01	2.3E-01	6.5E+01
Nitrobenzene	1.1E+00	60	3.6E-02	5.7E-03	6.3E+00
Propylene oxide	3.1E+02	2	1.7E-01	8.6E-03	2.0E+01
Toluene	6.5E+02	55	1.5E+01	1.1E-01	1.4E+02
Trichlorofluoromethane	1.3E+03	2	1.6E+00	2.0E+00	8.0E+01
1,1,1-Trichloroethane	1.0E+04	20	1.2E+02	2.9E-01	4.1E+02
Triethylamine	1.5E+01	15	1.0E-01	2.0E-03	5.0E+01
Vinyl acetate	1.4E+02	20	1.1E+00	5.7E-02	1.9E+01

ranked in carcinogen Class A (known human carcinogens). These two chemicals were included in the MEI evaluation.

ALOHA™ was used to estimate the carcinogen concentration and duration of exposure for the MEI. A standard risk equation and standard assumptions for inhalation rate (0.014 m^3/min and body weight of 70 kg [approximately 155 lb]) were used in calculating risks (EPA, 1989b). Risks ranged from 7×10^{-6} to 2.1×10^{-4} and are presented in Table E-37. All except one are within a risk range generally considered acceptable for HW sites. The risk of 2.1×10^{-4} was for hydrazine, a chemical shipped 12 times under the

Table E-37. Lifetime Increased Carcinogenic Risk to an MEI

Chemical	Concentration at MEI Location (ppm)[a]	Exposure Time (min)	Intake (mg/kg/d)[b]	Slope Factor $(mg/kg/d)^{-1}$	Cancer Incidence Risk to MEI
1,2-Dibromoethane	1.0E+01	60	3.6E-05	7.7E+01	2.8E-05
1,3-Butadiene	4.5E+02	2	1.6E-05	9.8E-01	1.5E-05
Acrylonitrile	2.5E+02	20	8.5E-05	2.4E-01	2.0E-06
Benzene	6.0E+02	20	3.0E-04	2.9E+02	8.7E-06
Ethylene oxide	5.55E+02	5	3.9E-05	3.5E-01	1.4E-05
Formaldehyde	8.15E+03	2	1.6E-04	4.6E-02	7.1E-06
Hydrazine	2.0E+01	60	1.2E-05	1.7E+01	2.1E-04
Tetrachloroethane	5.0E+01	60	1.6E-04	2.0E-01	3.3E-05
Vinyl chloride	1.85E+03	2	3.4E-05	2.9E-01	2.2E-05
Vinylidene chloride	1.25E+03	2	7.7E-05	1.8E-01	1.4E-05

[a] MEI is assumed to be located 30 m (100 ft) from release point.
[b] Adjusted to short-term exposures.

No Action Alternative; therefore, increased carcinogenic risk for the MEI is insignificant for all carcinogens except hydrazine; however, note that several of these carcinogens (specifically, acrylonitrile, ethylene oxide, and formaldehyde) are severe irritants and would be expected to result in eye and respiratory irritation to the MEI at the modeled dose levels.

E.17.1.3.4 *Accident and Routine Vehicle-Related Transportation Risks*

The risk of fatality and injury under each alternative is directly proportional to the number of miles traveled. For this reason, risks of the Decentralized, Regionalized, and Regionalized 2 Alternatives are approximately one-half those of the No Action Alternative. These risks may be refined to reflect fatality and injury rates specific to urban, suburban, and rural roadways as these data become available. The risks of fatalities and injuries from collisions occurring during HW transport are reported in Table E-34 for each alternative.

The routine vehicle-related risks associated with truck emissions are directly proportional to the number of miles traveled in urban areas for each alternative: the alternative with the most miles through urban areas has the greatest risk. The collective annual population risks (to the public and workers) from onsite and

offsite HW transportation under routine nonaccident conditions are reported for each alternative in Table E-34. The data clearly show that routine risk estimates are linearly dependent on only one variable, total HW transportation distance. Truck shipments of HW through urban areas are 40 to 55% more frequent under the Regionalized 1 Alternative than under the other alternatives.

E.17.2 TRANSURANIC WASTE

E.17.2.1 TRUW Alternatives

See Section E.2.2.3 for a detailed description of the six TRUW alternatives.

E.17.2.2 Cargo-Related Accident Transportation Risks (Chemical Dose Through Inhalation)

Organic liquids constituted the TRUW waste stream class which would present the greatest risk to the public in terms of hazardous waste impacts if a transportation accident occurred. Therefore, this case was studied in detail for both truck and rail transportation modes. For truck mode, the results revealed that the footprint area for the work-case shipment was within 30 m (98 ft) of the roadway, where no residents were assumed to live. This was true for both the "any adverse effects" and "increased carcinogenic risk health" endpoints. Recall that no substance evaluated for the potentially-life threatening endpoint was included in the TRUW inventory. Since the most hazardous shipment was assessed, all other shipments would also result in zero population risks. Similarly, the plume footprint area for the most hazardous rail mode shipment was also within 30 m (98 ft) of the roadway, so the population risk was zero. Therefore, the population risk for both transportation modes under all alternatives was zero, primary due to TRUW transportation in TRUPACT-II containers.

E.17.2.3 Cargo-Related Accident Transportation Risks (Chemical Dose Through Inhalation) for the MEI

Truck Mode. The impacts to the MEI are the same for all alternatives under the truck transport mode since each alternative involves transport of organic liquids via truck or rail, and the MEI for each alternative is

assumed to be located 30 m (98 ft) from the roadway. The MEI calculations were performed using assumptions and methods consistent with those presented above for hazardous waste. The carcinogenic risks and risks for any adverse effect are presented in Tables E-38 and E-39. The potential life-threatening effects endpoint was not assessed, because no PIH substances were included in the TRUW inventory. The risks to the MEI are very small but are nonzero. The risks shown are consistent with the result of zero population risks, because only carcinogenic risks of 10^{-6} or greater or hazard quotients of 1 or greater would result in a population risk that is reported in this assessment.

Rail Mode. The railcar accident release rates are twice the truck accident rates, because the railcars have a TRUPACT-II capacity of six (versus a truck capacity of 3). Therefore, the carcinogenic risks and risks for any adverse effects presented in Tables E-40 and E-41 are twice the risks presented for truck mode. The hazard quotient to the MEI from carbon tetrachloride is 1.06. This hazard quotient indicates a very borderline potential for any adverse effects (potential for effects is considered unlikely for hazard quotients

Table E-38. Lifetime MEI Carcinogenic Risks for Mixed TRUW—Truck Mode

Chemical Name	Concentration at MEI Location (ppm)	Exposure Time (min/d)	Inhalation Air Intake (mg/kg/d)	Slope Factor $(mg/kg/d)^{-1}$	Carcinogenic MEI Risk
Carbon tetrachloride	2.15E-01	60	6.34E-07	5.25E-02	3.3E-08

Table E-39. MEI Hazard Quotients for Adverse Effect Endpoint for Mixed TRUW—Truck Mode

Chemical Name	Molecular Weight	Concentration at MEI Location (ppm)	Exposure Time (min/d)	Inhalation Air Intake (mg/kg/d)	Inhalation RfD $(mg/kg/d)^{-1}$	Hazard Quotient Risk
1,1,1-trichloroethane	133.42	5.86E-01	60	2.1E-02	2.9E-01	7.52E-02
Carbon tetrachloride	153.82	2.15E-01	60	9.1E-03	1.7E-02	5.30E-01
Freon 113	187.38	1.85E-01	60	9.5E-03	8.6E+00	1.11E-03

Table E-40. Lifetime MEI Carcinogenic Risks for Mixed TRUW—Rail Mode

Chemical Name	Concentration at MEI Location (ppm)	Exposure Time (min/d)	Inhalation Air Intake (mg/kg/d)	Slope Factor $(mg/kg/d)^{-1}$	Carcino-genic MEI Risk
Carbon tetrachloride	4.3E-01	60	6.34E-07	5.25E-02	6.6E-08

Table E-41. MEI Hazard Quotients for Adverse Effect Endpoint for Mixed TRUW—Rail Mode

Chemical	Concentration at MEI Location (ppm)	Exposure Time (min/d)	Inhalation Air Intake (mg/kg/d)	Inhalation RfD (mg/kg/d)	Hazard Quotient
1,1,1-trichloroethane	1.17E+00	60	2.1E-02	2.9E-01	1.50E-01
Carbon tetrachloride	4.30E-01	60	9.1E-03	1.7E-02	1.06E+00
Freon 113	3.70E-01	60	9.5E-03	8.6E+00	2.22E-03

less than 1). As a general guideline, the assumption may be made that the risk of adverse effects in minimal for substances with HQ values between 1 and 10, due to the uncertainties and conservatism associated with the use of EPA RfD values to evaluate single, brief exposures. Therefore, adverse effects due to carbon tetrachloride exposure would be unlikely unless the MEI receptor was extremely sensitive with respect to chemical exposures.

Accident and routine vehicle-related risks from transportation of TRUW are presented in Part I.

E.17.3 Low-Level Mixed Waste

E.17.3.1 LLMW Alternatives

See Section E.2.2.4 for a detailed description of the six LLMW alternatives. In summary, the alternatives assessed for the HW component of LLMW consist of the following:

- Decentralized (49 sites treat contact-handled waste [CH]; 16 sites dispose)
- Regionalized 1 (11 sites treat CH; 12 sites dispose)

- Regionalized 2 (7 sites treat CH; 6 sites dispose)
- Regionalized 3 (7 sites treat CH; 1 site disposes)
- Regionalized 4 (4 sites treat CH; 6 sites dispose)
- Centralized (1 site treats and 1 site disposes of CH

Under all alternatives, remote-handled waste would be treated and disposed of at four sites. The No Action Alternative does not involve HW transportation risks, and thus is not discussed here.

E.17.3.2 Cargo-Related Accident Transportation Risks (Chemical Dose Through Inhalation)

The collective cargo-related population risks to the general public for 10 years of off-site WM transportation are summarized in Table E-42 for truck transport mode and in Table E-43 for rail transport mode. The potential life-threatening effects endpoint was not assessed, because no PIH substances were included in the LLMW inventory.

The potential population risks involving liquid waste shipments by trucks and railcars are attributed to the direct release of aerosolized liquid droplets. Truck-accident increased cancer risk and any adverse effect risk from aerosolized liquid droplets are highest for highway shipments under the Centralized Alternative, Severity Category IV. Railcar-accident risks from aerosolized liquid droplets are also highest for rail shipments under the centralized alternative and the same severity category.

The potential population risks involving solid waste shipments by trucks and railcars are attributed to evaporative organic vapor emissions from a waste spoils-pile ground spill and to the direct release of respirable particulates from an overturned vehicle or a ruptured container (or both). Both truck and railcar accident risks from evaporative and from respirable particulate releases are found to be zero for all of the cases.

Table E-42. Summary of Cargo-Related Population Risks[a] for WM (10-Year Period)[b] LLMW Shipments by Highway

Population Risks	LLMW Treatment Options					
	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Regionalized 4	Centralized
Shipment summary						
Number of shipments	5.00E+01	6.30E+02	1.23E+03	1.18E+03	2.49E+03	5.13E+03
Distance (km)	4.73E+04	3.23E+05	5.00E+05	4.44E+05	8.27E+05	2.33E+06
Liquid wastes						
Potential for increased cancer incidence						
Severity Categories I	0	0	0	0	0	0
Severity Categories II	0	0	0	0	0	0
Severity Categories III	0	5.98-07	2.54E-04	2.54E-04	2.61E-04	3.08E-04
Severity Category IV[c]	*2.49E-07*	*3.90E-06*	*3.42E-04*	*3.42E-04*	*3.53E-04*	*4.30E-04*
Severity Category V	3.42E-08	4.89E-07	4.39E-05	4.39E-05	4.54E-05	5.55E-05
Severity Category VI	9.76E-09	1.16E-07	1.10E-05	1.10E-05	1.14E-05	1.41E-05
Severity Category VII	4.99E-10	7.08E-09	6.44E-07	6.44E-07	6.67E-07	8.21E-07
Severity Category VIII	6.30E-11	7.30E-10	7.09E-08	7.09E-08	7.38E-08	9.20E-08
Potential adverse health effects						
Severity Categories I	0	0	0	0	0	0
Severity Categories II	0	1.39E-06	8.01E-04	8.01E-04	8.09E-04	9.28E-04
Severity Categories III	0	8.28E-06	9.21E-04	9.21E-04	9.50E-04	1.22E-03
Severity Category IV[c]	*1.53E-06*	*1.98E-05*	*1.33E-05*	*1.32E-03*	*1.37E-03*	*1.67E-03*
Severity Category V	2.10E-07	2.51E-06	1.70E-04	1.70E-04	1.76E-04	2.15E-04
Severity Category VI	6.01E-08	6.07E-07	4.26E-05	4.25E-05	4.42E-05	5.45E-05
Severity Category VII	3.07E-09	3.65E-08	2.50E-06	2.49E-06	2.59E-06	3.18E-06
Severity Category VIII	3.88E-10	3.86E-09	2.75E-07	2.75E-07	2.87E-07	3.57E-07
Solid wastes (volatile-organic-contaminated soil/debris evaporative releases)						
Potential for increased cancer incidence	0	0	0	0	0	0
Potential adverse health effects	0	0	0	0	0	0
Solid wastes (respirable contaminated aerosol releases)						
Potential for increased cancer incidence	0	0	0	0	0	0
Potential adverse health effects	0	0	0	0	0	0

[a] Cargo-related risks refer to the number of people affected and were computed from the product of the probability of accidental release times the number of people exposed to the health criteria concentration.
[b] Risks and travel distances are for the total shipping duration (10 years). To obtain the annual values, the risks and distances must be divided by 10.
[c] Values in italics present the highest risk for a specific risk category.

Table E-43. Summary of Cargo-Related Population Risks[a] for WM (10-Year Period)[b] LLMW Shipments by Railway

Population Risks	LLMW Treatment Options					
	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Regionalized 4	Centralized
Shipment summary						
Number of shipments	5.00E+01	5.30E+02	8.10E+02	7.60E+02	1.32E+03	2.34E+03
Distance (km)	3.88E+04	3.65E+05	5.76E+05	5.17E+05	9.15E+05	2.46E+06
Liquid wastes						
Potential for increased cancer incidence						
Severity Categories I	0	0	0	0	0	0
Severity Categories II	0	0	2.42E-05	2.42E-05	2.42E-05	2.42E-05
Severity Categories III	0	1.84E-07	*9.05E-05*	*9.05E-05*	*9.24E-05*	*1.12E-04*
Severity Category IV	*9.84E-08*	*1.03E-06*	7.42E-06	7.41E-05	7.60E-05	9.19E-05
Severity Category V	7.56E-09	7.51E-08	5.36E-08	5.35E-06	5.50E-06	6.70E-06
Severity Category VI	3.82E-10	3.41E-09	2.38E-07	2.38E-07	2.46E-07	3.04E-07
Severity Category VII	8.53E-11	8.66E-10	7.22E-08	7.21E-08	7.42E-08	8.90E-08
Severity Category VIII	1.57E-11	1.26E-10	9.62E-09	9.60E-09	9.98E-09	1.24E-08
Potential adverse health effects						
Severity Categories I	0	0	0	0	0	0
Severity Categories II	0	1.41E-07	1.38E-04	1.38E-04	1.38E-04	1.55E-04
Severity Categories III	0	3.13E-06	*4.08E-04*	*4.08E-04*	*4.17E-04*	*4.92E-04*
Severity Category IV	*4.41E-07*	*4.71E-06*	2.92E-04	2.91E-04	2.99E-04	3.64E-04
Severity Category V	3.39E-08	3.44E-07	2.11E-05	2.11E-05	2.17E-05	2.65E-05
Severity Category VI	1.17E-09	1.57E-08	9.38E-07	9.37E-07	9.69E-07	1.20E-06
Severity Category VII	3.82E-10	3.95E-09	2.84E-07	2.84E-07	2.92E-07	3.52E-07
Severity Category VIII	7.01E-11	5.88E-10	3.79E-08	3.78E-08	3.93E-08	4.91E-08
Solid wastes (volatile-organic-contaminated aerosol releases)						
Potential for increased cancer incidence	0	0	0	0	0	0
Potential adverse health effects	0	0	0	0	0	0
Solid wastes (respirable contaminants aerosol releases)						
Potential for increased cancer incidence	0	0	0	0	0	0
Potential adverse health effects	0	0	0	0	0	0

[a] Cargo-related risks refer to the number of people affected and were computed from the product of the probability of accidental release times the number of people exposed to the health criteria concentration.
[b] Risks and travel distances are for the total shipping duration (10 years). To obtain the annual values, the risks and distances must be divided by 10.
[c] Values in italics present the highest risk for a specific risk category.

E.17.3.3 Cargo-Related Accident Transportation Risks (Chemical Dose Through Inhalation) for the MEI

With regard to MEI risk evaluation, the increased cancer risk and any adverse effects endpoints are summarized in Tables E-44 and E-45. The methods used to estimate risks to the MEI were the same as those used for HW outlined in Sections E.17.1.3.2 and E.17.1.3.3 above. The risk calculations are based on the maximum ambient concentrations at 30 m (98 ft) from the release point for all shipments for a single

Table E-44. Lifetime Increased Cancer Risk to an MEI for LLMW Transportation

Transportation Mode	Release Mode	Chemical Name	Concentration at MEI Location (ppm)	Exposure Time (min/d)	Inhalation[a] Air Intake (mg/kg/d)	Slope Factor $(mg/kg/d)^{-1}$	Cancer Incidence Risk to MEI
Highway	Liquid aerosol (direct)	Dichloromethane	1.22E+00	60	1.99E-06	1.65E-03	3.3E-09
		Dichloroethane	7.21E-01	60	1.37E-06	9.10E-02	1.2E-07
		Tetrachloroethene	1.15E+01	60	3.66E-05	5.95E-03	2.2E-07
		Benzene	1.28E+03	60	1.92E-03	2.91E-02	5.6E-05
	Vapor spoils pile (Superfund)	Dichloromethane	2.51E-03	60	4.09E-09	1.65E-03	6.7E-12
		Dichloroethane	1.69E-03	60	3.21E-09	9.10E-02	2.9E-10
		Tetrachloroethene	6.59E-04	60	2.10E-09	5.95E-03	1.2E-11
		Benzene	8.05E-03	60	1.21E-08	2.91E-02	3.5E-10
	Particulate (severity Category II)	Dichloromethane	5.28E-03	60	8.60E-09	1.65E-03	1.4E-11
		Dichloroethane	2.31E-03	60	4.38E-09	9.10E-02	4.0E-10
		Tetrachloroethene	2.47E-02	60	7.86E-08	5.95E-03	4.7E-10
		Benzene	8.09E-02	60	1.21E-07	2.91E-02	3.5E-09
	Particulate (severity Category III)	Dichloromethane	5.28E-02	60	8.60E-08	1.65E-03	1.4E-10
		Dichloroethane	2.31E-02	60	4.28E-08	9.10E-02	4.0E-09
		Tetrachloroethene	2.47E-01	60	7.86E-07	5.95E-03	4.7E-09
		Benzene	8.09E-01	60	1.21E-06	2.91E-02	3.5E-08
	Particulate (severity Categories IV-VIII)	Dichloromethane	5.28E-01	60	8.60E-07	1.65E-03	1.4E-09
		Dichloroethane	2.31E-01	60	4.38E-07	9.10E-02	4.0E-08
		Tetrachloroethene	2.47E+00	60	7.86E-06	5.95E-03	4.7E-08
		Benzene	8.09E+00	60	1.21E-05	2.91E-02	3.5E-07
Railroad	Liquid aerosol (direct)	Dichloromethane	1.57E+01	60	2.56E-05	1.65E-03	4.2E-08
		Dichloroethane	7.27E+00	60	1.38E-05	9.10E-02	1.3E-06
		Tetrachloroethene	2.33E+01	60	7.41E-05	5.95E-03	4.4E-07
		Benzene	3.22E+03	60	4.82E-03	2.91E-02	1.4E-04
	Vapor spoils pile (Superfund)	Dichloromethane	2.51E-03	60	4.09E-09	1.65E-03	6.7E-12
		Dichloroethane	1.69E-03	60	3.21E-09	9.10E-02	2.9E-10
		Tetrachloroethene	6.59E-04	60	2.10E-09	5.95E-03	1.2E-11
		Benzene	8.05E-03	60	1.21E-08	2.91E-02	3.5E-10
	Particulate (severity Category II)	Dichloromethane	5.28E-03	60	8.60E-09	1.65E-03	1.4E-11
		Dichloroethane	2.31E-03	60	4.38E-09	9.10E-02	4.0E-10
		Tetrachloroethene	2.47E-02	60	7.86E-08	5.95E-03	4.7E-10
		Benzene	8.09E-02	60	1.21E-07	2.91E-02	3.5E-09
	Particulate (severity Category III)	Dichloromethane	5.28E-02	60	8.60E-08	1.65E-03	1.4E-10
		Dichloroethane	2.31E-02	60	4.38E-08	9.10E-02	4.0E-09
		Tetrachloroethene	2.47E-01	60	7.86E-07	5.95E-03	4.7E-09
		Benzene	8.09E-01	60	1.21E-06	2.91E-02	3.5E-08
	Particulate (severity Categories IV-VIII)	Dichloromethane	5.28E-01	60	8.60E-07	1.65E-03	1.4E-09
		Dichloroethane	2.31E-01	60	4.38E-07	9.10E-02	4.0E-08
		Tetrachloroethene	2.47E+00	60	7.86E-06	5.95E-03	4.7E-08
		Benzene	8.09E+00	60	1.21E-05	2.91E-02	3.5E-07

[a] Adjusted to short-term exposures.

Table E-45. Any Adverse Effects Risk to an MEI for LLMW Transportation

Transportation Mode	Release Mode	Chemical Name	Concentration at MEI Location (ppm)	Exposure Time (min/d)	Inhalation Air Intake (mg/kg/d)	RfD (mg/kg/d)	HQ
Highway	Liquid spill	Dichloromethane	1.22E+00	60	2.9E-02	8.6E-01	3.33E-02
		1,1,1-Trichloroethane	7.21E-01	60	2.6E-02	2.9E-01	9.25E-02
		Freon 113	1.15E+01	60	5.9E-01	8.6E+00	6.90E-02
		Toluene	1.28E+03	60	3.2E+01	1.1E-01	2.84E+02
	Spoils pile vapor (Superfund)	Dichloromethane	2.51E-03	60	5.9E-05	8.6E-01	6.84E-05
		1,1,1-Trichloroethane	1.69E-03	60	6.2E-05	2.9E-01	2.17E-04
		Freon 113	6.59E-04	60	3.4E-05	8.6E+00	3.95E-06
		Toluene	8.05E-03	60	2.0E-04	1.1E-01	1.78E-03
	Particulate (severity Category II)	Dichloromethane	5.28E-03	60	1.2E-04	8.6E-01	1.44E-04
		1,1,1-Trichloroethane	2.31E-03	60	8.5E-05	2.9E-01	2.96E-04
		Freon 113	2.47E-02	60	1.3E-03	8.6E+00	1.48E-04
		Toluene	8.09E-02	60	2.0E-03	1.1E-01	1.79E-02
	Particulate (severity Category III)	Dichloromethane	5.28E-02	60	1.2E-03	8.6E-01	1.44E-03
		1,1,1-Trichloroethane	2.31E-02	60	8.5E-04	2.9E-01	2.96E-03
		Freon 113	2.47E-01	60	1.3E-02	8.6E+00	1.48E-03
		Toluene	8.09E-01	60	2.0E-02	1.1E-01	1.79E-01
	Particulate (severity Categories IV-VIII)	Dichloromethane	5.28E-01	60	1.2E-02	8.6E-01	1.44E-02
		1,1,1-Trichloroethane	2.31E-01	60	8.5E-03	2.9E-01	2.96E-02
		Freon 113	2.47E+00	60	1.3E-01	8.6E+00	1.48E-02
		Toluene	8.09E+00	60	2.0E-01	1.1E-01	1.79E+00
Railroad	Liquid spill	Dichloromethane	1.57E+01	60	3.7E-01	8.6E-01	4.28E-01
		1,1,1-Trichloroethane	1.29E+02	60	4.7E+00	2.9E-01	1.66E+01
		Freon 113	7.65E-02	60	3.9E-03	8.6E+00	4.59E-04
		Toluene	2.68E+03	60	6.8E+01	1.1E-01	5.94E+02
	Spoils pile vapor (Superfund)	Dichloromethane	2.51E-03	60	5.9E-05	8.6E-01	6.84E-05
		1,1,1-Trichloroethane	2.87E-03	60	1.1E-04	2.9E-01	3.68E-04
		Freon 113	2.98E-05	60	1.5E-06	8.6E+00	1.79E-07
		Toluene	2.04E-03	60	5.2E-05	1.1E-01	4.52E-04
	Particulate (severity Category II)	Dichloromethane	5.28E-03	60	1.2E-04	8.6E-01	1.44E-04
		1,1,1-Trichloroethane	3.85E-02	60	1.4E-03	2.9E-01	4.94E-03
		Freon 113	9.64E-04	60	5.0E-05	8.6E+00	5.78E-06
		Toluene	7.34E-02	60	1.9E-03	1.1E-01	1.63E-02
	Particulate (severity Category III)	Dichloromethane	5.28E-02	60	1.2E-03	8.6E-01	1.44E-03
		1,1,1-Trichloroethane	3.85E-01	60	1.4E-02	2.9E-01	4.94E-02
		Freon 113	9.64E-03	60	5.0E-04	8.6E+00	5.78E-05
		Toluene	7.34E-01	60	1.9E-02	1.1E-01	1.63E-01
	Particulate (severity Categories IV-VIII)	Dichloromethane	5.28E-01	60	1.2E-02	8.6E-01	1.44E-02
		1,1,1-Trichloroethane	3.85E+00	60	1.4E-01	2.9E-01	4.94E-01
		Freon 113	9.64E-02	60	5.0E-03	8.6E+00	5.78E-04
		Toluene	7.34E+00	60	1.9E-01	1.1E-01	1.63E+00

Note: RfD = inhalation reference dose.

truck or railcar accident predicted by the ALOHA™ model on a chemical-specific basis. As indicated in Table E–44, carcinogenic risks for all chemicals are between 1.2×10^{-11} and 1.4×10^{-4}.

All except one for the liquid shipment assessed (both by truck and rail) are lower than or within a risk range generally considered acceptable for HW sites (i.e., 10^{-6} to 10^{-4}). The carcinogenic risks of 5.6×10^{-5} for truck shipment and 1.4×10^{-4} for railcar shipment were for LLMW classified as soluble hydrocarbon. As a conservative assumption and to facilitate calculations, soluble hydrocarbon waste was assumed to be the carcinogenic substance benzene. The risks presented for this waste category are probably overestimated, because it is highly unlikely that the soluble hydrocarbons are actually composed of pure benzene. However, more data on the composition of the material would be required to refine the risk estimate. Adverse effects are considered possible for substances with associated hazard quotient values greater than 1. As shown in Table E–45, HQs are greater than 1 for the liquid shipment assessed (both by truck and rail), and for solid-waste truck and rail shipments of toluene under accident severity categories IV through VIII. Thus, accidental release involving any of these shipments would have a potential to result in adverse effects for receptors at the MEI location.

Increased cancer risks and any adverse effects risks are also presented in the technical support document by alternative (ANL, 1996e).

E.18 Uncertainty

The consecution of analysis leading to estimates of transportation risk for HW and HW components of TRUW and LLMW has the following major components: (1) computation of transportation routes; (2) development of health effects criteria; (3) selection of appropriate truck accident, toxic chemical release, and ruptured container probabilities; (4) quantitative estimation of source terms and atmospheric transport and dispersion; (5) calculation of exposure areas exceeding health endpoint specific chemical concentration levels; and (6) estimation of worker, general population, and MEI risks. Various levels of uncertainty are associated with each of these components. Uncertainties exist in the way the physical systems being analyzed are represented by the computational models, in the data required to exercise the models (due to measurement errors, sampling errors, natural variability, or unknowns simply due to the future nature of the actions being analyzed), and in the calculations themselves (for example, empirical data inherent in the model structure and the theoretical assumptions incorporated in the model). The errors in data used as input

to the model or models applied to compute risk can be referred to as *parameter uncertainty*. Errors in the model algorithm or empirical data incorporated in the model can be referred to as *model uncertainty*.

In principle, one can estimate the uncertainty associated with each model input data parameter, each model empirical parameter, and each model theoretical assumption, and predict the resultant uncertainty in each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final result (that is, human health risk); however, conducting such a full-scale quantitative uncertainty analysis is often impractical because of the lack of actual data (for example, field measurements), which does not permit development of the necessary probability distributions needed to quantify uncertainty in every parameter. This is especially true for actions to be taken in the future; however, one can typically assume that the accuracy of Gaussian model predictions of maximum ground level concentrations, such as those from ALOHA™, are within a factor of 3 of corresponding field observations (Turner, 1994). The remainder of the error inherent in the risk calculations is in parameter uncertainty. Three main types of parameter uncertainty exist: random error resulting from data entry or reporting, systematic error induced from biases in data collection and analysis procedures, and errors resulting from variability over time and space (that is, meteorology or waste volumes). Certain key model input parameters can be identified for analysis that should capture the most significant contributors associated with parameter uncertainty and, when combined with model uncertainty, to the overall uncertainty in the risk assessment. These parameters come from the following six areas:

- *Meteorologic conditions* (for example, windspeed and direction, atmospheric stability, relative humidity, and ambient temperature) at the time of the accident
- *Number of shipments* of hazardous chemicals, which depends on the accuracy of the total annual shipment inventory and its variation from year to year
- *Release amounts* from any given accident caused by impact physics (the vehicle's speed, collision type, and number of vehicles involved), the location of the container rupture, and the number and contents of ruptured containers
- Hazardous material truck *accident rates* and the *release probability*, given an accident
- *Population density* in the vicinity of the accident
- *Health criteria* and extrapolation to humans, including the adjustment of each health criterion to the actual exposure time of the human to the vapor plume

Estimates of the potential range of uncertainty or variability in the absolute HW risk can be made by varying these parameters independently within probable parameter error bands or known variability bands. Although not a quantitative uncertainty analysis, this type of sensitivity analysis is useful in providing some

semiquantitative estimate of potential absolute uncertainty in the risk estimates associated with each parameter. To do this, the data used to estimate the risk of potential life-threatening effects discussed in Section E.17.1.2.1 of this appendix were used to carry out a sensitivity analysis to estimate potential parameter error bands. Because the risk estimate results from these data show that more than 50% of the risk for potential life-threatening effects under the No Action Alternative is contributed by a small fraction of the total shipments (5 of 63 PIH shipments), a sensitivity analysis using these data should provide a reasonable estimate of the magnitude of parameter error bands. The specific chemicals in the five waste truckloads that contribute to most of the chemical-inhalation potential life-threatening risk are two shipments of arsine (0.03 m^3 [8 gal]), two shipments of hydrogen fluoride (0.06 m^3 [17 gal]), and one shipment of hydrogen selenide (3.8 L [1 gal]). The atmospheric transport and dispersion from the release of all five truckloads of these three chemicals were modeled as a negatively buoyant heavy or dense vapor plume.

The first parameter examined was meteorologic conditions. Although random error (error of data collection and reporting) and systematic error (error of instrument calibration) are associated with this parameter, uncertainty associated with meteorologic variability should produce variability bands that overlap the smaller error bands associated with random and systematic error. Windspeed, atmospheric stability, and ambient temperature were varied to estimate the risk associated with meteorologic variability for the top six HW shipments contributing more than 50% of the risk. Windspeeds were varied from 1 to 20 m/s (2.2 to 45 mi/h) for conditions of daytime neutral stability (stability Class D) with 35°C (95°F) and 10°C (50°F) ambient temperatures and were varied from 2 to 5 m/s (4.5 to 11 mi/h) for nighttime stable (stability Classes E and F) conditions with 20°C (70°F) and -9°C (15°F) ambient temperatures. The PEIS risk assessment assumed 4-m/s (9-mi/h) winds, neutral stability, and an ambient temperature of 35°C (95°F). This parameter variability produces a risk uncertainty varying from approximately a factor of 3 smaller to approximately a factor of 11 larger. Risk standard deviations range from 4.3×10^{-4} (for the arsine shipment) to 2.0×10^{-2} (for the hydrogen selenide shipment).

The uncertainty in the number of shipments per year depends on the accuracy of reported manifested waste volume inventory of PIH, ICRC, and PAEC chemicals and the year-to-year variability in shipping these chemicals. Although risk is linear with transportation miles, the number of shipments is not linear with manifested waste volumes. With the assumption that a fully implemented waste minimization program would offset any positive bias in the waste inventory, a 20% reduction in volume could lead to 5% fewer shipment miles.

The release amount depends on many factors, such as the vehicle's speed at impact, the position and quantity of drums in the truck, and the truck type. Preliminary sensitivity analysis indicated that variations in these factors can lead up to a factor of 10 difference in risks for a single route.

Release probabilities have an approximately linear relationship to risk. The same six routes and chemicals mentioned previously were analyzed for transportation risk by using 20% more or less than the probabilities used in actual risk analysis. Risk results appeared to be linearly related because 20% higher probabilities led to an approximately 20% higher risk.

Changing the health criteria (for lethality) to 0.1 to 10 times the value used in the risk assessment led to dramatic changes in the risk. Typically, changes in the risk between 1 and 2 orders of magnitude resulted along any one route of the six tested. Errors of 0.1 to 10 are possible for the health criteria for different chemicals, but that range likely covers any reasonable error in estimation of that health criterion. Some cancellation of errors is likely as the risk from many routes and chemicals is summed to provide the total risk for a specific alternative; however, the risk from the top 10% of the routes with the greatest risk likely dominates this summation process.

Looking at the individual contributors to risk uncertainty is useful from a modeler's perspective for gaining insight on the weaknesses and strengths of a particular modeling analysis. However, it would be more useful from a decision maker's perspective to have some estimate of the overall uncertainty in the computed risk estimate. To do this, a risk estimate model that provides both deterministic and probabilistic estimates was employed (Policastro et al., 1995). The results from this exercise show an approximately 98.6% probability that after 20 years of hazardous waste shipments, no people would suffer potentially life-threatening health effects. The deterministic prediction of risk for the 20-year period, 3.48×10^{-3} people suffering potentially life-threatening health effects, was found to be at the 99.5th percentile of the probability distribution.

The transportation risk assessment is designed to ensure—through uniform and judicious selection of scenarios, models, and input parameters—that relative comparisons of risk among the various alternatives are meaningful because the errors in each alternative evaluation repeat themselves in the same way. Because the uncertainty is in the absolute risk estimates; for example, the potential number of fatalities, relying on the relative risk comparisons among alternatives normalizes this uncertainty and therefore reduces the level of uncertainty in the comparative results. In the transportation risk assessment, input parameters and assumptions are uniformly applied to all HW alternatives. Therefore, although considerable uncertainty is

inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

E.18.1 Counterposing or Reinforcement of Errors (Absolute Uncertainty)

The previous discussion describes the major sources of parameter and model uncertainty in the HW risk analysis calculations and the ranges of likely uncertainty in those parameters and models used. For some parameters, an estimate of the possible risk value range for a 1.6-km (1-mi) segment due to the parameter range was given as well; however, the total risk calculated for a specific alternative (and health endpoint) is actually the sum of the risk values computed for each of the many 1.6-km (1-mi) segments encompassing the many routes traveled by the many HW shipments for that alternative (No Action, Decentralized, Regionalized 1 or 2). The computed risk is the summation of the predicted risk for each mile in the routing. There is some error in the risk prediction for each mile. There would be some degree of cancellation of errors during this risk summation process (risk for some miles being overestimated and for others being underestimated), unless there is a systematic overprediction or underprediction of the risk at each mile. That possibility is not expected because the most accurate value was chosen for component of risk in the risk calculation for each single mile. The interplay of uncertainties by parameter and assumption could be estimated only by using a detailed probabilistic risk assessment approach, which was not taken in this appendix. Recognizing that some error cancellation and actually some error reinforcement do occur is key to understanding the uncertainty in the final or total risk numbers computed. The effect of the combined set of parameter and model errors is estimated to be within plus or minus one order of magnitude for the total risk numbers presented for a specific alternative and endpoint.

E.18.2 Relative Uncertainty

Although the absolute uncertainty may seem large from the previous discussion, the relative uncertainty is most important, and that uncertainty is believed to be sufficiently small to allow reliance on the management conclusions that result from comparing differences in the risk predictions among the alternatives. Relative uncertainty is the uncertainty in the difference between pairs of alternatives. Because a risk value is computed for each of the four alternatives (and same endpoint) by using exactly the same methods, models, and parameter values, differences in the results should be caused by meaningful differences in the structure of the alternatives; for example, with one alternative, more miles may be covered by HW shipments than

another. This relative risk is believed to be smaller than the actual differences in risk values from the various alternatives; for example, if the risk from the Regionalized 2 Alternative is greater than the risk from the No Action Alternative, the behavior—of Regionalized 2 being larger than No Action—is believed to be accurate, although the actual risk numbers computed may each contain significant error. The accuracy of these statements about relative risk are critical to the meaning of the risk analyses in this PEIS.

E.19 Mitigative Measures

When transporting HW and LLMW, DOE follows all applicable regulations of DOT and EPA, such as using absorbent overpacking to prevent liquid releases, using placards, preparing manifests, and employing licensed transporters. For each named chemical, the CFR identifies permissible containers for transporting that chemical. The containers are ranked based on their sturdiness and the hazard class of the chemical to be transported. These regulations are designed to minimize the risks of transporting HW and to allow for rapid mitigative action in the event of an accidental release.

The DOE may consider additional measures to further minimize risks associated with HW and LLMW transportation. Examples include rerouting shipments through low-population density areas, pretreating the more dangerous chemicals at DOE sites, or substituting for the chemicals that lead to the greatest risk. Where possible, the potential decrease in risk that could be achieved through using rail transport may also be investigated.

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Appendix F

Treatment and Storage Facility Accidents

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Acronyms and Abbreviations

The following is a list of acronyms and abbreviations (including units of measure) used in this appendix.

Acronyms

ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
ARF	airborne release fraction
BTX	benzene, toluene, and xylene
Cd	cadmium
CFR	Code of Federal Regulations
CH	contact-handled
CIF	Consolidated Incineration Facility
CO_2	carbon dioxide
CPC	Chemical Process Cell
Cr	chromium
DBE	design-basis earthquake
DF	damage fraction
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DST	double-shell tank
DWPF	Defense Waste Processing Facility
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ER	environmental restoration
FEMP	Fernald Environmental Management Project
FY	fiscal year
GDC	general design criterion
GTCC	Greater-Than-Class-C
GWSB	Glass Waste Storage Building

^3H	tritium
Hanford	Hanford Site
HCl	hydrogen chloride
HEPA	high-efficiency particulate air
HFEF	Hot Fuel Examination Facility
Hg	mercury
HLW	high-level waste
H_2O	water
HW	hazardous waste
HWSF	hazardous waste storage facility
HWVP	Hanford Waste Vitrification Plant
INEL	Idaho National Engineering Laboratory
LANL	Los Alamos National Laboratory
LDR	land disposal restriction
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LPF	leak path factor
MAR	material at risk
MEI	maximally exposed individual
NEPA	National Environmental Policy Act
NH_3	ammonia
NH_4	ammonium
NO_x	nitrogen oxides
NPH	natural phenomena hazards
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PC	performance category
PEIS	Programmatic Environmental Impact Statement
PGDP	Paducah Gas Diffusion Plant
PORTS	Portsmouth Gaseous Diffusion Plant
PIH	poison inhalation hazard

PREPP	Process Experimental Pilot Plant
PSAR	Preliminary Safety Analysis Report for the Retrieval of Transuranic Waste
RARF	respirable airborne release fraction
RCRA	Resource Conservation and Recovery Act
RF	respirable fraction
RFETS	Rocky Flats Environmental Technology Site
RH	remote-handled
RWMC	Radioactive Waste Management Complex
SAR	safety analysis report
SCC	secondary combustion chamber
SCT	shielded canister transport
SO_2	sulfur dioxide
SQUG	Seismic Qualification Users Group
SRS	Savannah River Site
SWEPP	Solid Waste Experimental Pilot Plant
TC	treatment code
TRF	total release fraction
TRUW	transuranic waste
TSA	Transuranic Storage Area
TSD	treatment, storage, and disposal
WAC	waste acceptance criteria
WCSF	Waste Canister Storage Facility
WERF	Waste Experimental Reduction Facility
WIPP	Waste Isolation Pilot Plant
WM	waste management
WRAP	Waste Receiving and Processing Facility
WVDP	West Valley Demonstration Project

Abbreviations

atm	atmosphere(s)
°C	degree(s) Celsius
Ci	curie(s)
cm	centimeter(s)
cm^3	cubic centimeter(s)
°F	degree(s) Fahrenheit
ft	foot (feet)

ft^2	square foot (feet)
ft^3	cubic foot (feet)
g	gravity (acceleration due to)
gal	gallon(s)
h	hour(s)
kg	kilogram(s)
kPa	kilopascal(s)
lb	pound(s)
m	meter(s)
m^3	cubic meter(s)
mi	mile(s)
mm	millimeter(s)
mol	mole(s)
MPa	megapascal(s)
PE-Ci	Pu-239-equivalent curies
psig	pound(s) per square inch gauge
yr	year(s)

APPENDIX F
Treatment and Storage Facility Accidents

F.1 Introduction and Overview

F.1.1 SUMMARY

This appendix documents the methodology, computational framework and results for facility accident analyses performed for the U.S. Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS). The methodology is in compliance with the most recent DOE EIS guidance (DOE, 1993a) in that it considers the spectrum of accident sequences that could occur in activities covered by the WM PEIS and uses a graded approach emphasizing the risk-dominant scenarios to facilitate discrimination among the various WM PEIS alternatives. The main goal of the accident analysis is to provide results that allow reliable estimates of the relative risks among the alternatives rather than reliable values of absolute impact. The relative risk provides a sufficient basis for discriminating among alternatives. In the analysis of accident sequences, the accident models have been systematically applied to approximate the key source term parameters as functions of (1) the phenomenology and severity of the accident, (2) the process parameters, (3) the characteristics of the facility, and (4) the properties of the waste types. Uncertainties in data have been treated in a consistent manner to enhance the value of the relative risk comparisons.

The output of the facility accident analyses is consists of identification of the accidents potentially important to human health risk for each waste type, an assessment of the frequencies of these accidents, and an evaluation of the radiological and chemical source terms resulting from these accidents. A radiological source term is defined by specifying the amount (in curies) of each radionuclide released during an accident. Release is conservatively assumed to be instantaneous.

A chemical source term is defined by specifying the rate and duration of release for each toxic chemical released during an accident. The frequencies of the accidents and the results of the source term evaluation are provided as input to the WM PEIS for calculations of the human health and risk impacts.

Numerous DOE waste management sites were analyzed in this study. However, generic DOE facility characteristics were assumed in developing the accident sequences for all sites. Facility waste inventories assumed for each DOE site were derived from the storage inventories, generation rates, and treatment throughputs developed in the WM PEIS. Site safety documentation was used to help identify the frequencies and potential risk importance of extreme events such as seismic or tornadic events or aircraft crash events. Existing facility documentation and accident data were used only for general guidance in source term development; thus, the accident analyses herein may not necessarily duplicate the results produced in individual site environmental impact statements (EISs) or safety analysis reports (SARs) in which specific facilities are assessed.

The accident sequences analyzed were selected for their potential importance relative to human health effects. In light of the lack of specific process and facility design information, the analyses focused on accidents with the potential for airborne releases to the atmosphere. Although disposal alternatives are included in the WM PEIS waste management options, the details of ultimate disposal are not addressed. Consequently, accidents were not developed for this phase of waste management.

F.1.2 Scope and Objectives

The WM PEIS addresses strategic alternatives for management of five different types of waste in the DOE complex: high-level waste (HLW), transuranic waste (TRUW), low-level waste (LLW), low-level mixed waste (LLMW), and hazardous waste (HW). For each waste type, four alternatives or strategies have been analyzed for treatment, storage, and disposal (TSD): (1) no action, where existing sites will generally store and treat their own wastes consistent with currently approved plans; (2) centralization, where from one to a few DOE sites will be used to treat, store, and dispose of a given waste type from the entire DOE complex; (3) regionalization, where several sites distributed throughout the country will be used to treat, store, and dispose of that waste type for their geographic regions; and (4) decentralization, where regionalization is extended to include more sites. Alternatives for consolidation of waste involve both existing and conceptual-design facilities at the DOE sites. Moreover, a number of waste treatment technologies and storage options are assessed for each type of waste.

The most recent guidance (DOE, 1993a) from the Office of National Environmental Policy Act (NEPA) Oversight within the DOE calls for consideration of the spectrum of accident scenarios that could occur in activities being evaluated. This guidance also calls for a graded approach in which risk-dominant scenarios

are emphasized. Determination of risk dominance requires assessment of both the likelihood and the severity of plausible accident scenarios that could present a significant health hazard to either the workforce or the public. The spectrum of accident scenarios includes all accidents important to risk, from low-frequency events with potentially high consequences (as typified by accident sequences associated with severe natural phenomena, such as earthquakes) to relatively high-frequency events with very low consequences (as typified by routine industrial accidents).

The broad scope of the WM PEIS and the recent NEPA guidance result in a very large number of combinations of possible TSD options, existing or new facilities, and related possible accident scenarios to be evaluated for assessing management alternatives for each waste type. Accordingly, one obvious objective of the methodology for accident analysis was the development of a screening methodology that would enable focus on the risk-dominant sites and facilities for the storage and treatment operations and for waste consolidation.

A second objective was to develop a methodology for accident analysis that would allow sufficient discrimination of risk impacts among the various options and alternatives to support the WM PEIS decision-making process. Although the method must provide reasonable estimates of the risk impacts associated with each alternative, providing reliable estimates of the relative risks among the alternatives is more important. To accomplish these goals, the accident models must be adequate to approximate the key source term parameters as a function of the phenomenology and severity of the accident, the process parameters, the characteristics of the facility, and the properties of the waste types. Although developing all accidents in detail is not necessary, systematically applying the underlying approximate models is necessary. Many of the uncertainties in the data that are reflected in estimates of absolute risk tend to be canceled in estimates of relative risk. Thus, systematic application of the models is required to provide a sufficient and scrutable basis for estimating relative risk and discriminating among alternatives.

A consistent database must also be applied. Current safety analyses, environmental assessments, and EISs provide much site-specific information, but they have been developed over many years as the underlying technology base and the related regulatory guidance have improved. The scope and supporting levels of detail in site safety reports vary widely. Thus, a third objective was to support the data requirements for the implementation of the computational framework by appropriately combining existing data and documentation on the safety of facilities with the most recent guidance on accident modeling.

The last objective was to provide an automated capability to facilitate the overwhelming number of calculations in the accident analysis that are required to provide relative risk for the many combinations of process technology, facility selection, and site consolidation strategies for each waste type. The purpose is not only to provide baseline accident frequency and source term estimates, but also to provide a capability for sensitivity analysis that can be used in the review process. Accident frequencies, radiological and chemical release source terms, and health effects on various populations are all sensitive to waste throughput. Accordingly, the computational packages for the accident analysis and the databases (storing the data on the waste inventories) have been be integrated among themselves and with the computer codes for health effects to allow accident risk to be characterized as a function of the throughput for a given waste type and facility.

F.1.3 ANALYTIC APPROACH

To meet these objectives, an integrated approach was developed, which included the following interrelated elements: (1) selection of operations and related facility configurations across the DOE complex that have potentially hazardous inventories of radioactive or chemically toxic wastes when considering facilities' vulnerabilities and demographics; (2) development and evaluation of a uniform set of the risk-dominant accident sequences; and (3) determination of the compositions of radiologically or chemically hazardous source terms predicted to be released during the sequences. A personal-computer-based computational framework and database (WASTE_ACC) have been developed to automate these elements and to provide source term input for the analyses of health effects to the general public and to the workforces (ANL, 1996d). This assessment is discussed elsewhere (see WM PEIS Appendix D).

The other important elements in assessing risk include (1) development or integration of existing site-specific demographics and meteorologic data into calculation of site-specific unit risk factors and (2) assessment of the radiological or toxicological consequences of accident releases to the general public and to the occupational workforces by (combining the source term and unit risk information).

Figure F.1-1 illustrates the integration of these elements into a systematic approach for performing risk impact analysis. The WM PEIS waste management alternatives encompass siting options for storing and treating each waste type before disposal. The volume and radionuclide composition of each waste stream is tracked in a relational database as the waste is processed and finally disposed of. Details of the method

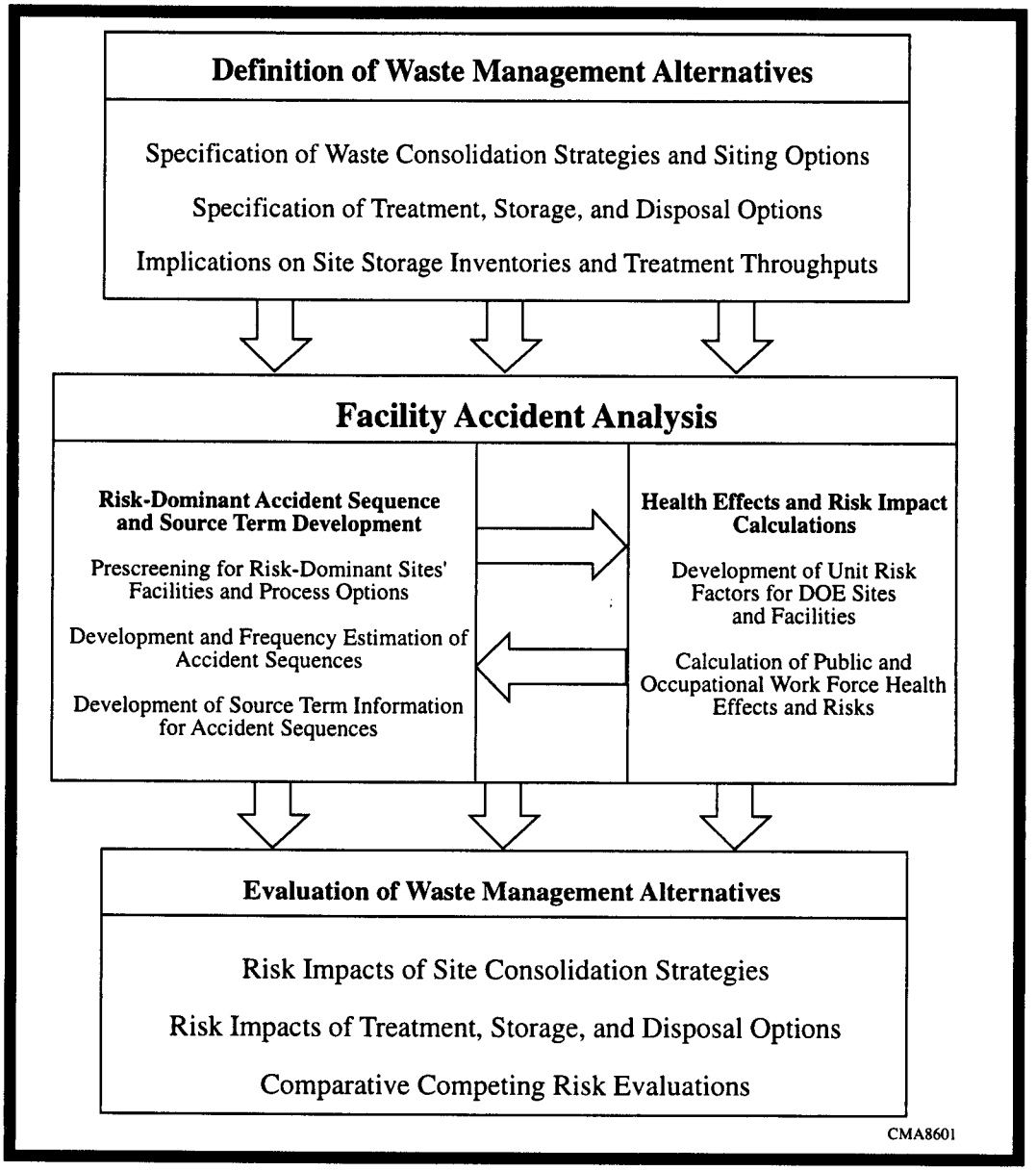

Figure F.1-1. Overview of Facility Accident Analysis Interactions for the WM PEIS.

and computational framework developed to link these elements for the accident analysis are described in Section F.2, with the remainder of this appendix discussing the accident analyses, leading to source term generation, for each waste type. The source terms for all accidents analyzed are provided in the technical support document (ANL, 1996a).

F.1.4 ORGANIZATION OF APPENDIX

Section F.2 describes the overall method and computational framework utilized in the WM PEIS accident analysis. The section also describes the use and integration of generic and site-specific accident analysis data, waste stream inventory data, storage and treatment process characterizations, and site and facility demographic information.

Calculations with currently projected waste generation rates, storage inventories, and treatment process throughputs have been performed. Specific source term results are presented in this report for each of the waste streams in the WM PEIS in Sections F.3 through F.7. Frequencies and source term parameters are presented for each of the major DOE sites for various analysis cases for each waste stream. Key assumptions in the development of the source terms are identified. The compilations of the chemical and radiological source terms for all of the accidents are provided in the report by ANL (1996a).

The listed references include DOE orders and standards, U.S. Nuclear Regulatory Commission (NRC) regulations, and NEPA documentation, as well as technical reports developed in support of this regulatory guidance. The reference section also includes site-specific safety analysis and environmental impact documentation and related supporting technical reports that were used in support of the WM PEIS accident analysis.

F.2 Methodology and Computational Framework for Accident Analysis

F.2.1 OVERVIEW

This section describes the methodology and computational framework for the facility accident analysis for the WM PEIS. Figure F.2-1 illustrates the major components and related input and output of data from the facility accident analysis and presents an overview of the interactions of the analysis with other elements of the WM PEIS. Implementation of this analysis framework included selection and development of the accident sequences and associated source terms. Unit risk factors developed as part of the WM PEIS effort were used to screen accident sequences for risk dominance. A unit risk factor is the consequence associated with a unit release of a radionuclide to the environment from a facility at a given site for a given receptor.

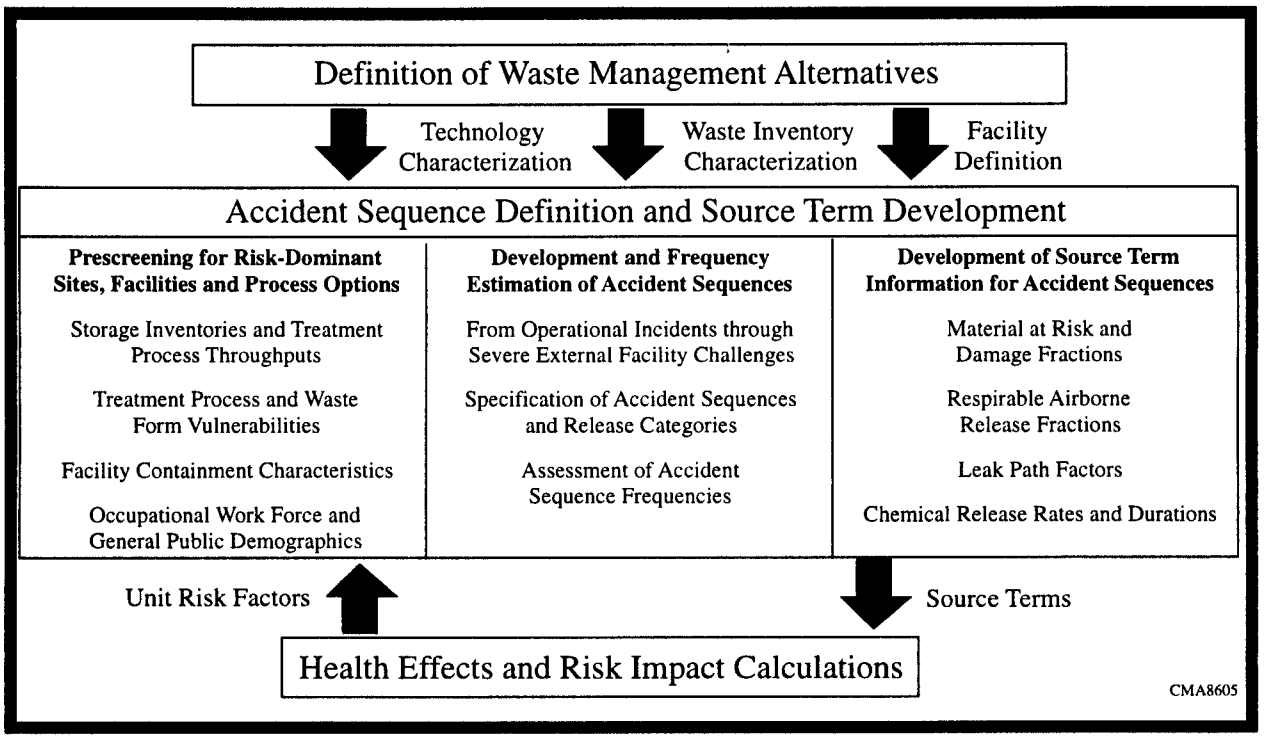

Figure F.2-1. Major Components and Related Input and Output of Data for Facility Accident Analysis.

Section F.2 is organized to reflect the integrated approach depicted in Figure F.2-1. Section F.2.2 sets forth the underlying assumptions of the analysis. Sections F.2.3 through F.2.5 explain how the elements are applied to the WM PEIS accident analysis. The general discussion in the sections is applicable to the overall WM PEIS accident analyses for all waste types. Sections F.2.6 and F.2.7 discuss the general modeling assumptions and the data used to evaluate the frequencies for the various accidents and to determine the appropriate source terms for specific accidents, facilities, and waste types. Sections F.2.8 and F.2.9 discuss the calculation of source term estimates and the uncertainties inherent in the analysis, respectively.

F.2.2 General Assumptions Applied in the Analysis

A limited set of general assumptions were applied in the analysis. These assumptions and the bases for using them are discussed below.

In the analysis, it was assumed that all facilities will be considered per local building codes, including earthquake/seismic codes. Treatment facilities were assumed to be designed to Hazard Category 2

requirements (generally to Performance Category [PC] 3 for seismic criteria). Figure F.2-2 summarizes the relationships of the Hazard Categories and the Performance Categories. In some cases, it is possible that treatment facilities would be designed to the less stringent Hazard Category 3 requirements (and accordingly to Performance Category 2 for severe natural phenomena). While such facilities would be designed to less stringent design requirements, it is also true that in the Safety Analysis Report process, it would be necessary to demonstrate that accidents at such facilities have no impact on offsite personnel and only limited to minor impact to onsite workers. Hence, it was concluded that the more conservative approach was to assume that the facilities were designed to Hazard Category 2 requirements where there would be a greater impact to the onsite workers in the event of accidents, were they to occur.

Generally in this Appendix for the analysis associated with storage of existing waste material, specific accident analyses were not performed. That decision was based on the underlying assumption in the PEIS analysis that all the sites will continue to accumulate, or at least not reduce, waste inventories for roughly the next 10 years, at which time complexwide treatment will begin. Thus all sites will be at their maximum inventory in about 10 years, at which time the potential for release will be maximum. This assumption is independent of the existing inventory. Thus, detailed analysis would not assist in discriminating among the alternatives.

F.2.3 Selection of Risk-Dominant Operations, Facilities, and Related Types of Accidents

A review and screening were performed to focus the analysis of the large number of processes and facility configurations possible within the WM alternatives such that only those configurations with accidental radiological or chemical releases potentially important to overall risk were treated in detail. This approach assisted in illuminating the factors that provide reasonable discrimination among the alternatives. This section describes the process of screening and then describes the three classes of accidents selected for analysis: (1) general handling accidents, (2) accidents at storage facilities, and (3) accidents involving treatment processes and facilities.

F.2.3.1 Categorization and Screening

Waste management activities fall within three operational regimes: (1) current or pretreatment storage, which includes placement in and retrieval from storage and transfer to facilities for pretreatment or

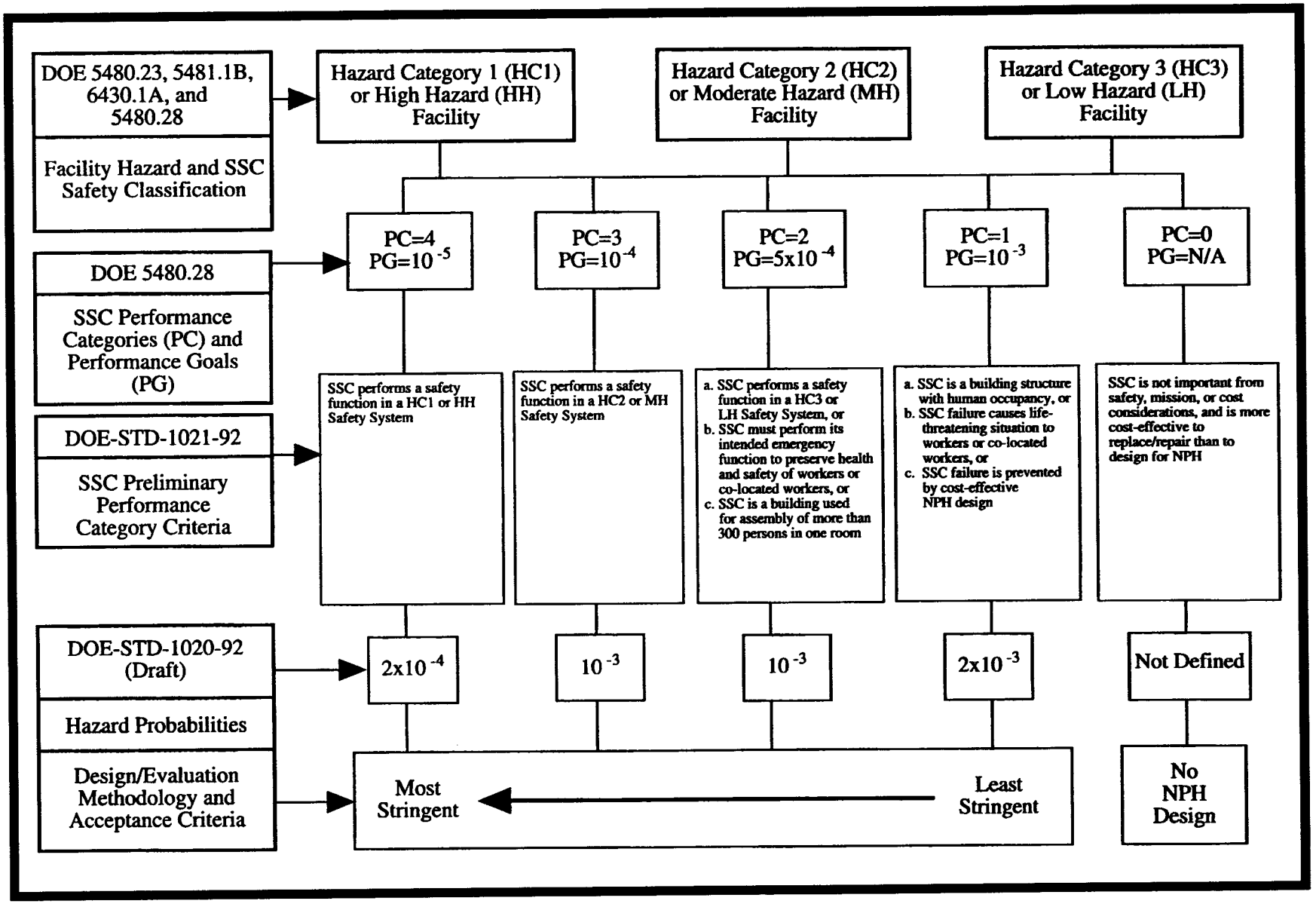

Figure F.2–2. DOE Performance Goals for Hazard Category 1, 2, and 3 Facilities.

treatment; (2) processing, which includes pretreatment (which applies only to HLW) and treatment; and (3) interim or predisposal storage. Because of the more stable nature of wastes in their final forms before disposal, the last operational regime was judged to pose a much smaller risk than current storage and processing. As a result, among the waste types, accidents affecting storage before final disposal were analyzed only for HLW.

The inventories in storage, the throughputs for treatment, and the sizing of the facility are all functions of the alternatives being investigated by the WM PEIS. Criteria were developed to help identify and classify potentially risk-dominant facilities and operations for each waste stream by their characteristics with respect to accidental radiological or chemical releases. These criteria included the amount and composition of the material at risk (MAR); the vulnerability of this material to airborne releases; the containment characteristics of the facility; and the demographics of the site/facility and the general population.

Review of the operations and facilities led to the establishment of three broad classes of accidents as determined by their release characteristics and the facilities and populations affected. These classes are (1) general handling accidents involving a breach of the waste packaging, (2) accidents at storage facilities, and (3) accidents involving treatment (or pretreatment) processes and facilities. Within these classes, individual operations or facilities were then reviewed to better define potentially risk-dominant operations or facility configurations.

Only airborne releases were considered based on evidence in existing DOE safety analyses that airborne pathways dominate the accident consequences and drive the facility risks. Releases to surface runoff or to groundwater cause longer term effects and are not a strong indicator or discriminator of the risk associated with the WM PEIS alternatives. The only reasonable threats that could cause immediate and appreciable effects via nonairborne pathways are criticalities involving the various waste types. However, facilities handling materials with high fissile content will have rigorous procedures and checks to prevent inadvertent criticalities. Regulations require that facilities and processes used to handle fissile materials be designed so that at least two separate events must occur before a condition exists that could result in a criticality, which would be a highly improbable event. As such, releases via nonairborne pathways are not considered.

The following factors were included in the screening process to arrive at risk dominant accident sequences for derived analysis.

Amount and Composition of MAR. Each alternative for waste consolidation discussed in the WM PEIS implicitly defines pretreatment and posttreatment inventories and throughputs for treatment of each waste type at each DOE site. Specification of the storage inventories and treatment throughputs by volume, by physical and chemical form, and by radionuclide or chemical composition of the wastes was obtained from the WM database (ANL, 1996b). Accordingly, for each alternative and each waste type, the DOE sites were ranked by relative radiological hazard to determine those sites and waste types presenting the greatest risk. A similar ranking was performed to determine sites with the greatest chemical inventories for each waste type (chemical accidents during treatment that could not be correlated with waste inventories or throughputs were not analyzed). These rankings led to the reduction in the number of analyses for any given waste type so they were focused on sites with sufficient inventories to justify development of distinct source terms.

Vulnerability of MAR. Another focus of the screening was the vulnerability of the MAR to potential fire or explosion accident sequences. The physical and chemical stability of the waste was reviewed to preclude unnecessary analysis of storage or process operations involving highly stable wastes that would require extremely severe and improbable conditions to attain significant airborne releases. The packaging of the wastes and the overall configuration of the containment facility were also reviewed.

Characteristics of Facility Containment. Facilities considered in the WM PEIS range from outdoor storage pads which provide no containment to facilities that have the structural capability to withstand the forces from significant natural phenomena. The containment characteristics of the existing or proposed facilities were judged by their hazard category or natural phenomena hazards (NPH) PC and the corresponding structural capabilities. Hazard category and NPH PC are discussed and defined in Section F.2.6.1.

Demographics. The hazard to the workforce is directly related to the radiological or chemical inventory involved in the accident, the number of workers affected, and the proximity of these workers to the point of release. Consideration of work force populations and their locations helped provide initial identification of those processes and facilities that would potentially dominate the risk to the worker population. The demographics for the general public were included as an input to the development of the health effects and risk impact analysis but were not specifically used to select accidents.

F.2.3.2 General Handling Accidents

General handling accidents were selected as a distinct class because hands-on operational accidents are expected to dominate the radiological and chemical risks to workers due to the relatively high frequency of such accidents and the proximity of the workers to any release. Such operations include handling in storage and staging areas, packaging and unpackaging, movement of waste within treatment facilities, and some treatment operations. These operations are prone to mechanical stresses in industrial accidents such as drops and spills of a container or punctures by a forklift. The resulting breaches in a container can be shown to lead to insignificant airborne releases relative to those releases involving fires or explosions. As a result, these handling accidents usually constitute little hazard to the general public.

F.2.3.3 Storage Facility Accidents

Accidents at storage facilities were selected as a separate class because they potentially involve large quantities of MAR. Moreover, many storage facilities provide little or no formal containment or containment that would likely be breached in the event of severe thermal or structural challenges; severe accidents (such as fires) in a storage area may result in a significant risk to onsite personnel and the general population for many DOE sites.

In addition to potential importance to risk, two other criteria were used to determine which storage facilities and related accidents should be analyzed or reviewed: (1) their potential for discriminating among PEIS alternatives and (2) quantity and quality of information available for input to analysis. As a result, storage prior to treatment of LLMW, LLW, and TRUW was not analyzed because the results will not help to discriminate among alternatives. This is a result of the underlying assumption used in the PEIS analyses that all sites will accumulate or at least not reduce their waste inventories for roughly 10 years, at which time complexwide treatment will begin. Thus, all sites will achieve their maximum inventories (leading to maximum potential releases), independent of alternative in about ten years. Nevertheless, because recent DOE safety or NEPA information on storage facility accidents provides guidance on the potential risk impacts applicable to LLW, LLMW, and TRUW storage, the information will be discussed in the appropriate sections for these waste steams.

Calculations of the cost and risk impacts for current storage of HLW are not within the scope of the PEIS, and as a result, no analyses have been performed. However, the storage of vitrified HLW was analyzed

because it could be a factor in discriminating among alternatives for HLW management. For the other waste streams, accidents were not analyzed for storage facilities housing solidified, vitrified, or otherwise highly stable wastes prior to disposal because of their low potential for risk-significant releases.

Finally, the characteristics of current or pretreatment storage for hazardous wastes do vary by alternative. Thus, HW storage accidents have been generically analyzed and will be discussed.

F.2.3.4 Treatment Facility Accidents

Accidents involving treatment processes and facilities were identified as a separate class of accidents. Unlike storage accidents, where the overriding concern relates to the large amount of MAR, treatment introduces different safety considerations such as the joint presence of high temperatures and pressures, combustible materials, and feed lines for natural gas or fuel. Moreover, the MAR may not only involve substantial inventories but the MAR may be highly concentrated toxicological or radiological materials that pose a threat to both the immediate workforce of the facility and the populations surrounding the facility. The facilities for treatment typically have containment structural design and filtration capabilities commensurate with these hazards.

Treatment operations were reviewed, and many were excluded from detailed investigation on the basis of the absence of sufficient radiological and hazardous material concentrations or lack of sufficient mechanistic stresses and energies capable of creating significant airborne releases. These operations included evaporative processes and solidifying operations such as grouting and cementation (EG&G, 1992a,b). In general, benign operations, such as packaging and nonthermal size-reduction activities (including shredding, compaction, and supercompaction), were excluded from large-scale accident consideration. Technologies for mercury (Hg) separation were excluded because of their relatively low-energy operating characteristics. Thermal desorption of residues, sludges, and resins or of debris wastes involves combustible material; however, the process was excluded because it operates at lower temperatures and pressures than incineration, and the output product is much less dispersible than the ash from incineration.

Other high temperature or pressure processes were more closely reviewed in light of the potential energy source for dispersing airborne radioactive or toxic material and for challenging a facility's integrity and capability for filtration. Similarly, operations involving or being performed in the presence of combustible materials or involving feed lines of natural gas or fuel were reviewed in light of the potential for ignition

and subsequent fire or explosions. Thus, thermal or heat-accumulating processes (such as fractionation by using ion-exchange columns, metal melting, incineration, wet-air oxidation, and vitrification) were identified for their potential for major airborne release.

These processes are discussed below.

Ion Exchange. Ion exchange is a standard technology for removing dissolved ionic material, radionuclides, and toxic pollutants from solution. Ions in an aqueous phase displace complementary ions from ion-exchange sites on the surface of an insoluble support material. Depleted resins are removed, replaced, or regenerated. Regeneration involves displacing contaminant ions with fresh complementary ions by washing with acid or base solution. The dominant accident considered in the literature is an explosion of the ion-exchange column, where self-heating of the ion-exchange resin results in fire or explosion, with attendant discharge of the radionuclide-loaded resin to the surroundings as a radioactive and chemically toxic aerosol. Some of the conditions causing self-heating of the resin include introduction of a solution with a high concentration of nitric acid (which would result in a highly exothermic reaction), column overloading, drying out of the resin in the column, resulting in high column temperatures (leading to ignition) (Ayer et al., 1988). Analysis shows that these accidents have no impact on the operation of the ventilation system of the facility (Mishima et al., 1986).

Metal Melting. Metal melting is used to prepare, melt, and cast incoming scrap ferrous and nonferrous bulk metals. The incoming metal is shredded and transported to a furnace where it is melted and cast as ingots. Any combustible material in the incoming feed is thermally destroyed in a secondary combustion chamber. Highly radioactive materials tend to collect in the slag, which is skimmed from the top of the melt and cast into crucible molds. The cast slag is stored before final disposal, and the cast metal is sent to a fabrication plant for reuse into overpack containers and shielded caskets. The accident of concern is overpressurization and rupture of the combustion chamber with dispersal of the contents, particularly the radioactive slag.

Incineration. Incineration is a means of reducing the volume of combustible solid waste and destroying organic waste. Key characteristics of the incineration process with implications for potential airborne release include high temperature, the presence of combustible materials, the potential for rupture of the vessel, elevated concentrations of radioactivity in the ash byproduct, and the high dispersibility of the ash. Because incineration often results in a volume reduction factor of roughly 100, the ash byproduct could have a concentration of radionuclides roughly 2 orders of magnitude greater than the input feed waste. Accidents

of concern for an incineration facility include explosions of the incinerator or fires involving the feedstock, ash residue, or residues in the filtration system. Feedstock fires may pose a toxicological risk for mixed wastes because of the relatively high concentrations of organic materials.

Wet-Air Oxidation. Wet-air oxidation is the aqueous-phase oxidation of suspended organic substances using elevated temperatures and pressures. Water (H_2O) catalyzes oxidation so that reactions proceed at much lower temperatures (175–340 °C than are required for oxidation in open-flame combustion such as incineration. Although the pressures (2–20 MPa) are higher than those in other thermal treatment processes, the MAR is more dilute and is in an aqueous noncombustible liquid form. Rupture of the oxidation vessel followed by a pressurized release is considered plausible but was judged to be relatively insignificant in terms of radiological risk to the public or to occupational workforces. Potential accident impacts are enveloped by incineration, a competing technology.

Vitrification. In vitrification, prepared wastes are mixed with glass-forming materials and transferred to the melter that melts the material at a nominal temperature of 1,150 °C. The final product of vitrification is a molten borosilicate glass. The key accident in vitrification processes identified in the WIPP SEIS-II (DOE, in preparation) is rupture of a vessel from a steam explosion due to the interaction of molten glass with water. This accident could affect the integrity of the cell in which the equipment is located. There is also the potential for shrapnel formation, and damage to the off-gas filtration units and to adjacent areas of the facility. The serious nature of this accident indicates it is the risk-dominant vitrification accident for the involved workforce. Other vitrification-related accidents considered in the WIPP SEIS-II include failure of a drum containing vitrified treated waste and a beyond-design-basis earthquake with resultant collapse of the waste treatment facility.

A comparison of the characteristics of the identified treatment processes led to the selection of incineration as the technology most likely to dominate risk to site workers and to the surrounding general populations for LLW, LLMW, TRUW, and HW. As discussed previously, the characteristics of radioactive release from wet-air oxidation are clearly enveloped by those for incineration, a competing technology. Nevertheless, because some of the treatment trains for LLMW sites have greater volumes of waste to be treated by wet-air oxidation than by incineration, source terms were developed for tank ruptures with pressurized releases from wet oxidation processes.

Although accidents with fractionation and with vitrification may be important in assessing pretreatment or treatment operations for HLW, these accidents do not affect WM PEIS decisions with respect to HLW

alternatives. Vitrification of LLW incineration ash, of sludges and resins, or of wastes resulting from HLW partitioning is a process comparable to incineration in terms of temperature, potential for pressurization, and the combustible-material hazards. Dispersibility of the feedstock would be equivalent to dispersal of the feedstock for incineration, and the forms of the vitrification material (molten and solidified borosilicate glass) would be less dispersible by several orders of magnitude than ash from a kiln or from a secondary combustion chamber (SCC). Similarly, the dispersibility of the contents of the radioactive slag in metal melting is also very low relative to the ashes in the incineration process.

In summary, source term analyses for treatment operations were generally focused on incineration accidents. Accidents associated with other types of treatment were generally not considered because of the low vulnerability and dispersibility of MAR as discussed above. Further, the throughputs for the other treatment processes are generally low compared with incineration.

F.2.4 Development of Risk-Dominant Accident Sequences

This part of the analysis involved the development of a framework that would accommodate the spectrum of accidents possible over the range of DOE facilities managing the different waste types. Orders, standards, and other regulatory guidance from the DOE, the NRC, and the U.S. Environmental Protection Agency (EPA), as well as key supporting documents, were reviewed to identify the spectrum of accidents, accident initiators, and potential releases routinely evaluated in safety analyses. The DOE *Defense Programs Safety Survey Report* (Pinkston, 1993) and other internal DOE reports related to the Idaho National Engineering Laboratory (INEL) and spent fuel EIS were also reviewed to provide guidance for the selection and evaluation of accidents. Finally, recent SARs and other facility-specific analyses were reviewed for applicability to both specific facilities and related generic facilities.

Probabilistic risk assessment techniques were used to structure the computational framework for operational events and to track the progression of accidents for external events. Potential accident initiators were first reviewed and grouped into categories for analysis of subsequent accident progression (see Section F.2.4.1). A generic set of accident sequences was then developed to follow the progression of accidents into various source term categories organized by release characteristics and severity levels (see Section F.2.4.2). Nuclear criticality events were considered independently (see Section F.2.4.3).

F.2.4.1 Selection and Categorization of Accident Initiators

The selection of accident initiators was based primarily on the expected importance to human health risk of the potential radiological or chemical releases. Populations at risk include the workforce in the facility where the accident occurs, the population onsite, and the general population surrounding the site. In general, operational safeguards and equipment are in place to ensure that the impacts on the public health of all events are extremely limited, except in the most severe (and unlikely) accident situations. Higher frequency operational events, such as spills or drops, are expected to dominate the risks to workers, but the limited amount of material generally ensures that such events contribute little risk to public health. The less-frequent severe accidents have large inventories at risk, and the potential exists for breaching multiple containment barriers and filtering systems and disrupting standard emergency procedures. As a result, the low frequency of such accidents is offset by their larger consequences; typically, severe accidents are predicted to dominate overall risks to public health. With different populations at risk, a spectrum of accidents covering a wide range of frequencies and expected consequences must be considered. The accidents considered meet the "reasonably foreseeable" criteria recommended by DOE (DOE 1993a).

To facilitate subsequent analyses, all generic accident initiators were first categorized on the basis of the nature of the initiator and the potential magnitude of releases. These categories included (1) operational events initiated from within the facility (internal events) and (2) external challenges to the facility. Internal events were subdivided to account for mechanically induced breaches of waste containers, fires, and explosions—all resulting from human errors, equipment failures, or industrial accidents internal to the facility. The external events were subdivided to consider accidents from (1) generally man-made events, such as aircraft crashes and fires and explosions onsite or at adjacent facilities, and (2) potentially catastrophic natural phenomena (for example, earthquakes, extreme winds or tornadoes, floods, and volcanoes) with likely implications for other facilities at the site.

These accident initiator categories were then mapped into the risk-dominant WM operations or facility configurations identified in Section F.2.3. The screening process used to compare the process and facility characteristics with generic accident consideration is illustrated in Figure F.2–3. Table F.2–1 shows the matrix of accident categories analyzed.

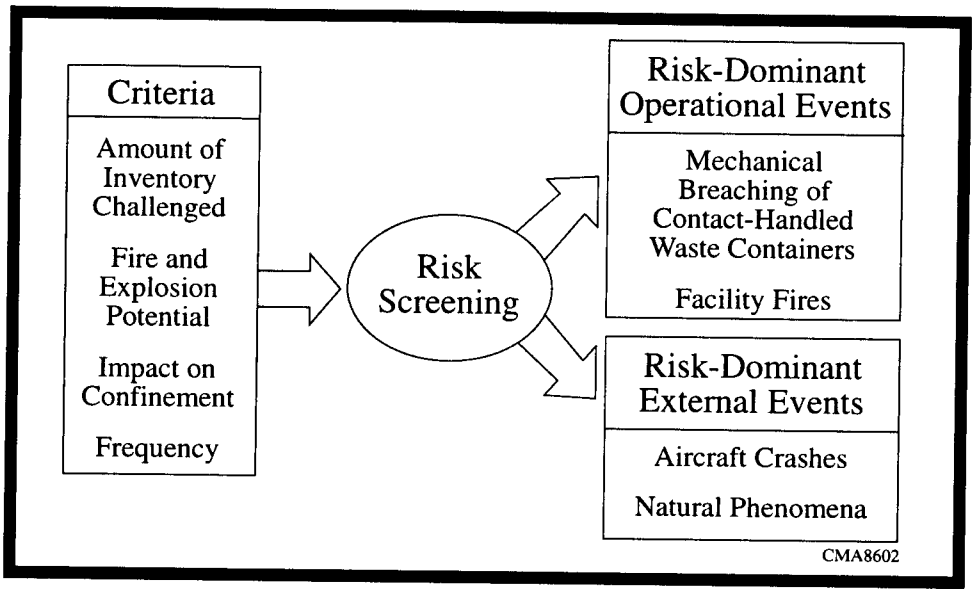

Figure F.2–3. Screening of Risk-Dominant Accident Sequences.

Table F.2–1. Risk-Dominant Accident Initiator Categories for WM Operations and Facilities

Function or Operation	Containment Characteristics of Facility	Internal Operational Accidents: Operational Breaches of Waste Packaging	Internal Operational Accidents: Operating Fires or Explosions	External Challenges to Facility: Man-Made	External Challenges to Facility: Natural Phenomena
General waste-handling operations	Not relevant	X[a]	X	-[b]	-
Large-scale storage	Less than Hazard Category 2[c]	Included above	X	X	X
Treatment or pretreatment	Hazard Category 2	Included above	X	X	X

[a] X = risk-dominant accident initiator.
[b] - = not applicable.
[c] See Figure F.2–2 for definitions of hazard categories.

Finally, the accident sequences emerging from the initiators were classified by the frequency categories traditionally considered in safety documentation (Table F.2–2). Although the descriptive terminologies of these categories have changed through the years in safety documentation, the frequency ranges remain the same. Risk-dominant accident sequences from each of the frequency ranges shown were assessed in a manner consistent with the recent NEPA (DOE, 1993a) guidance, in light of their potential for affecting different populations; however, accident initiators leading to sequences with nominal frequencies less than 1.0E-06/year (yr) were generally ignored unless (1) the predicted consequences were so high that the risk (product of frequency and consequence) was likely to be dominant or (2) the uncertainty in the estimated frequency of the sequence was so large that a significant chance existed that

Table F.2-2. Frequency Categories Traditionally Considered in Safety Documentation

Frequency Category[a]	Frequency (yr^{-1})	Definition
Likely	>1.0E-02	May be expected to occur once or more during the lifetime of the facility.
Unlikely	1.0E-02 to 1.0E-04	Not expected but may occur during the lifetime of the facility.
Extremely unlikely	1.0E-04 to 1.0E-06	Will probably not occur during the lifetime of the facility.
Not credible	<1.0E-06	Has extremely low probability of occurring.

[a] Although the descriptive terminologies of these categories have changed through the years in safety documentation, the frequency ranges remain the same.

the true frequency was greater than 1.0E-06/yr. The final risk-dominant accident sequences selected were at or near the maximum reasonably foreseeable accidents.

Qualitative descriptions of the types of events comprising the accident initiator categories are found in Table F.2-3. Surrogate accident initiators were defined for the aforementioned subcategories of internal accidents on the basis of their expected frequency, dominant accident stress mechanisms, and potential consequences. Accident initiators were assigned frequencies appropriate to the process and facility configuration being evaluated, as reflected in the most recent safety documentation for DOE facilities managing nuclear waste and HW.

External event initiators for man-made challenges include impacts of aircraft and fires or explosions in adjoining or nearby facilities that would challenge the primary facility. Although the expected frequency of an aircraft impact is intuitively very low for most DOE facilities, certain facilities are located relatively close to airports or are in or near flight patterns for commercial, regional, or military airports. For these sites, aircraft crashes with attendant fires or explosions involving aviation fuel could dominate public risk. Impacts from small and large aircraft will have different frequencies and consequences and are considered independently. Frequencies for air crashes were derived (Appendix F of ANL [1996a]) for each site from either site-specific documentation or generic guidance, depending on the proximity to airports and the exposure to flight patterns. In general, derived frequencies of aircraft crashes were well below 1.0E-06/yr. Frequencies for fires and explosions were generally derived from generic data. Appendix C of ANL (1996a) summarizes fire and explosion information used for guidance. Natural phenomena considered as external accident initiators included earthquakes, floods, extreme winds or tornadoes, and volcanic activity;

Table F.2-3. Descriptions of Accident Initiators

Internal Operational Events (Generally with No Public Health Consequences)

Representative Industrial Accidents

Breach of primary containment of waste by an operational event, such as a handling accident, vehicular impact, improper system operation, system malfunction, or component failure, or resulting from failure of a support system such as a loss of power. Breach of containment by a small fire or process explosions originating inside the facility are included. Large-scale fires from industrial accidents are also considered, independent of large-scale fires and explosions that challenge the facility from outside and which are treated separately. To the extent possible, initiation frequencies are taken or derived from information in the SARs or supporting documentation. Frequencies of fires and explosions accompanying or subsequent to the breach are based on the combustibility of involved materials or the presence of combustible materials within the facility and are conditioned on the frequencies of events precipitating the accident sequence.

Severe External Challenges to the Facility (Other Than Catastrophic Natural Phenomena)

Fire or Explosion

A fire or explosion originating outside the facility challenges the facility. Examples of initiators include explosions of fuel or volatile chemical tanks or trucks and fires impacting nearby facilities, fires in adjoining facilities, explosions of natural gas or process chemical lines or tanks, and naturally caused fires, such as prairie fires. If the facility is breached, concurrent (common cause) or subsequent accident events challenge the primary waste-containment barriers within the facility.

Impact of Aircraft

An aircraft or major aircraft component (engine) impacts the facility. If the facility is breached, concurrent (common cause) or subsequent accident events challenge the primary waste-containment barriers within the facility. The initiating frequency of impact reflects missiles posing a credible threat to secondary confinement and primary containment. Impacts from small and large aircraft will have different frequencies and consequences and are considered independently.

Catastrophic Challenges to the Site and Facility from Natural Phenomena

Earthquake

An earthquake exceeding the design basis for the facility occurs. Concurrent (common cause) or subsequent accident events challenge the primary waste-containment barriers within the facility.

Flood

A flood exceeding the design basis for the facility occurs. Concurrent (common cause) or subsequent accident events challenge the primary waste-containment barriers within the facility. Because subsequent significant airborne releases are both implausible and enveloped in magnitude by airborne releases resulting from other natural phenomena in the same frequency range, airborne source terms for flooding are not developed in this report. Dominance by airborne releases is especially true since liquid HLW storage is not included in the analysis.

Extreme Winds or Tornado

Extreme winds or tornadoes exceeding the design basis for the facility occur. Concurrent (common cause) or subsequent accident events challenge the waste-containment barriers within the facility.

Volcanic Activity

A volcanic eruption occurs, with ashfall or lava flow (or both). Breach of primary containment may be caused by an operational accident or malfunction due to loss of power or by impacts of structural failure due to heavy ashfall or lava flow. Concurrent (common cause) or subsequent accident events challenge the primary waste-containment barriers within the facility. Because volcanic activity is of concern at very few sites and because potential subsequent source term releases are enveloped either by analogous releases following other natural phenomena in the same frequency range or by the effects of the eruption itself, source terms from volcanic activity are not developed in this report.

Criticality

Nuclear Criticality

A nuclear criticality occurs within a storage facility or process vessel. Concurrent (common cause) or subsequent accident events challenge the primary waste-containment barriers within the facility.

however, source terms were not developed for catastrophic flooding accidents because subsequent significant airborne releases are both implausible and enveloped in magnitude by airborne releases resulting from other catastrophic natural phenomena in the same frequency range. This is especially true since liquid HLW storage is not included in the analysis.

Source terms were also not developed for volcanic activity because such activity is believed to pose a credible threat to WM facilities at only three major sites, the Hanford Site (Hanford), Los Alamos National Laboratory (LANL), and INEL. Eruption of the active volcanoes near Hanford or LANL would only result in ashfall, the potential effects of which are overwhelmed by analogous effects for earthquakes in the same frequency category. Although INEL is considered vulnerable to lava flow, the airborne releases of radiological waste are expected to be comparable to those from large-scale facility fires. Thus, for the analyses herein, seismic events are analyzed as an enveloping scenario for floods and most volcanic activities, and large-scale facility fires envelop the lava flow accidents at INEL.

Seismic events are also used as the surrogate initiator for extreme winds or tornadoes, with the overriding reason being that standard atmospheric dispersion modeling would predict much greater dispersion (and hence, greatly reduced airborne concentrations) for high wind conditions than for the stable wind conditions assumed to be present during earthquakes. Existing analyses in U.S. Department of Energy (DOE) SARs and in the DOE *Defense Programs Safety Survey Report* (Pinkston, 1993) show that seismic events generally bound the risks of winds or tornadoes, including the risks from wind-driven projectiles. With respect to such projectiles, unpublished preliminary analyses for TRUW drums stored on outdoor pads at the Savannah River Site (SRS) suggest that damage from projectiles could exceed damage caused by seismic events, primarily because of the stability of the drum-stacking arrangement and the lack of protection against projectiles. To appropriately bound potential damage by projectiles to unprotected outdoor storage areas, the damage for seismic events in the WM PEIS analysis is conservatively defined to have higher damage ratios than those used in the aforementioned SRS report in order to envelop the damage caused by high winds or wind-driven projectiles.

Frequencies of occurrence for natural phenomena were generally taken from DOE design and evaluation guidance regarding natural phenomena (see Appendix E of ANL [1996a]); however, the frequencies of loss of integrity of a facility from the challenges of natural phenomena were determined in accordance with DOE facility NPH design performance goals, as discussed in Section F.2.6.1.

F.2.4.2 Specification and Evaluation of Accident Sequences

For the internal accident initiators defined in Table F.2-3, the plausible accident scenarios and the associated frequencies were based on existing accident analyses in SARs and EISs for DOE facilities. These existing analyses for DOE facilities with WM activities constitute a significant resource of information on accident assessment, and many of the analyses have been reviewed by peers and approved by the DOE. These analyses included scenarios that are very similar to those needed for the WM PEIS. They are a plausible source for estimating accident frequencies. In many cases, the existing analyses included probabilities for failure that were based on experience or on data on plant failures. The use of existing scenario frequencies precluded the need to estimate numerous event tree conditional probabilities for equipment failures and human errors that constitute the accident sequences.

High and low frequency estimates were taken from existing accident analyses with accident initiators, facility types, hazardous material types, and circumstances similar to accidents considered in the WM PEIS evaluation. The frequency selected for the WM PEIS evaluation was based on the overall similarity of the existing analysis to the analysis in question. In some cases, adjustments were made to include or remove frequency contributions from preventive and mitigative features that may or may not be included in the WM PEIS alternative. In most cases, the frequencies used in the WM PEIS were on the conservative side of the frequencies reported in existing analyses, as discussed in Section F.2.7.

For the external initiators, the analyses from existing SARs and EISs were sparse and often outdated. Because external events are rare, the facilities have no experience with direct impact of external forces or experience such as that of the Nuclear Utility Seismic Qualification User's Group (SQUG); therefore, analysis on the basis of experimental data could not be achieved. Event trees were developed to project the progression of the accidents associated with external initiators through plausible generic sequences. The extent of any release is a function of (1) the accident-related stresses affecting and rendering airborne the material involved in the accident and (2) the response of the containment barriers and filtration systems (if any). Accident stress mechanisms can be categorized as mechanical, fire-driven, or explosion-driven mechanisms. Branches of event trees were specifically defined to delineate fire and explosion categories for which experimental information is available to support the associated estimates of the release fraction.

The containment response is a function of the structural strength and operational status and efficiency of the buildings, equipment, and materials providing containment or filtering (or both), as well as the emergency response capabilities of the mitigative systems and relevant personnel. Accordingly, event tree

branches were similarly defined to incorporate the key containment responses affecting the amount of airborne activity released to the atmosphere. This structuring of the event trees to incorporate stresses and responses of containment allowed a step-by-step characterization of the likelihood of the sequence and the magnitude of the release as the accident sequence progressed.

The accident sequences were developed and analyzed for accident categories applicable to facilities. They (1) provide a uniform treatment of accident analysis to a wide range of facilities with similar design characteristics across the DOE complex and (2) reduce the number of actual analyses performed to a manageable level. To implement this approach, existing facilities were generally mapped into a DOE-STD-1027-92 Hazard Category (DOE, 1992b) (see Section F.2.6.1) and into DOE-STD-1021-93 facility NPH PCs (DOE, 1993b). In general, conceptual treatment process facilities were assumed to be Hazard Category 2. A no-confinement category was assigned to concrete pads used for packaged storage, weather protection sheds, Butler buildings, and facilities providing no real barriers to release, up to and including general-use buildings. This treatment is appropriate for catastrophic releases and conservative for more benign sequences.

A generic matrix of release characteristics was then developed as a function of the event tree branches to facilitate the tracking of potential source terms through the accident sequences. This approach enabled the determination of the fractional release of each radionuclide or toxic chemical in the original inventory (the airborne release fraction [ARF]) at each point in the progression of the accident. Each accident sequence is then terminated in a generic release category. This approach adapts the source term treatment used in the DOE *Defense Programs Safety Survey Report* (DOE, 1993e) to accident progression analysis (see Section F.2.4). The approach also allows the evaluation of contributions from both the accident initiation and the subsequent accident sequence steps in determining the overall ARF.

The final step in evaluation involved the integration of the radionuclide or chemical compositions of the waste process inventories of MARs in the accidents with the accident data to derive the source terms. Preliminary estimates of the effects on health were obtained by combining the information on source term with the unit risk factors for each site. With this information, a reduced set of risk-dominant source terms covering the plausible frequency spectrum was developed for final calculations on health effects and risk.

F.2.4.3 Nuclear Criticality

On the basis of existing safety analyses, criticalities are judged to be incredible for LLW and LLMW storage, treatment, and post-treatment storage. The safety analysis of the consolidated incineration facility (CIF) at the SRS (Du Pont, 1987) considered nuclear criticality as implausible on the basis of design basis feedstocks and as incredible on the basis of the large number of independent operator errors and other failures necessary to introduce an unsafe quantity of fissile material into the incinerator and processes. The numerous combinations of failures in the waste packaging, classification, and handling processes required to both introduce sufficient fissile material into an LLW or LLMW storage or process facility and create a critical geometry or arrangement of the waste storage arrays simply rule out a credible criticality before or after treatment for these waste types. Because the WM PEIS addresses only the shipping and interim storage options related to canisters of vitrified HLW, for which no plausible mechanisms exist to achieve criticality, source term analysis for HLW criticality is not warranted.

A nuclear criticality in a TRUW solid-waste storage-and-handling facility (for example, Waste Receiving and Processing Facility [WRAP] Module 2 and the Radioactive Waste Management Complex [RWMC] [EG&G, 1993b]) is also judged to be incredible because of the low density and inventory of fissile material in the solid wastes, coupled with the dispersed geometry. Nuclear criticality can be conceived in some aqueous processing alternatives, depending on the dissolution of fissile material in the throughput of the process, the design of the vessel, and the flowsheet parameters (see Appendix C of ANL [1996a]); however, this criticality would require numerous breakdowns of administrative and accountability controls or unforeseen design deficiencies in the processing system (or both).

The DOE requires specific analyses to estimate the frequency of criticality for such processes. If the analysis indicates credibility ($>1.0E-06$/yr), the DOE then requires specific design provisions to preclude or mitigate the effects. With these safeguards in place, accidents of nuclear criticality have been ruled out as not being sufficiently important to risk to justify source term analysis for TRUW and are not discussed further in this chapter.

F.2.5 Development of Source Terms for Accident Sequences

F.2.5.1 Radiological Source Terms

The method used to estimate radiological source terms is similar to that used in the DOE *Defense Programs Safety Survey Report* (Pinkston, 1993). The source term associated with each accident is the product of four factors that vary for each radionuclide within the inventory affected by the accident:

$$source\ term = MAR \times DF \times RARF \times LPF\ , \qquad \text{(F.2-1)}$$

where

MAR = material at risk,
DF = damage fraction,
$RARF$ = respirable airborne release fraction, and
LPF = leak path factor.

Figure F.2-4 illustrates the evolution and development of the source term components from accident initiation through delivery to the atmosphere. While the disaggregation of the source term into these components broadly follows the treatment used in the DOE *Defense Programs Safety Survey Report* (Pinkston, 1993), the treatment of the components has been extended as discussed in Section F.2.4.2 to allow the tracking of these parameters at each point in the accident sequence.

All accident sequences culminated in fractional release categories defined to accommodate the various combinations of generic sets of DF, RARF, and LPF. The source term total release fraction (TRF) is defined as

$$TRF = DF \times RARF \times LPF \qquad \text{(F.2-2)}$$

and provides the fraction of each radionuclide or toxic material in the MAR that escapes the confinement and is available for atmospheric transport. This term, multiplied by the MAR, provides the source term used in the calculations of health effects and risk (see Section F.2.4).

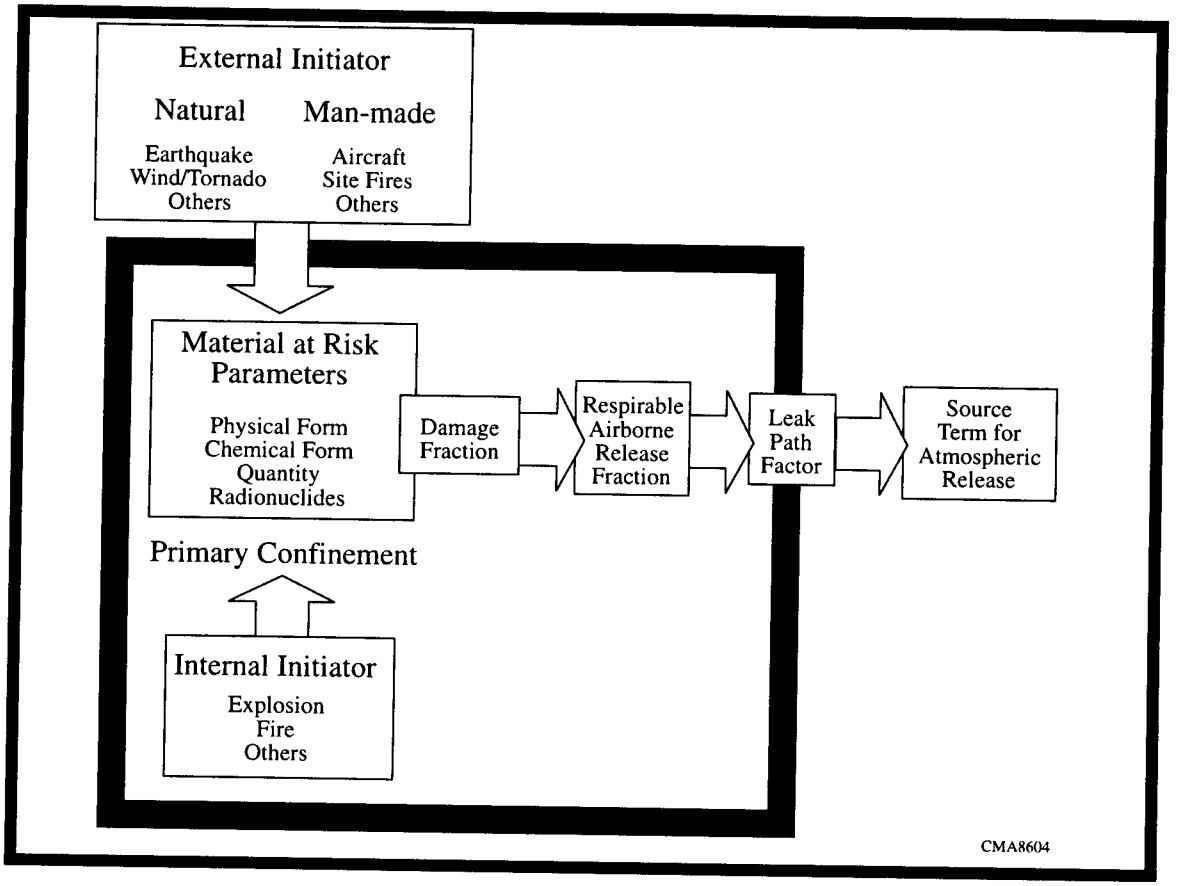

Figure F.2–4. Conceptual Flow Diagram for Source Term Development.

F.2.5.1.1 *Material at Risk and Damage Fraction*

The MAR is the total inventory of waste in a facility or particular operation with the potential of being impacted. The MAR is a function not only of the configurations of the process and facility but also of the severity of the accidents challenging the process or facility; for example, catastrophic accident initiators such as earthquakes clearly have the potential to affect greater inventories of waste than do industrial accidents and thus have greater MARs.

The DF refers to the fraction of MAR involved in the accident sequence and actually susceptible to airborne release. The DF is a function of the severity of the initiator and is generally small for operational events and larger for more severe events, such as external challenges to a facility from natural phenomena. The DF is also a function of the process and facility characteristics and of the subsequent phenomena encountered in the accident sequence, such as fires or explosions that have the capability of challenging or propagating to additional inventories of the MAR. More benign sequences without such mechanisms

have sequence DFs that are zero or very small. Damage fractions were assigned as a function of the severity of the accident sequence, the physical and chemical forms of the MAR, and the vulnerability of the containment of the MAR.

F.2.5.1.2 *Respirable Airborne Release Fraction*

The ARF is the fraction of the potentially available inventory of the radionuclides rendered airborne at the point of the accident. The ARF is a joint function of the original physical form of the waste and the accident mechanisms and concomitant stresses acting to create airborne materials. The airborne release of radioactive materials depends on the ability of an accident sequence to overcome the barriers between the radioactive material and the ambient environment and to subdivide and suspend the radioactive material. Liquids or solids must be either fragmented or deagglomerated and suspended. All materials in the gaseous state (noncondensable gases and vapors under ambient conditions) were assumed to be transportable and respirable. The ARF is also a function of the physical or chemical properties of the individual radionuclides or chemical species. The respirable fraction (RF) for particulates is conservatively defined as the fraction of particulates with aerodynamic equivalent diameters below 10 μm. The aerodynamic equivalent diameter is that of a sphere of a material, with a density of 1 g/cm^3, that will have the same terminal velocity as the particle.

Many experiments and analyses have been conducted to provide both bounding ranges and best estimates of the release fractions of various radionuclides as a function of their chemical and physical form under a variety of accident stresses. The RARFs used in the accident sequences herein were derived by multiplying the ARF and RF for the applicable stress provided in DOE-HDBK-3010-94 (DOE, 1994b), which examines experimental data for the airborne release of materials under five types of stress: (1) explosions (shock and blast effects), (2) fires, (3) venting of pressurized liquids and powders (or venting of pressurized volume above solids), (4) crush-impact (either fragmentation by the impact of a falling hard unyielding object or the impact of a falling material on a hard unyielding surface), and (5) aerodynamic entrainment or resuspension. Where ARFs and RFs were unavailable for the type of material or the level of stress, values were derived by assessing the effect of some characteristic of the initiator or materials involved (for example, the effect of viscosity on the fragmentation and suspension of liquids in free-fall spill or pressurized release).

Matrices were developed for each waste type to account for the physical and chemical characteristics of the MAR by mapping the treatability categories into the physical forms for which airborne release data were developed. These matrices and results for the RARFs developed for the various physical forms of waste encountered in DOE waste management as a function of the stresses encountered in the potential accident sequences are shown in ANL (1996a). This treatment allows the analyses of the stresses encountered in the initiating events and the accident sequences to be evaluated independently, which, in turn, allows the step-by-step generation buildup of the source term to be tracked and integrated with the response of the protection systems to facilitate calculations of health effects for both the occupational workforce and the public.

F.2.5.1.3 *Leak Path Factor*

The LPF is the fraction of the airborne inventory that passes through the containment barriers and filters to the atmosphere. The LPF is a function of the physical form of the nuclide being released, the susceptibility of the nuclide to removal or reduction phenomena (such as precipitation or agglomeration) and to subsequent capture within the containment walls or filtering systems, and the effectiveness of the filtration systems in place. In-containment transport and filter effectiveness can be heavily dependent on the accident sequence, as well as on the structural characteristics and physical design of the facility. The LPFs were assigned on the basis of the integrity of the containment (if any) and the functionality of filtration systems in the facilities for the accident sequences. The more severe accident sequences generally involved breach of confinement, for which a conservative LPF of unity was assigned. Appendix D of ANL (1996a) provides LPFs as a function of the effectiveness of the filters used in DOE facilities and the intracontainment transport properties of gases and particulates.

F.2.5.2 Chemically Hazardous Source Terms

Chemical source terms were specifically developed for two waste types: HW and LLMW. All accidents were divided into three general categories, each having subcategories and including sublethal and lethal exposure concentrations:

- Spills resulting in partial vaporization of the waste ("spill only")
- Spills followed by ignition of the waste ("spill plus fire")

- "Other event combinations"
  - Spills followed by ignition of the waste and an induced explosion in a waste container ("spill plus fire plus explosion")
  - Facility fires resulting in a waste container breach ("fire only")
  - Mechanical failure of a compressed gas container resulting in an explosion ("spill and explosion")
  - Explosion from exposure of reactive material to air followed by fire ("fire and explosion")

The MAR and DF for the various chemical accident sequences were based on the same considerations as discussed for the radiological accidents.

In general, these accidents involve chemical or physical change in materials affected by the initial incident. The chemical and physical properties of the MAR were reviewed, and toxic gaseous products were identified for the accident sequences. The masses of these products were estimated from the mass of the reactants and the stoichiometry of the reactions. Rates of releases were generally estimated by assuming exponential decay with time. Obviously, the exact course of an accident is shaped by a multitude of factors, including (but not limited to) temperature, humidity, pooling versus spreading of spills, the exact composition or concentration of reactive materials (often unknown), and the proximity and nature of nearby reactive materials (including packaging, shelving, and flooring). The details on the selection of the accident scenarios, on the chemistry involved in their progress, and on the estimation of the rates of release of the toxic gases are provided in the sections for HW and LLMW (Sections F.6 and F.7).

F.2.6 General Facility Modeling and Inventory Assumptions

As discussed in Section F.2.3.1, the accidents considered in the WM PEIS accident analysis include general handling accidents, storage facility accidents, and accidents involving treatment processes or facilities. To appropriately evaluate these accidents, descriptions and assumptions concerning the design and configuration of facilities must be established. This section discusses the generic DOE design and performance criteria and the design aspects and associated modeling assumptions that are the basis for the accident evaluation.

F.2.6.1 DOE Design and Performance Criteria

To understand how the facilities for TSD operations are affected by the various accident initiators discussed in Section F.2.4.1, an understanding of how DOE facilities are designed and evaluated is necessary. The DOE has established general design criteria (GDCs) for all types of facilities in DOE Order 6430.1A (DOE, 1989). The GDCs in DOE Order 6430.1A provide the minimum requirements for the design, construction, and maintenance of facilities, and these GDCs must be followed for all new construction, including modifications of facilities. For facilities constructed before 1989 (the year when the order was approved), similar predecessor GDCs were used, but compliance was less strictly enforced and the GDC were somewhat less stringent and specific. However, in the last few years, great emphasis has been placed on achieving compliance through facility upgrades or demonstrating that noncompliance with a particular GDC does not cause undue risk. An implied assumption exists throughout the WM PEIS accident analysis that WM facilities involved in all of the alternatives conform to an acceptable design pedigree (such as control system redundancy or natural phenomena resistant design) for structures, systems, and components that perform a safety function. An acceptable design pedigree is established using the "graded approach" concept for design.

The "graded approach" for facility design, as applied by DOE Order 6430.1A and other DOE orders and standards, is a particularly important design concept that affects the results and assumptions in the WM PEIS accident analysis. The graded approach is a common sense concept that the design pedigree, as well as the operational maintenance and surveillance, for structures, systems, and components should be commensurate with the importance that the structures, systems and components have with respect to the protection of the onsite workers, the public, and the environment. To achieve the appropriate design pedigree and to select appropriately stringent criteria from DOE Order 6430.1A, the DOE classifies facilities by using criteria in DOE Standard DOE-STD-1027-92 (DOE, 1992b). This standard categorizes nuclear facilities into hazard categories 1, 2, or 3 on the basis of the effects of unmitigated releases of hazardous materials. Category 1 facilities are the most hazardous and are considered to have the potential to cause significant offsite effects. Category 3 facilities are the least hazardous and do not have the potential to cause offsite effects or more than minor onsite effects. Analogous categories for nonnuclear facilities (no radiological hazards) are also established and are referred to as high-, moderate-, or low-hazard facilities.

It is reasonable to assume that the safety significant aspects of the facility design (i.e., those that may affect the PEIS analysis) comply with the GDC since compliance must be demonstrated as part of the authorization basis for facility operations. As such, noncompliant features that may threaten the safety envelope

documented in the authorization basis are reviewed for their safety impact and modifications and retrofits are made as necessary. The GDC are also considered in the safety review of design changes to ensure that compliance is achieved, and the authorization basis is maintained. Facility compliance to the GDC ensures the facility safety envelope is maintained and assuming GDC compliance for the PEIS accident analysis is reasonable and justified.

An assumption or assertion that a facility is in a particular hazard category implies that the facility has a design pedigree commensurate with the level of risk posed by the facility. However, the assumption of a higher design pedigree does not in itself ensure that risks to the public and workers are appropriately controlled. The assumption of a design pedigree simply implies that structures, systems, and components are designed to prevent accidents or to mitigate the consequences of accidents. The assessment that risks are adequately controlled is documented in safety analysis documentation that uses risk-based methods to demonstrate that appropriate programmatic functions and controls are used in concert with the facility design to achieve acceptable risk performance.

To achieve a performance goal of not exceeding a certain annual probability of loss of function in a facility, the facility (and related structures, systems, and components) must be designed to withstand a certain magnitude of hazard (the design basis natural phenomena event). Report UCRL-15910 (Kennedy et al., 1990) provides guidelines for selecting the natural phenomena design basis and the maximum acceptable annual probability of exceedance of the hazard to achieve a predetermined performance goal for a facility. In the WM PEIS, a facility of a particular hazard category is assigned a performance goal as defined in DOE-STD-1021-93 (DOE, 1993b). The design basis hazard magnitude for earthquakes and winds corresponding to the hazard annual probability of exceedance (listed in UCRL-15910) is obtained from site-specific hazard curves reported in the Natural Phenomena Hazards Modeling Project (Coats and Murray 1984). For example, for a Hazard Category 2 facility, the performance goal is 1.0E-04 (for loss of function), and based on UCRL-15910, the recommended maximum annual probability of exceedance of a seismic hazard to meet such a performance goal is 1.0E-03. Thus, for a given site such as Argonne National Laboratory-East (ANL-E), the peak ground acceleration corresponding to an annual probability of exceedance of 1.0E-03 is 0.12 g (Coats and Murray, 1984), where *g* is the gravity acceleration. Therefore, a Hazard Category 2 facility at ANL-E with a 0.12 g seismic design basis has an annual probability of exceedance (beyond seismic design basis) of 1.0E-03 and an annual probability of loss of function of 1.0E-04 (beyond performance goal).

Figure F.2-2, abstracted from DOE-STD-1021-93 (DOE, 1993b), depicts the performance goals of 1.0E-05, 1.0E-04, and 5.0E-04 assumed herein to represent frequencies of facility containment failure under challenge from natural phenomena for Hazard Category 1, 2, and 3 buildings, respectively. This figure also shows the relationship between the criteria of resistance to natural phenomena and the PCS and performance goals. The DOE orders and standards to implement the use of these criteria, including DOE Orders 5480.23 (DOE, 1993d), 5481.1B (DOE, 1987), 6430.1A (DOE, 1989) and 5480.28 (DOE, 1993c; formerly 5480.NPH), are also shown. The primary DOE standards for performing structural design and evaluation with respect to natural phenomena resistance are DOE-STD-1021-93 (DOE, 1993b) and DOE-STD-1020-94 (DOE, 1994a), formerly UCRL-15910 (Kennedy et al., 1990).

In general, the facility categories referenced in the WM PEIS analysis refer to the hazard category that is established by using criteria from DOE-STD-1027-92 (DOE, 1992b). Most of the facilities considered in the WM PEIS alternatives are Hazard Category 2 or 3 or general-use facilities. Treatment facilities were assumed to be Hazard Category 2 for accident analyses. Storage facilities were conservatively assumed to have no containment.

F.2.6.2 Storage Facility Accidents

LLW, LLMW, and TRUW. The underlying assumption used in the PEIS is that all sites will accumulate or at least not reduce these waste inventories for roughly ten years at which time complexwide treatment will begin. Thus all sites will achieve their maximum inventories (leading to maximum potential releases), independent of alternative in about 10 years. This condition applies to all analysis of storage facility accidents and offers no discrimination. Hence accidents during current storage of LLMW, LLW, and TRUW were not analyzed. However, to provide guidance on the likely impacts of storage facility accidents, a review of recent DOE NEPA guidance or safety documentation is provided in the individual sections for LLMW, LLW, and TRUW. Although not relevant in the discrimination of PEIS alternatives, this guidance facilitates qualitative comparisons of the relative impacts of storing wastes in their current form versus treating these wastes prior to disposal.

Current storage for these waste streams is accomplished in a variety of ways. Low-level waste is generally packaged in drums or containers and stored on outdoor concrete or asphalt pads or in weather-protective sheds pending treatment or shallow land disposal. Low-level mixed waste is generally packaged in drums or containers and stored in Resource Conservation and Recovery Act (RCRA)-compliant weather-protective

sheds pending treatment. Transuranic waste is generally packaged in drums or containers and stored in concrete structures, in weather-protective sheds, in earthen berms, or in below-grade caissons (remote-handled [RH] TRUW). Most contact-handled (CH) TRUW, which dominates the total TRUW inventories, is stored in facilities with minimal containment, although DOE sites are moving toward qualified TRUW storage.

High-Level Waste. Most DOE HLW is stored in large underground tanks at Hanford and Savannah River with much smaller amounts stored at INEL and West Valley. Because calculation of the cost and risk impacts of current storage of HLW is not within the scope of the PEIS, no analyses of these storage facilities were performed. However, the storage of vitrified HLW was analyzed because it could be a factor in discriminating among alternatives for HLW management. These analyses are described in the section on HLW.

Hazardous Waste. Hazardous waste is generally packaged in 55-gal drums and stored in RCRA-compliant staging areas or weather protection sheds before offsite shipment for commercial treatment and disposal.

A HW storage facility (HWSF) typically has over 100 different chemicals, which may include chlorinated solvents, acids, bases, photographic chemicals, ignitable solids and liquids, compressed gases, metallic salts, lab-packed wastes, polychlorinated biphenyls, asbestos, and other regulated wastes. With explosives generally prohibited, the potential hazardous characteristics include volatility, flammability, dispersibility, and toxicity; and the HW is characterized and segregated on the basis of toxicity, corrosivity, reactivity, and ignitability. Most HWSFs have containment berm areas and individual storage cells that permit waste segregation according to RCRA and EPA criteria; some HWSFs have the capability of fire detection and suppression, and some have forced ventilation.

Because of the great diversity of storage facility designs among the DOE sites, a generic facility configuration with design characteristics such as storage arrays and segregation (as illustrated in Figure F.2–5) was assumed in the analyses. No credit was taken for containment or filtration.

F.2.6.3 Treatment Facility Accidents

The configuration of the generic treatment facility for the WM PEIS accident analysis consists of a series of linked process modules, each providing a specific treatment process. Modules providing common service

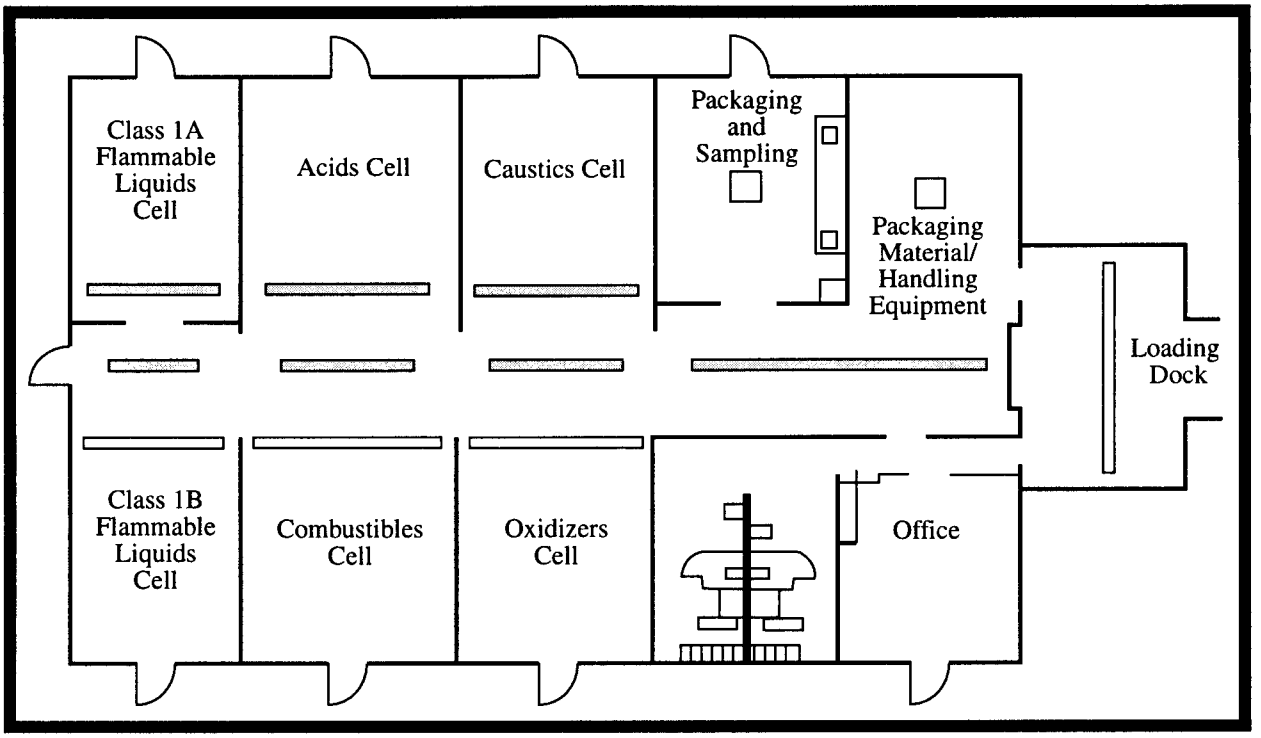

Figure F.2–5. Typical Design for Hazardous Waste Storage Facility.

to the process modules consist of (1) front-end support, providing waste receipt and lag storage; (2) treatment receiving and inspection; (3) container opening, dumping, and sorting; (4) certification and shipping; and (5) back-end interim storage before disposal. Process modules consist of specific treatment operations and process support services. The treatment facility is assumed to consist of process trains for both RH and CH operations, with similar unit operations, differing only in the degree of shielding and the degree of contact operations and maintenance. The RCRA contaminant removal technologies entail modules for (1) sorting and segregation (for example, before incineration); (2) removal or destruction of aqueous organics before evaporation; (3) metal removal; (4) metal recovery; (5) Hg removal and recovery; and (6) stabilization of various waste constituents by immobilization, conversion to stable forms, or removal.

As discussed in Section F.2.3.4, a generic incineration facility was selected for the evaluation of LLW, LLMW, and TRUW accidents. The RH and CH incineration portions of the facility shown in Figure F.2–6 have the following general functional areas: a receiving, storage, and feed area; the incinerator area, housing the rotary kiln and an off-gas secondary combustion chamber; an incinerator off-gas treatment area; a liquid treatment area; a solidification area (when cement solidification is applied to the ash); and facility and process exhaust air treatment, including the high-efficiency particulate air (HEPA) filtration systems.

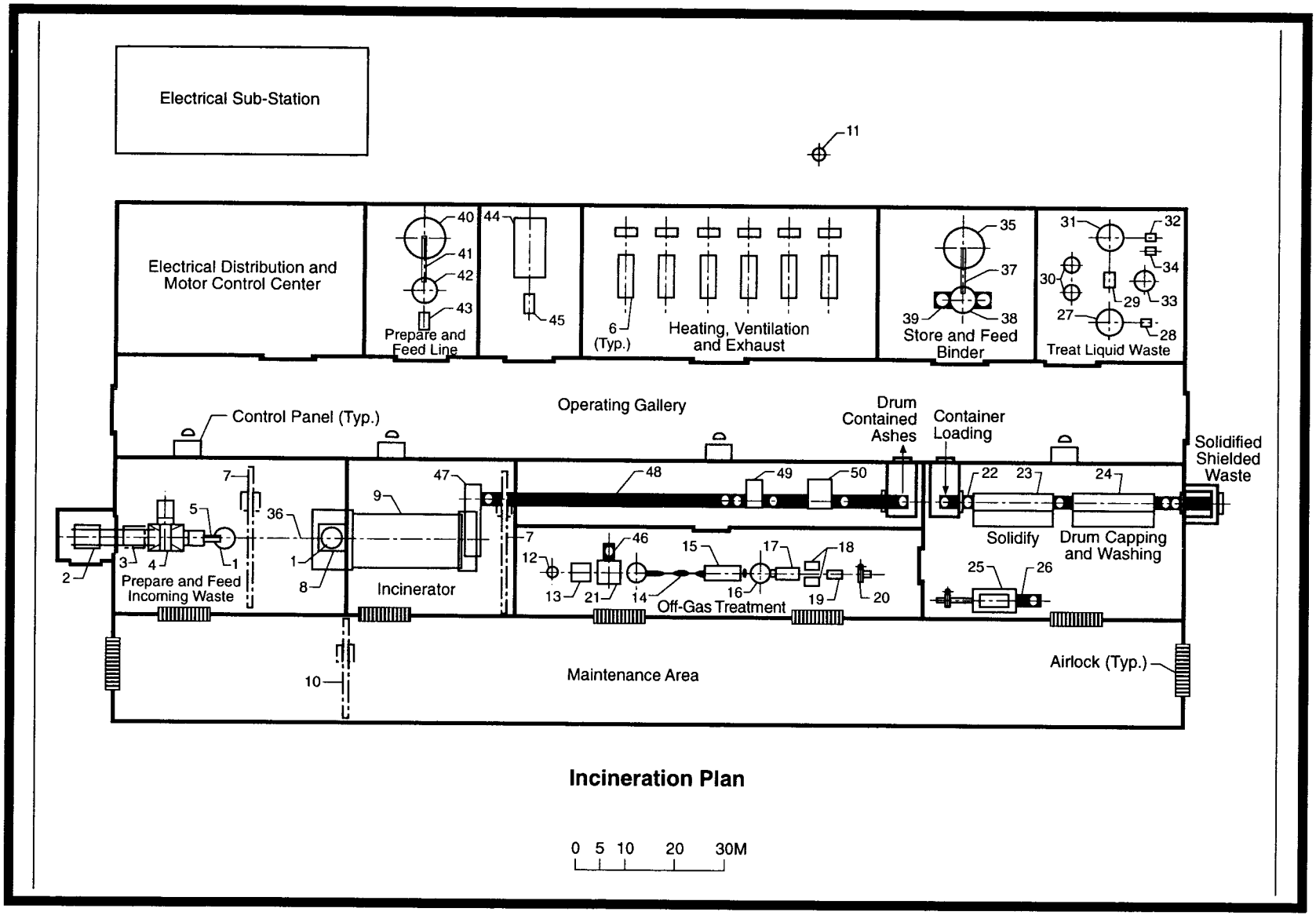

Figure F.2–6. Plan View of Incinerator Facility (See key on following page.)

Figure F.2–6. Key to Equipment.

1 = Waste Transfer Bin
2 = Incoming Waste Bin
3 = Skip
4 = Shredder 2 With Feed Hopper, Dust Hood, and Hydraulic Ram
5 = Auger Feeder
6 = HEPA Filter and Fan
7 = Underhung Crane in Enclosed Process Area
8 = Feed Bin
9 = Incinerator
10 = Underhung Crane in Enclosed Maintenance Area
11 = Stack
12 = Afterburner
13 = Cooler
14 = Double Venturi
15 = Condenser
16 = Mist Eliminator
17 = Reheater
18 = Double HEPA Filters
19 = Final HEPA filter
20 = Interior Decontamination Fan
21 = Ceramic Bag Filter
22 = Drum Staging Conveyer (Powered Roll)
23 = Solidification System
24 = Drum Capping and Washing System
25 = Dust Collector, Fan, and HEPA Filter
26 = Drum Staging Conveyor (Powered Roll)
27 = Receiving Tank
28 = Pump
29 = Filter
30 = Ion Exchange
31 = Treated Waste Tank
32 = Pump
33 = Sludge Tank
34 = Pump
35 = Storage Bin
36 = Bin Hoist
37 = Conveyor
38 = Day Bin
39 = Drum Staging Conveyor (Gravity)
40 = Lime Silo
41 = Screw Conveyor
42 = Mixing Tank With Mixer
43 = Feed Pump
44 = Chiller
45 = Circulation Pump
46 = Drum Staging Conveyor (Powered Roll)
47 = Drag Conveyor
48 = Drum Staging Conveyor (Powered Roll)
49 = Capping Device
50 = Washing Device

The receiving and storage area contains waste in various (but mostly solid) physical forms. Waste is fed to the incinerator after preparation (sorting or shredding, or both, as required). All combustible materials are destroyed, leaving a solid (ash) residue. The ash is generally solidified or packaged (or both) before transportation and disposal.

Incineration off-gas treatment includes a condenser and fume scrubber and generates a liquid waste stream of condensate and spent gaseous scrubber solution. In the liquid treatment area, dissolved and suspended solids are removed, liquid residue is prepared for immobilization, and treated wastewater is recycled to the system. In the solidification system, the sludge from the liquid residue and the ash resulting from the incineration are mixed with concrete and immobilized. Waste in the other areas is in the form of ash. In the CIF at the SRS, wet ash is found in all ash areas except the two combustion chambers (Du Pont, 1987). Dry ash is generated in other DOE incinerators and, because of its greater dispersibility, is assumed here for source term development.

The incineration facility also produces a residual gaseous waste stream. The incinerator off-gas treatment unit is designed to remove particulates, sulfur dioxide (SO_2), hydrogen chloride (HCl), and nitrogen oxides (NO_x). Acid gases are typically removed by scrubbing. Radioactivity and some toxic metals are released directly in off-gas as volatilized compounds and radionuclides (iodine, ruthenium, and cesium) or radioactive gases (carbon dioxide [CO_2], H_2O, and SO_2 formed with carbon-14, tritium [^3H], and sulfur-35, respectively). Some fission products are also released indirectly in combination with particulates that are removed by off-gas scrubbing and filtering.

Detailed modeling of facilities was beyond the scope of the WM PEIS. Accordingly, a treatment facility with generic confinement characteristics defined previously was used to assess accidents to envelop the releases from accidents in the treatment process. A DOE Hazard Category of 2 and the associated performance requirements on its systems were assumed. Double-HEPA-filtration structures, systems, and components were assumed to be in place. The waste inventory at the time of the accident was based on the facility throughput at each site and included unique volumetric inventories and physical, chemical, and radiological compositions for each site for each alternative.

F.2.7 EVALUATION OF SOURCE TERM PARAMETERS AND FREQUENCIES

This section discusses the development of the frequency and source term data generally used across the waste types. The evaluation of the frequencies and source term parameters required not only generic data applicable to broad classes of accidents but also data specific to the various waste types to account for differences in the physical and chemical forms, the packaging used as primary containment, and the facilities used to store or treat that waste type. The final selection of data used for facility accidents for each waste type is discussed in further detail in the chapters describing the analyses for that waste type (Sections F.3 through F.7).

After the generation of these data, a number of new or previously unavailable accident analyses addressing facility accidents were obtained. These accident analyses were performed in support of recently published DOE SARs and EISs. Another new document of particular relevance that has recently been published is the new DOE Standard DOE-HDBK-3010-94 (DOE, 1994b) on RARFs, which provides the latest RARF values published by DOE for use in accident analysis. These latest values supersede some of the RARF values used herein. These reports have been reviewed to determine whether they would significantly affect the source term calculations or frequency assignments developed herein. It was concluded that the Draft WM PEIS accident calculations lead to somewhat more conservative releases than would be calculated using the most recent DOE guidance; consequently, values in this Appendix have generally not been revised for the Final WM PEIS.

F.2.7.1 General Handling Accidents

The dominant contributor to worker risk from radiological or chemically hazardous releases for general handling accidents is expected to result from mechanical breaches of waste containers. This expectation stems from the relatively high frequency of such occurrences and the proximity of the worker to the point of release in such operational incidents. Handling accidents include container breaches caused by package drops, by forklift or other vehicular impacts, by crane drops or crushing, and by overpressurization. The use of heavy equipment poses a potential for damage to waste packages either because of package handling or inadvertent collisions. For many facilities, such as WRAP (DOE, 1991b) at Hanford and the RWMC (EG&G, 1993b) at INEL, cranes are used to move drums and boxes, with the height of movement generally exceeding the nominal 1.2-m height design specification for drum integrity in the event of a drum drop (Type A package; Code of Federal Regulations [49 CFR Part 173]). In all facilities, crushing of drums or

boxes caused by impact with trucks, forklifts, and other equipment is possible. Although one waste container would generally be breached in an accident, rupture of multiple containers could occur in instances when several containers are handled at a time.

Handling accidents during treatment processes entail minor hazards to the operating staff. Hazards include puncture wounds during waste sorting, minor contamination from glove failures, and minor spreads of contamination from treatment equipment pressurization failure events and from off-gas treatment confinement failures (corrosion, gasket failures, etc.). The risk from exposure to radiation from these operational incidents is judged to be enveloped by the analysis for general handling accidents.

The frequencies for chemical spills involving HW or LLMW are derived by using site-specific inventories of individual representative chemicals, along with the assumptions identified previously on the frequencies of breach per operation. Conditional probabilities of fire or explosion of chemically reactive or combustible chemicals are also developed. These discussions are included in the sections on HW and LLMW accident analyses (Sections F.6 and F.7).

Evaluation of Source Term Parameters. For fall or crush damage scenarios in operations with stacked arrays, the MAR will generally vary from one to four packages, depending on the method of stacking and the arrangement of the array. Storage packages are typically (1) Type A (49 CFR Part 173) plastic-lined, carbon steel 55-gal drums; (2) plastic-lined wooden boxes (120 cm × 120 cm × 210 cm or 60 cm × 120 cm × 210 cm); (3) TRUPACT-II standard waste boxes (metal boxes measuring 120 cm × 120 cm × 210 cm; or (4) ST-5 metal boxes (120 cm × 120 cm × 180 cm). The Waste Isolation Pilot Plant (WIPP) final SAR (DOE, 1990b) and the WIPP SEIS-II (DOE, 1996) assume that 25% of the package contents are spilled (that is, a DF of 2.5E-01) for events dislodging the drum lid and that 10% of the waste package contents are spread by events where there is an inadvertent puncture by forklift tines.

In the majority of handling accidents or hands-on processing incidents, the MAR would be limited to a single package. For more severe sequences involving an array of several containers being dropped or impacted in a single accident, the MAR would depend on the configuration but would be limited to the maximum number of packages in the array. Because the accident releases of greatest overall risk to the workforce involve single-drum handling operations where the worker is in contact with or very near to a breached package, a MAR of one drum is specified to calculate source terms for general handling accidents for all waste types.

The DF of the MAR subjected to spill, crush-impact, or overpressurization would depend on the location of the breach, the physical form of the MAR, and the severity of the accident stress. Liquids and volatiles would be free to flow out of a breached container, whereas most solid material would remain inside. Breached containers of LLW, LLMW, and TRUW are assumed to hold solid wastes, with a single-container DF of 2.5E-01. Breached containers of HW are assumed to hold liquid, with a single-container DF of 1.0E+00 for the representative handling accidents analyzed herein. The physical composition of the MAR in storage was defined by volume weighting the treatability category inventories at each site.

Evaluation of Frequencies. Numerous frequency estimates for waste package breaches in a facility are reported, although facility inventories are generally not reported in existing safety analyses. The SAR for the RWMC (EG&G, 1993b) estimates an annual frequency of external drum breach of 1.4E+00/yr per facility. The EIS for new production reactor capacity (DOE, 1991a) estimates a total annual frequency of externally induced drum breaches of 2.0E-02/yr and a rate of vehicular crashes of 1.8E-02/yr. Published joint probabilities for a drop from a crane and for the drum or container to breach range from 1.2E-01 to 8.0E-02/yr per facility. The various WRAP studies (DOE, 1991b,c; WHC, 1991a,b) assume that 10% of dropped containers are breached. A low value (8.0E-02/yr) has been estimated for damaging packages during loading drums into TRUPACT containers, which is similar to an estimate for breaching drums during ATMX railcar loading (1.1E-01/yr) and the value of 1E-02/yr applied in the WIPP SEIS-II (DOE, 1996). A higher value of 1.2E-01/yr was estimated for damage during the retrieval and restorage of buried TRUW drums and boxes at INEL (DOE, 1992a). This value is assumed to be more applicable to TRUW because of the large number of package movements required in the operations of the storage facilities. A frequency of 7.5E-02/yr has been estimated for puncturing up to two packages with forklift tines or, in some fashion, damaging one or more waste packages during heavy equipment operation (for example, dislodging the top tiers of a four-package-high array).

The approach used herein was to develop an estimate of the frequency of mechanical breaches for general handling operations on a per-operation basis, with an operation defined as picking up, moving, and setting down a container. The SAR for the HWSF (EG&G, 1990) uses an estimated frequency of one drum breached per 10,000 operations, on the basis of analyses at the Rocky Flats Environmental Technology Site (RFETS). A fault tree analysis of container rupture at the HWSF resulted in a probability of 3.0E-03 of an operation error, with a conditional probability between 2.0E-03 and 1.0E-02 for drum breach after an impact, depending on the type of container, or 1.0E-01 for drum piercing. Although several handling errors are considered, this analysis leads to a frequency of rupture between 6.0E-01 and 3.0E+00 for every 10,000 operations. The WIPP fire hazards analysis (Westinghouse Electric Corp., 1991) used a

frequency of 5.0E-05 failures per forklift operation when a crew of two is performing the handling operations. A value of 1.5E-04 accidents per forklift operation, with a conditional probability of 2.5E-01 for drum rupture, leading to a breach frequency of 0.4E-04, was used in a probabilistic safety analysis of a Los Alamos National Laboratory (LANL) facility (Sasser, 1992). The LLMW systems analysis (EG&G, 1992c, 1993a) used a value of 1.0E-03 drum breaches per operation but included very minor breaches and spills. Finally, analysis of actual event data at the Savannah River Site (SRS) resulted in a forklift drum drop probability of 5.0E-05 per operation and a drum piercing probability of 3.0E-05 per operation (WSRC, 1994).

On the basis of all of these studies, a probability of 1.0E-04 per operation for significant drum breaches consistent with the aforementioned estimates of source term parameters was used in the analysis herein. To apply this operational failure probability to storage area facilities, residency times in the interim storage area, which vary greatly, must be considered. Most areas are simply staging areas for treatment or disposal operations. Generally, for such staging areas, two handling operations would occur, one for receiving and one for removal. Thus, the expected annual frequency (f_{mb}) of a container breach for waste product x caused by a handling accident is

$$f_{mb} = 0.0002 \times n_x \ , \qquad \text{(F.2-3)}$$

where n_x is the number of waste containers of waste product x received annually. To convert this value to a throughput number, a conservative assumption was made that the complete inventory turns over each year. Then the expected annual frequency of significant mechanical breaches is given by

$$f_{mb} = 0.0002 \times N \ , \qquad \text{(F.2-4)}$$

where N is the capacity of the facility in number of drums.

The previous frequency estimate should envelop frequencies for breach of postprocessing storage containers that contain immobilized residues from treatment. With the exception of potential gas generation and pressure buildup, no significant breach mechanisms are present. For miscellaneous TRUW solids, the SAR for the RWMC (EG&G, 1993b) includes a facility frequency estimate of 2.1E-02 events per year for severe internal stresses, such as a hydrogen pressure buildup from radiolysis of cellulose material or other gas-generating mechanisms. Thus, the operational estimate of Equation F.2-4 envelops this facility estimate.

The frequencies for container damage internal to a treatment facility would also be expected to be lower than those for lag storage because of the significantly lower inventory of drums and reduced drum vulnerability during handling. The estimate for metal-box drop and breach was 1.0E-02/yr for WRAP Module 2 (DOE, 1991c). A value of 3.8E-02/yr is estimated for the crane-drop scenario for the WRAP Module 1 facility (WHC, 1991a). For processing facilities, fewer drums and other packages are handled per year than would be the case for the range of potential operations of the lag storage areas (for example, consolidation of the contents of a number of waste pads onto a new pad). Furthermore, the operating conditions internal to a processing facility are superior to those for outside pads in terms of equipment reliability and working environment.

An approach similar to that discussed previously is used for estimating container breaches from operational events involving canisters of vitrified HLW. The glass product is noncombustible, and the stainless steel canister used as a container for the glass offers a high degree of protection from external incidents (for example, the HLW canisters are designed to be dropped from a height of 9 m without loss of integrity). Beyond 9 m, the integrity of the canisters is uncertain (for example, the maximum height that a Hanford canister can drop in a storage facility is 13 m). Canisters are probably most vulnerable to damage during transfer from the onsite canister transporter into the vault tube (Braun et al., 1993). On the basis of this observation, the only accident analyzed for the glass storage facility is an operational event involving the crush-impact of a glass canister. Given that a simple drop of a canister (from a height less than 9 m) would not result in a breach, canister rupture would require the drop of a heavy structure (for example, a crane or concrete cover) on top of a canister during handling.

The estimated frequency for a canister breach for the Hanford glass storage facility, which would handle approximately 370 canisters, is 4.0E-03/yr (Braun et al., 1993). By assuming that the annual frequency of a canister breach depends on the number of canisters, which is taken to be equal to the annual rate of canister production, the frequency for an HLW breach (f_{HLW}) is

$$f_{HLW} = 0.004/370 = 0.00001/canister. \quad \text{(F.2-5)}$$

Thus, the frequency for canister break at SRS is approximately 4E-03/yr on the basis of an annual production rate of 410 canisters per year. The West Valley Demonstration Project (WVDP) will handle approximately 100 canisters per year, and the annual frequency for canister break is therefore 1.0E-03/yr. The preliminary design at Hanford assumes a production rate of 890 canisters per year, leading to a frequency of 9.0E-03/yr.

The frequencies for chemical spills involving HW or LLMW are derived by using site-specific inventories of individual representative chemicals, along with the previously identified assumptions on frequencies of breach per operation. Conditional probabilities of fire or explosion of chemically reactive or combustible chemicals are also developed. These discussions are included in the sections on HW and LLMW accident analyses.

F.2.7.2 Storage or Staging Area Accidents

The major concern with storage and some staging facilities is the large inventory of waste in a centralized area and releases during accidents involving fires or explosions. The sections that follow summarize the accident types considered that would affect either dedicated storage areas or areas for staging waste prior to treatment. The discussion is generic in that it is not tied to a specific treatment process or waste type. The final determination of source term parameters for HW storage accidents is discussed in the section addressing that waste type. Both internally initiated accident sequences and external events were taken into account.

F.2.7.2.1 *Internally Initiated Fires*

Internally generated facility fires generally occur because of ignition of fuel sources, combustion of rubbish, or spontaneous combustion of the contents of a waste package. Combustible or flammable fuel sources include diesel fuel or gasoline for tractors, trucks, or other vehicles and natural gas or fuel supplies. Combustible rubbish fires generally result from poor housekeeping and are probably the principal cause of minor facility fires. Spontaneous combustion of the contents of a waste package has been reported (DOE, 1990a) but is considered unlikely.

Design and operational safeguards are in place to prevent propagation from a localized source (such as a single package or drum or a rubbish pile) to a much larger inventory. Packages for combustible materials are either steel drums, fire-resistant boxes, or fire-protected shipping containers. Moreover, sites are generally bound by the RCRA to segregate storage by waste form compatibility and RCRA category; therefore, combustibles are segregated. Finally, most facilities have fire detection and suppression capabilities from fire-watch or operator surveillance, automatic sprinkler systems, fire barriers, or onsite fire department response (or some combination of these types of protection). As a result, fires can be

categorized as either local fires involving very limited inventories of wastes or, at the other end of the spectrum, as major facility fires induced by forces that provide a source of fuel (such as gasoline) and that also disable or overwhelm any available safeguards. Accidents affecting staging-area waste packages can generally be enveloped by those affecting storage areas because of the similarity of the primary containment (packaging) and are included herein.

Evaluation of Source Term Parameters. The MAR in all fire scenarios is limited to the waste exposed to the fire, which depends on the facility configuration and the detection of and response to the fires. The DF is a strong function of the packaging and the physical form (and combustibility) of the MAR. Two categories of fires were considered: waste-container fires and facility fires. The former category was assumed to have a MAR equivalent to the contents of a single 55-gal drum and to have a DF of 1.0E+00. This DF is conservative relative to the value of 0.1 applied in the WIPP SEIS-II (DOE, 1996). The representative fire in a storage facility was assumed to encompass the spectrum of undetected or unsuppressed fires, and the entire facility's inventory of waste was assumed to constitute the MAR. A DF of 1.0E-01 was assumed as a generic value to account for segregation and separation of waste packages in the facility and for the nature of the waste packaging as described previously.

Evaluation of Frequencies. Reported fire-initiator frequencies for drum storage (DOE, 1990b; Salazar and Lane, 1992; EG&G, 1993b) for operationally related events range from 1.0E-03/yr to 2.0E-04/yr. The higher value is estimated for general miscellaneous combustibles. The lower value is also fairly typical of estimates for scenarios involving ignition of leaking fuel or natural gas. Because some references distinguish between operationally generated waste and the packaged waste being stored, the upper value is probably associated with poor housekeeping. For fire initiating in a waste package, frequencies on the order of 9.2E-04/yr have been reported for the RWMC (EG&G, 1993b), with a value of 1E-04/yr reported in the WIPP SEIS-II (DOE, 1996). This range of values is inferred to apply to storage situations involving minimal intervention by operators. Fire frequencies associated with fuel from transport vehicles, cranes, and forklifts range from 3.3E-03/yr to 8.3E-04/yr for initiation (Davis and Satterwhite, 1989; EG&G, 1993b). Fires resulting from subsequent ignition upon violent breach of TRUW drums can be envisioned because of hydrogen buildup from alpha activity in contact with cellulose material (DOE, 1990a). Although frequencies for waste-package damage scenarios have been estimated, conditional probabilities for ignition and fire following package breach have not been reported, but would be higher for TRUW than for LLW and LLMW, for which hydrogen buildup is much less likely.

Because of the relative infrequency of a single-container fire and the much greater consequences of fully developed facility fires, only the latter were analyzed for source term development for the WM PEIS. The estimated annual frequency is 1.0E-04/yr for a fully developed facility fire in the absence of treatment process operations. (See also section on treatment facility fires.) This frequency is the product of a generic facility fire frequency of 1.0E-02/yr and a fire suppression system failure probability of 1.0E-02 (DOE, 1982). This value is consistent with existing documentation and is judged to be reasonable in light of the existing preventive and mitigative safeguards discussed previously.

F.2.7.2.2 *Internally Initiated Explosions*

Explosion scenarios for packaged wastes can be postulated for LLMW, TRUW, and HW. Most LLMW accident analyses focus on storage of miscellaneous organic liquid waste (for example, benzene at the SRS [WSRC, 1994]), where blankets of inert gas serve to preclude ignition and detonation. Most TRUW analyses focus on the accumulation of hydrogen or methane from radiolysis of organics, with subsequent ignition and detonation. Inadvertent chemical reactions are considered for HW but should be unlikely because waste sorting and segregation at the point of generation act to preclude combining reactive materials and oxidants. Storage activities are generally not climate controlled, but heating gas is a candidate source for explosion where some control is maintained. Postprocessing storage is less of a problem than pretreatment storage because of the greater stability of the final forms (for example, grout).

Damage to packages from an explosion is governed by projectile behavior and the location and configuration of the package. One type of array is a four-tier-high stack of two pallets, each holding a two-drum-high, tightly packed array of four drums (Salazar and Lane, 1992). Here, the number of drums that could be directly affected by projectile impact would be five, although the array could be toppled, or other ancillary damage (for example, to adjacent arrays) could be envisioned. A similar rationale applied to waste boxes would indicate two affected adjacent boxes.

Evaluation of Source Term Parameters. The MAR for an explosion would generally be limited to a single package because very little explosive energy is typically associated with currently generated wastes, and extrapolation of scenarios to include high-energy projectiles is difficult. The DF for explosions internal to a container would be 1.0E+00 (that is, the entire contents of the package are assumed to be affected). This damage is judged to conservatively envelop any projectile damage to nearby packages. For external

explosions, projectile damage to a waste package is similar to puncture of a package, and a damage ratio of 2.5E-01 or 1.0E+00 would be expected, depending on whether the contents are solid or liquid.

Evaluation of Frequencies. The WRAP Module 1 at Hanford (WHC, 1991b) considered various potential explosions for CH TRUW and LLW operations and assigned a frequency range of 1.0E-06/yr to 1.0E-04/yr for a drum exploding because of hydrogen buildup during storage in the shipping and receiving area (after receipt). Presumably, the hydrogen resulted from radiolytic decomposition of H_2O or hydrocarbons, which is plausible for TRUW but unlikely for LLMW. A glove box sorting area explosion frequency of 6.3E-05/yr was estimated for opening a RH TRUW drum containing a hydrogen-air mixture with failure to vent, failure to detect, and ignition.

Because of the relative infrequency of single-container explosions, and the lack of any known large-scale explosions, radiological source terms for explosions in storage and staging areas for other than hazardous waste were not judged sufficiently important to risk to justify source term development. Process explosions, however, were analyzed as discussed in the section on treatment facility accidents (Section F.2.7.3).

F.2.7.2.3 *External Event Accident Sequences*

External event challenges are important to the human health risk insofar as these challenges have the potential to create fires or explosions that can disperse and render airborne radioactive waste materials. As discussed in Section F.2.4.1, plausible external accident initiators leading to direct fire and explosion scenarios include impacts from military, general aviation, or commercial aircraft; impacts from large trucks carrying fuel or chemicals; and fuel or process chemical fires and explosions in nearby facilities or storage tanks. Natural phenomena such as earthquakes can cause natural gas, fuel, or process chemical fires and explosions in nearby facilities. The severity of such phenomena makes mitigation by onsite fire brigades very unlikely.

Event trees described by ANL (1996a) are used to model the accidents caused by external events and to project the progression of the accidents through plausible generic sequences. The event tree methods are based on accepted probabilistic risk assessment methods and are consistent with methods prescribed by the NRC, the American Institute of Chemical Engineers (1989), and the DOE. Accident sequences are developed for aircraft impacts (small aircraft and large aircraft are considered separately) and seismic events. As discussed in Section F.2.4.1, the safety impacts of aircraft accidents envelop impacts for other

man-made severe external challenges, and the damage and safety impacts from seismic events generally envelop effects from other natural phenomena. These accident initiators and the associated accident sequences are developed for the designs for the generic facilities described in Section F.2.6. The results are covered in the following sections on specific waste types.

F.2.7.3 Treatment Facility Accidents

The major concern with treatment facilities involves fire- or explosion-driven releases of process inventories that are often much more concentrated than the inventories of waste in current storage or in staging areas. This section primarily summarizes internal event-initiated treatment process accident types and discusses the associated source term and frequency data used for the analyses. However, external event sequences were also analyzed using event trees in ANL (1996a) to structure and facilitate the evaluation. Results for both internal and external events are shown in the individual sections for each waste type (Sections F.3 through F.7).

F.2.7.3.1 *Treatment Process Incidents*

In general, the processes of the generic treatment facility described in Section F.2.6.3 entail minor hazards to the operating staff, including puncture wounds during waste sorting, minor contamination from glove failures, and minor spread of contamination from the events involving treatment equipment pressurization, spills, and off-gas treatment confinement failures (corrosion, gasket failures, etc.). Such minor operational incidents in treatment have been folded into general handling accidents analysis and, as a result, are not discussed further.

F.2.7.3.2 *Off-Gas System Failures*

Potential onsite and offsite effects may result from failure of the off-gas treatment system to perform as designed or from introduction, into the off-gas treatment, of species for which the treatment steps are ineffective (for example, noble gases, volatile radionuclides such as ^{3}H, or high-temperature conversion of dichlorodifluoromethane [HALON] to phosgene); but off-gas events tend to be minor because of dilution due to a high gas sweep rate and the inertness of the off-gas constituents relative to the chemically reactive

or hazardous materials given off during facility fires and explosions. The onsite and offsite risks from such accidents are enveloped by potential facility fires or explosions that involve releases of chemically reactive materials or radionuclides that have extended residence times in the body. Thus, these events are not considered further.

F.2.7.3.3 *Treatment Process Vessel Releases*

Aqueous processes to remove RCRA contaminants entail short-term storage in tanks, transfer pumps, vessels, pipelines, and reaction vessels. Because most sites have some capability to reduce volume and to immobilize or to dispose of low-activity liquid wastes, long-term storage of these liquid wastes is limited to specific situations, such as the LLMW stored in tanks at Hanford. Nevertheless, rupture or failure of these tanks could arise from corrosion, internal stress, or external impact. More severe events can also be conceived, such as hoop stress failure from severe overpressurization (for example, vapor-space gas detonation from ignition of radiolytically generated hydrogen or benzene vapor), with subsequent fires or explosions; however, both frequencies and consequences for such severe events should be extremely low for all radioactive waste types except possibly HLW. Because tank storage of HLW is not included in the evaluation of the WM PEIS alternatives, such accidents are not addressed here.

On the basis of inventories of the various waste types and identified treatment technologies, wet-air oxidation of LLMW was selected as a potentially risk-dominant process with vessel breach the accident of concern. However, details of the process and related system descriptions were inadequately specified in the WM PEIS to allow detailed accident analyses. As a result, source terms for wet-air oxidation were analyzed by using MAR and facility containment parameters consistent with those used to analyze accidents involving incineration facilities (discussed subsequently). This approach allows an order of magnitude scoping of the risks of wet-air oxidation process accidents and provides a reasonable relative risk comparison with incineration accidents. The MAR was assumed to be the entire contents of the vessel (DF = 1.0E+00), which was assumed to hold 1% of the annual wet-air oxidation throughput at the site. The radiological composition at each site for each alternative was obtained from the WM database (Avci et al., 1994). An earthquake was the only plausible accident capable of rupturing the process vessel and at the same time defeating the facility containment integrity and filtration systems. For conservatism, the airborne release was assumed to be pressurized, with RARFs chosen accordingly.

F.2.7.3.4 *Treatment Facility Fires*

Two categories of fires at treatment facilities have been considered: (1) operation-specific fires developed from consideration of the characteristics of a particular treatment technology or the related process and facility characteristics, and (2) generic fires. Existing onsite safety documentation has been reviewed to develop the source terms and frequencies associated with plausible accident sequences for the first category, which includes fires in incinerator facilities. The CIF analysis (Du Pont, 1989) treats the fire initiator potential of the incinerator system as governed by the nature of the feedstocks and attributes the initiation of fire to (1) spontaneous combustion of solid waste in lag storage or (2) ignition of contaminated organic liquids in storage. The Waste Experimental Reduction Facility (WERF) (EG&G, 1993b) analysis considered a fire in the baghouse of the filtration system. Both analyses were used to define a reference scenario, as discussed subsequently.

Facility or facility operations characteristics other than those associated with the treatment process can clearly be correlated with the occurrence of fire. These characteristics include the presence of highly combustible materials (or materials that can undergo spontaneous combustion, such as dried tetraphenylborate salts), the existence of activities involving these materials (such as machining of pyrophorics), maintenance activities (such as welding) that involve fuel and ignition sources, and building support systems such as the heating and electrical distribution systems (especially switchgear). The assumption is that these characteristics are reflected in the generic database used to establish the generic data on fire frequency. Site-specific analyses include ignition of the contents of a breached drum and general room fires (Salazar and Lane, 1992). In general, existing LLW and TRUW safety analyses seem to focus less on facility fires than on other accidents; for example, analyses for the various Hanford WRAP modules mention but do not analyze fires. The WIPP SEIS-II (DOE, 1996) analysis considered a scenario in which a single TRUW drum was postulated to erupt into flames as it was opened but before it was emptied onto a conveyor belt for sorting. Engineering judgment, which is based, in part, on the information developed herein and largely presented in Appendix C of ANL (1996a), has been used to assign reasonable source term and frequency parameters to generic facility fires.

Evaluation of Source Term Parameters. The representative incineration facility fire used to envelop radioactive releases is based largely on information for the Waste Experimental Reduction Facility (WERF) (EG&G, 1993b). The assumption that a fire starts in the baghouse of the filtration system and propagates to the HEPA filters is plausible because of the high temperatures of the material entering the baghouse. The fire causes the housing seals to fail on the baghouse and the filters, yielding a direct release of fly ash to

the atmosphere. The total ash inventory accumulated in the baghouse and the HEPA filters is assumed to constitute the MAR. It has been assumed that the ash fed to the baghouse during the fire, if the facility has not shutdown, is a small fraction of the ash accumulated in the baghouse, and it is therefore neglected in the calculations. The MAR was estimated by averaging the fractions of the total facility ash inventories in the CIF and the Process Experimental Pilot Plant (PREPP) actually present in the baghouse and HEPA filters, a value of roughly 3.0E-02 (Du Pont, 1989). All of the baghouse and HEPA filter ash was assumed to be affected by the fire, resulting in a DF of 1.0E+00. Any subsequent explosions of accumulated waste ready to be incinerated were judged to be enveloped by the dispersion of ash. A more detailed description of the external events analyses can be found in the report by ANL (1996a).

The representative incineration facility fire for HW used to envelop hazardous releases assumes that the fire engulfs the feedstock. For further information, refer to the HW analysis.

Evaluation of Frequencies. Fire frequencies for production operations are based on occurrences in the SRS data bank for the operations in the SRS 200 Area and on other industrial experience. The frequency of spontaneous ignition of accumulated combustibles (poor housekeeping) is 5.0E-01/yr if (1) pyrophorics or (2) nitric acid and cellulose are available. The CIF analysis (Du Pont, 1989) assigned a value of 2.6E-02/yr for fire initiation in the lag storage area for cardboard boxes, on the basis of general experience with spontaneous combustion for F and H Canyon operations. The SAR for the CIF also addressed the possibility of a fire involving waste organic feedstock (5.0E-03 per tank per year, with three tanks). Maintenance activities, depending on the circumstances (confined space welding, use of greenhouses, etc.), initiate fires with a frequency of 3.0E-01/yr to 2.0E-01/yr. Fires from electrical shorts have similar frequencies. The expected frequency for a process-related fire in a canyon facility has been estimated to be 1.5E-02/yr on the basis of experience in the SRS's F and H Canyons (WSRC, 1994).

Analysis of actual event data at the SRS indicates a failure probability for manual fire suppression of 1E-01 to 5E-01 per demand, assuming the fire is detected (Benhardt and Held, 1994). Most SARs use a reasonably conservative value of 1E-02 per demand for failure of automatic fire suppression systems on the basis of the DOE study (DOE, 1982). More recent analyses of Hazard Category 2 facilities indicate a greater reliability for wet pipe sprinkler systems. Typical site-specific values range from 5.0E-02 to 1.0E-03 per demand for a fire department to fail to respond. Also, the SRS data indicate a probability range of 3.0E-02 to 3.0E-01 for the fire department to successfully put out the fire. Because this analysis presumes either automatic or manual fire detection and notification, either or both are required for any credit to be taken.

The EIS for the WIPP (DOE, 1990a) applies a frequency of 1E-03/yr for a fully developed fire in an operating area, as derived from the RWMC documentation. The more recent WIPP SEIS-II (DOE, 1996) estimates an annual occurrence frequency of about 1.0E-04. A study by the Electric Power Research Institute (EPRI, 1979) estimates 1.0E-02/yr for a fully developed fire (on the basis of a generalized fire initiator of 1.0E-01/yr), and general estimates of fire initiator frequencies (for TRUW processing and handling activities) for the RFETS range from 5.0E-02/yr to 5.0E-01/yr on the basis of facility-specific experience (for example, Building 910 [EG&G, 1992a]). The RWMC analyses (EG&G, 1993b) are predominantly focused on fires initiated by helicopter crashes (in various locations), typically with a frequency of 1.2E-05/yr to 5.4E-05/yr. Other sites are more concerned with external challenges from aircraft crashes and earthquakes. Aircraft fuel, ruptures of natural gas pipelines, and spilled organic liquids in storage facilities constitute the combustible or ignitable source for these challenges.

The estimated frequency for a fully developed facility fire used herein is 1.0E-03, consistent with the earlier WIPP estimates. This estimate includes a generic fire frequency of 1.0E-01/yr and a fire suppression system failure probability of 1.0E-02. In light of safeguards associated with hazard category 2 facilities, this estimate is judged to be conservative. For the HW feedstock fire, refer to the HW analysis section.

F.2.7.3.5 *Treatment Facility Incinerator Explosions*

Except for incineration and wet-air oxidation (of mainly aqueous wastes, with less severe consequences), no significant explosion initiators were identified for processing. Failure of a wet-oxidation unit would result in a pressurized spray release. Nitrated organic reactions at high temperatures in evaporators and driers were discounted in the SARs for RFETS Building 910 and Building 374 (EG&G, 1992a,b) because (1) alkaline solutions do not react significantly, (2) heavy metals are absent, and (3) processes are at low pressure. In general, the accident literature for evaporation focuses primarily on accidents involving loss of filtration; however, unlike many processing activities, incineration has a potential for accumulations and leaks of combustible gas, with a possibility for explosions.

Evaluation of Source Term Parameters. The assumption is that the explosion (which could potentially occur because of the existence of fuel, oxygen, and high temperatures) takes place inside the rotary kiln incinerator. The MAR was derived by averaging the ash inventory at the CIF and PREPP in the kiln incinerator and was determined to be 12% of the total ash inventory existing in the facility. All of the waste

present in the rotary kiln incinerator was conservatively assumed to be affected by the explosion, for a DF of 1.0E+00.

Evaluation of Frequencies. The safety analysis for the CIF, which is designed to accommodate LLW but includes various RCRA wastes as candidate feedstocks, estimates an annual frequency of 1.5E-02/yr for explosions in the rotary kiln assembly and in the secondary combustion chamber. Because it envelops the other estimates, the CIF estimated frequency of 1.5E-02/yr is used herein. A frequency of 2.9E-04/yr for an explosion during RWMC processing activities was estimated (no unit operation is specified), with a frequency for a facility room fuel-air explosion estimated at 2.0E-04/yr (previously reported values were as low as 5.0E-07/yr). A more refined and detailed analysis estimated that conditions conducive to an explosive event exceeding the 100-kPa capability of the vessels could occur at a frequency approaching 3.0E-02/yr. Such overpressures could potentially rupture the vessels and release the contents. Various INEL studies cite an explosion frequency of 1.0E-04/yr derived primarily from earlier analyses to support operations of the RWMC/Solid Waste Experimental Pilot Plant (SWEPP) with TRUW solid feedstock (EG&G, 1993b).

The posttreatment stored waste may be presumed to be more stable (depending on the method of immobilization) and more robustly packaged. The only qualitatively defined scenario entails a propane gas leak with ignition. The SAR for RFETS Building 910 assigned a conservative value of 4.4E-02/yr for a heating gas line rupture and ignition to impact postprocessing material stored in the processing facility. Because the source term for this accident is much smaller than that for the rotary kiln explosion, this sequence was not developed further.

F.2.7.4 Summary of Data Used

A summary of the key generic source term and frequency parameters discussed in the preceding sections is presented in Table F.2-4. Although the values actually applied for the accidents for the individual waste types are summarized in the chapters on specific-waste-type accident analysis, these values are largely based on this table. The MAR units of number of packages in the facility inventory were converted to curies for each waste type and DOE site, with the information provided in the PEIS waste characterization database. The activity was then distributed into the corresponding radionuclides in the source term files used for consequence calculations.

Table F.2–4. Frequency and Source Term Parameters for General Handling and Internal Facility Accidents

Event	Reported Annual Frequencies		WM PEIS Frequency Estimate per Year	Reported or Representative Source Term Parameters		
	Low	High		MAR	MAR Units	DF
General Handling Accidents						
Packaged Wastes						
Crane drop with impact and breach	8.0E-02	1.2E-01	--	1.0E+00	Package[a]	2.5E-01 or 1.0E+00[b]
Forklift puncture with impact, breach, and spill	--	7.5E-02	--	2.0E+00	Package	1.0E-01 or 1.0E+00[b]
Internal overpressurization and breach	--	2.1E-02	--	1.0E+00	Package	-
Toppled stacked array	--	7.5E-02	--	4.0E+00	Drum	2.5E-01 or 1.0E+00[b]
Representative breach and rupture	--	--	2.5E-04[c]	1.0E+00	Drum	2.5E-01 or 1.0E+00[b]
Fires in Storage or Staging Areas						
Spontaneous-combustion fire	2.6E-02	5.0E-01	--[d]	1.0E+00	Drum	1.0E+00
Small fuel or chemical fire	8.3E-04	3.3E-03	--[d]	2.0E+00	Drum	1.0E+00
Facility fire	2.0E-04	1.0E-03	--[d]	e	Drum	1.0E+00
Local manual-suppression failure	1.0E-01/d[f]	5.0E-01	--	--	--	--
Automatic-suppression failure	--	1.0E-02/d	--	--		--
Fire brigade response failure	3.0E-02/d	3.0E-01/d	--	--		--
Representative facility fire without mitigation	--	--	1.0E-04	e	Drum	1.0E-01
Explosions in Storage or Staging Areas						
Packaged Waste (LLMW and TRUW Only)						
Spontaneous combustion or explosion	1.0E-06	1.0E-04	--	1.0E+00	Drum	1.0E+00
Representative explosion	--	--	--[d]	--	--	--
Fires in Treatment Facilities						
Facility fire						
Local manual-suppression failure	1.0E-01/d	5.0E-01/d	--	--	--	--
Automatic-suppression failure	--	1.0E-02/d	--	--	--	--
Fire brigade response failure	3.0E-02/d	3.0E-01/d	--	--	--	--
Representative facility fire without mitigation	--	--	1.0E-03	1.0E+00	Baghouse and HEPA ash inventory	1.0E+00

Table F.2-4. Frequency and Source Term Parameters for General Handling and Internal Facility Accidents—Continued

Event	Reported Annual Frequencies		WM PEIS Frequency Estimate per Year	Reported or Representative Source Term Parameters		
	Low	High		MAR	MAR Units	DF
Explosions in Treatment Facilities						
Spontaneous combustion or explosion	1.0E-04	1.5E-02	-	1.0E+00	Incinerator kiln ash inventory	1.0E+00
Representative explosion	--	--	1.5E-02	1.0E+00	Incinerator kiln ash inventory	1.0E+00

Note: -- = covered by representative breach or rupture.
[a] A Type A 208-L (55-gal) plastic-lined carbon-steel drum was chosen as the representative waste package for MAR calculations in determining source terms for all packaged waste breach or rupture events.
[b] Waste packages containing liquids were assigned a DF of 1.0E+00.
[c] Per operation.
[d] Because of the combined relative infrequency and low health impact of individual container fires and explosions, only facility fires were analyzed in the WM PEIS.
[e] Total number of waste drums in facility.
[f] Per demand.

F.2.8 Selection and Calculation of Final Source Terms

Preliminary combination of the source term information discussed previously with selected so called unit risk factors (actually unit dose conversion factor) was performed to develop preliminary screening estimates of the impacts of the accident sequences to determine the risk-dominant scenarios. Unit risk factors were developed to estimate the health effects on the exposed populations from releases of unit amounts of radionuclides or hazardous chemicals (see WM PEIS Appendix D). This involved (1) the development of or integration of existing information on the site-, facility-, and treatment-specific demographics to characterize the workforce and general population potentially exposed to hazardous material and (2) the development of the meteorologic and release dynamics and characterization data necessary for calculating the transport of radioactive or toxicological plumes to the exposed population. Final source terms for the scenarios most important to public risk were then developed on the basis of the importance to risk to the maximally exposed individual (MEI) at the site boundary. The final risk-dominant scenarios selected were at or near the maximum reasonably foreseeable accidents.

The calculation of risk merged the frequencies and source term parameters for the accident sequences with the inventory characterization for the MAR. The computational framework and interaction of the code packages are illustrated in Figure F.2-7. Preliminary results of the operational and external event accident sequences described previously were screened for each waste type for the sites defined in the various

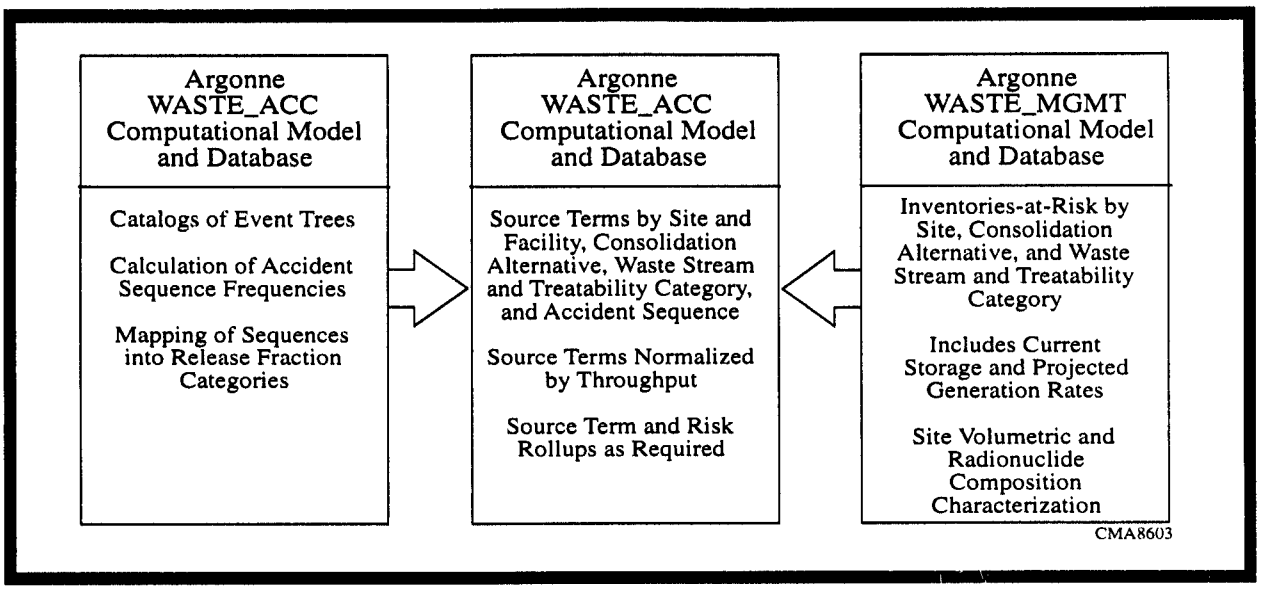

Figure F.2-7. Computational Framework for Facility Accident Analysis Source Terms.

alternatives for WM. Ranking of the accident sequences for risk dominance at each site was performed by using the frequency-weighted dose to the MEI as the screening criterion. Source terms were also selected from risk-dominant sequences in the following annual frequency categories: greater than 1.0E-02, between 1.0E-02 and 1.0E-04, between 1.0E-04 and 1.0E-06, and less than 1.0E-06. The selected source terms were then used to perform the health effects calculations for radiological and chemical releases from facility accidents.

The complete set of sequences, with classification of their frequency categories, is shown in the chapters describing the results for each waste type. A representative list of sequences is presented in Table F.2-5. The final calculation of the health effects for both general and occupational workforce populations by using the source terms described herein is reported in WM PEIS Appendix D.

F.2.9 Uncertainty in Facility Accident Analysis

Considerable uncertainties exist in various aspects of the facility accident analysis. The uncertainties range from issues pertaining to completeness of the analysis to numerical uncertainties in the parameters used in estimating the accident sequence frequency and the airborne release source terms.

Uncertainties in the representativeness and completeness of the accident analysis arise from inherent limitations of the accident sequence modeling and the incomplete knowledge of the facilities and operations

Table F.2-5. Representative Accidents Analyzed for Source Term Development

Type of Facility and Accident	Frequency	MAR × DF	Notes
Operational Handling			
Drum breach	2.0E-04/drum/yr	25% of drum (100% for liquid waste)	
Storage or Staging Area[a]			
Facility fire	1.0E-04/yr	10% of combustible drums in facility	Not applied to drums with vitrified, solidified, or otherwise highly stable waste or to noncombustible liquid waste
External Events			
Small- or large-aircraft impact	Site, aircraft, and accident sequence specific	Aircraft and accident sequence specific	Event tree sequences for both small and large aircraft screened on risk to identify single sequence
Earthquake[b] or tornado	Site[c] and accident sequence specific	Accident sequence specific	Event tree sequences screened on risk to identify single sequence
Treatment Facility[d]			
Operational Events			
Facility fire	1.0E-03/yr	Ash in baghouse and HEPA filters (3% of facility waste inventory or 0.03% of throughput)	Not for HW stream
Facility explosion	1.5E-02/yr	Ash in kiln (12% of facility waste inventory or 0.12% of throughput)	Not for HW stream
External Events			
Small- or large-aircraft impact	Site, aircraft, and accident sequence specific	Aircraft and accident sequence specific	Event tree sequences for both small and large aircraft screened on risk to identify single sequence
Earthquake	Accident sequence specific	Accident sequence specific	Event tree sequences screened on risk to identify single sequence

[a] Used for screening only.
[b] Earthquake used to upper-bound consequences of tornado.
[c] Frequency was assigned as the larger of those for a 0.15-g earthquake or a 113-kilometer per hour (km/h) (70-miles [mi]/h) wind.
[d] Applied only to incinerators at each DOE site. Vitrification accidents were screened out for LLW, and wet-air oxidation accidents were screened out for LLMW.

involved. Representativeness was addressed by reviewing existing safety analysis documentation and selecting accidents that were similar to or which bounded those found in the literature for the relevant operations, processes, and facilities. The issue of completeness was addressed by selecting surrogate accidents representative of classes of accidents and bounding the product of the frequency and the severity of the surrogates so that the risk from each class of accidents was enveloped.

The numerical estimates of the frequency of the different accident sequences analyzed are also uncertain. There exist uncertainties in both the frequency of the initiating events and in the conditional probabilities of the accident progression path. The numerical estimates were generally conservatively obtained using accepted DOE or NRC safety guidance or site-specific safety documentation. Event trees were used to help organize the information, structure the sequences, and automate the calculations. Uncertainties in the frequencies of the sequences are expected to range from factors of from 3 to 10 for anticipated accident sequences (i.e., those with annual frequencies greater than 1.0E-02 per year) to from 2 to 3 orders of magnitude for accident sequences with frequencies near or less than 1.0E-05 such as those initiated by beyond design basis earthquakes.

The uncertainties in the source term calculations apply for both the radiological and the chemical releases. The radiological source terms were calculated as the product of four contributing factors, namely MAR, DF, RARF, and LPF, all of which have uncertainties. Uncertainties in the MAR and DF arise from lack of precise knowledge of waste stream inventory amounts, physical characteristics, radiological profiles, and operational and containment configurations of the treatment and storage of waste streams under potential accident environments. Estimates of the current inventory radioactivity contents (i.e., reflecting both amount and composition) are probably uncertain by factors of from 2 to 100, depending on the type of waste, where it was generated, and its current disposition. Minimally conservative assumptions were used in developing the MAR. Damage fractions were chosen using generally conservative assumptions based on existing safety guidance and general knowledge of the physical characteristics of the MAR and the likely configurations and containment properties of the relevant storage and treatment facilities.

The RARF was conservatively adapted to the waste streams subjected to the dominant accident stresses encountered during the postulated sequences by assigning high or bounding values from the RARFs compiled in DOE-HDBK-3010-94 (DOE, 1994b). The uncertainties caused by imprecise knowledge of accident stresses and imprecise extrapolation of experimental values, which themselves are uncertain, suggest uncertainty ranges from factors of 3 to 10 for high RARF values, of greater than 1.0E-02, to orders of magnitude for RARF values of less than 1.0E-04. Uncertainties in the physical compositions and containment configurations of the MAR suggest an additional order of magnitude in the RARF uncertainty. Generally conservative RARF values were selected for analysis.

The LPF uncertainties for sequences with full or partial filtration exist due to incomplete knowledge of leak paths and filtration efficiency during accident conditions. For sequences in which the containment structure is damaged, a LPF of unity is conservatively assumed.

The chemical release source term uncertainties in the MAR and DF parallel those for the radiological release source terms. Uncertainties due to the completeness of the HW database, which was developed from actual shipping manifests, are expected to be small, roughly a factor of two. For the hazardous component of mixed waste the chemical breakdown was more generic and was not available on a drum by drum basis as it was for HW, suggesting an order of magnitude uncertainty. Also, only a small number of accident release types were identified due to the generic nature of the chemical profile available for those mixed waste types. This uncertainty is expected to add another order of magnitude. Uncertainties in the estimated chemical source terms are expected to have a variability of about one order of magnitude because chemical reactions can take place in different ways depending upon temperatures, the presence of catalysts, and the precise chemical concentrations of constituents, parameters for which there is very limited information only.

Recognizing that the uncertainties in the various source term factors are often interdependent, the uncertainty in source term estimates covers several orders of magnitude. Reasonable predictions of the distribution of source terms cannot be quantitatively established without a much greater level of knowledge of the waste stream inventories, the future generation of wastes within each category, and the actual characterization of the operations, processes, facility configurations, operating and safety procedures invoked. Developing this level of knowledge is beyond the scope of the WM PEIS.

Although the absolute values of the source term estimates range in uncertainty to several orders of magnitude, the comparisons among the source terms are much less uncertain. Considerable effort was expended to assure that the accident analysis approach and underlying assumptions were consistently applied for all waste streams, types of accidents considered, and operations, processes and facilities evaluated. Thus the relative health and risk impacts, to the extent that they depend on source terms that are ultimately derived from and calculated for different facility accident sequences, are judged to provide useful, comparative information for discriminating among strategic alternatives.

F.3 High-Level Waste

F.3.1 Alternatives and Sites Analyzed

Management of HLW can involve up to six phases: current storage, retrieval, pretreatment, treatment, interim storage, and geologic repository disposal. Current storage, retrieval, pretreatment, treatment, and

geologic repository disposal are outside the scope of the WM PEIS so that accidents during these phases are not considered. Thus only accidents which occur during interim storage are considered in the EIS for various alternatives at Hanford, SRS, and WVDP.

Canisters of vitrified HLW from Hanford, SRS, and WVDP are to be placed in an interim storage facility awaiting transport to a geologic repository. Table F.3–1 is a comparison of the interim storage facilities at the three sites. Canisters produced at WVDP will be placed in storage racks that hold four canisters each and then will be transported in these racks to the onsite Waste Canister Storage Facility (WCSF). The immobilized HLW will be temporarily stored in a previously decontaminated and refurnished process cell known as the Chemical Process Cell (CPC), which has been modified for HLW interim storage. The storage area has a capacity for 344 canisters and will be equipped with two coolers to remove the decay heat.

The interim canister storage facility at SRS is designed to hold canisters in vertically sealed cavities within a concrete structure forming the storage vault (that is, a concrete modular vault). The Glass Waste Storage Building (GWSB) at SRS will be an air-cooled dry storage vault. It consists of rows of tubes or vaults placed below grade into which the canisters are lowered. No stacking of canisters occurs within the storage tubes. Concrete plugs provide a cover for the tubes. Storage capacity is currently provided for 2,286 canisters, the output from approximately five years of vitrification operations at the Defense Waste

Table F.3–1. Interim Storage Facilities for HLW Canisters

Variable	WVDP	SRS	Hanford
Facility name	WCSF	GWSB	TBD[a]
Storage capacity (HLW canisters)	344	2,565[b]	15,000
Storage method	Process cell	Modular concrete vault	Modular concrete vault
Footprint (m^2)	190	4,343	12,200
Vault volume (m^3)	2,490	63,404	141,000
Cooling method	Air cooler	Exhaust fans	Natural convection

[a] Conceptual facility under design.

[b] Storage capacity for an additional 2,286 canisters will also be required.

Processing Facility (DWPF). The storage capacity of the existing facility was predicated on the assumption that a geologic repository would be available by the time 1992 fresh waste would be processed. Additional storage capacity for 2,286 HLW canisters is required to handle interim storage of the fresh waste for a total required capacity of 4,572 canisters at SRS.

The previous design for the Hanford Waste Vitrification Plant (HWVP), was estimated to produce about 2,000 canisters of glass from high-activity waste from the Hanford double-shell tanks (DSTs). The number of glass canisters from single-shell tank wastes depends on the pretreatment process to be selected, with a maximum of 60,000 canisters having been projected for minimal pretreatment (U.S. General Accounting Office, 1993). This analysis assumes that a total estimated 15,000 canisters will be produced from all the HLW at Hanford. The vitrified waste canisters are to be placed in interim storage on site. This storage is similar to storage at SRS, except that three canisters are stacked per storage tube and a thermosiphon ventilation system would be used to remove decay heat in the Hanford design. As currently designed, the conceptual facility at Hanford would be able to store 15,000 canisters containing vitrified HLW. Detailed descriptions of HLW treatment processes and facilities can be found in the report by ANL (1996c).

The HLW alternatives in the WM PEIS are shown in Table F.3-2. The decentralized alternative would provide onsite interim storage for all treated, stabilized HLW awaiting shipment to a geologic repository for permanent disposal. The regional consolidation alternatives call for the vitrified-HLW canisters produced at one site (or sites) to be transported for interim storage at another site. Centralization at one site (Hanford) is also considered.

F.3.2 Risk-Dominant Accidents and Modeling Assumptions

F.3.2.1 Selection of Accidents

Accidents with the potential to produce significant offsite consequences were identified using available safety documentation. Although HLW contains various hazardous components, the primary risk is from radiological hazards. Because of the stable nature of vitrified waste, chemical releases do not occur in interim storage being considered in the WM PEIS.

Table F.3-2. Programmatic Alternatives for HLW

No Action Alternative

- Store HLW canisters at Hanford, SRS, INEL, and WVDP in existing and approved storage facilities
- Continue current treatment approaches at each site
- Continue interim storage of liquid and calcine HLW at INEL
- Continue activities necessary for ultimate disposal of HLW in a geologic repository

Decentralized Alternative

- Continue storage of HLW at Hanford, SRS, INEL, and WVDP
- Continue current treatment approaches at each site
- Continue interim storage of stabilized (vitrified or glass-ceramic) HLW at each site
- Continue activities necessary for ultimate disposal of HLW in a geologic repository

Regionalized 1 Alternative

- Same as Decentralized Alternative, except provide interim storage facilities at SRS for WVDP vitrified HLW canisters

Regionalized 2 Alternative

- Same as Decentralized Alternative, except provide interim storage facilities at Hanford for WVDP vitrified HLW canisters

Centralized Alternative

- Same as Regionalized 1, except provide interim storage facilities at Hanford for WVDP, INEL, and SRS HLW canisters

Nuclear criticality was discounted due to the low concentration of fissionable material in the canister and due to the absence of a mechanism of accumulating a critical mass. This assumption was supported by safety documentation. 10 CFR 60.131(b)(7) (1993) requires that the effective multiplication factor for criticality in an interim storage facility be at least 5% below unity. Reported values for SRS canisters show a large margin of subcriticality (McDonell and Jantzen, 1986). Because the inventories of fissionable radionuclides at Hanford and WVDP are lower than at SRS, an even greater margin would be expected.

Radiological releases from severe fires and explosions were considered first. DOE Order 5480.7A (DOE, 1993e) establishes requirements for an improved level of risk for fire protection for all facilities for which either loss of value or risk to health and safety would be of concern. The SARs for the various HLW interim storage facilities (Herborn and Smith, 1990; WSRC, 1990; West Valley Nuclear Services Co., Inc., 1994) do not consider the risk of fire within an interim storage facility, generally because no significant accumulation of combustibles occurs in the vicinity to support significant fire propagation. Thus, a major destructive fire was judged to be unimportant to risk. Similarly, because a large source of combustible material would not be available for ignition or chemical reaction (or both), the possibility of a catastrophic operational explosion was discounted. An aircraft crash with a resulting aviation fuel fire was also discounted because it would have a frequency of less than 1.0E-06/yr and limited radiological consequences, given the containment of the encapsulated radioactive materials (Mishima et al., 1986).

Natural phenomena were also considered, with the limiting accident being an earthquake. Braun et al. (1993) estimated an annual frequency of 3.37E-08/yr for an earthquake-induced canister drop with subsequent airborne release for interim storage at Hanford (this scenario assumed full filtration; loss of filtration would result in an even lower frequency estimate). In general, natural phenomena-induced events, such as tornadoes and earthquakes, were discounted as important contributors to the overall risk of HLW interim storage operations (Braun et al., 1993) due to the high integrity of the HLW canisters, as well as the low probability of occurrence.

Review of the available safety documentation (DOE, 1982; Idaho Operations Office, 1982; Machida et al., 1989; Mishima et al., 1986; WSRC, 1990) suggests that the risk-dominant accident during interim glass canister storage is the breaching of an immobilized canister during handling operations, including a canister drop from the shielded canister transporter (SCT) into the vault tube during transfer, and canister damage during transfer because of movement of the SCT cask relative to the vault tube opening (Braun et al., 1993). A rupture could also occur from a cell cover dropping on an encapsulated canister. (Because a cell cover weighs approximately 27,216 kg, canister rupture is expected following a direct hit.) The initiating event is attributable to operator error in handling or to handling equipment failure (NRC, 1988). Particulates would then be generated that are small enough to be suspended and hence could be exhausted to the atmosphere. The energetics of the accident would not be expected to severely degrade the facility filtration. At the time of rupture, each canister is assumed to be full.

The estimated frequency for a HLW canister drop with subsequent release at the Hanford glass storage facility, which would handle approximately 370 canisters per year, is 4.0E-03/yr (Braun et al., 1993). The

frequency of a canister breach depends on the number of handling operations, which is taken to be equal to the annual canister production rate:

$$frequency\ (yr^{-1}) = (0.004/yr) \times canister\ production\ rate/370 \qquad (F.3\text{-}1)$$

This analysis assumes a canister loading rate of 790 canisters per year for Hanford; therefore, the initiating frequency for a canister drop at Hanford is estimated to be about 8.0E-03/yr. Given the previous information, the initiating frequency for a canister drop accident at SRS is estimated to be 4.0E-03/yr, on the basis of an annual production rate of 410 canisters per year. (The frequency of a canister rupture at SRS is estimated [WSRC, 1990] to be 2.0E-03/yr; the value used in this analysis can therefore be considered to be conservative.) The WVDP facility will only handle approximately 100 canisters per year, and the annual frequency is therefore reduced to 1.0E-03/yr.

F.3.2.2 Source Term Modeling Assumptions

Site-specific compositions were assumed for the MAR (taken to be the contents of one canister). A full canister of glass generally contains between 1,650 and 1,900 kg of glass (see Table F.3-3). This analysis

Table F.3-3. Dimensions, Weights, and Radioactivity of HLW Canisters

Variable	WVDP	SRS	Hanford
Outer diameter (cm)	61	61	61
Overall height (cm)	300	300	300
Material of construction	SS; 304 L[a]	SS; 304 L	SS; 304 L
Nominal wall thickness (cm)	0.34	0.95	0.95
Weight (kg)			
Canister	252	500	500
Glass or ceramic	1,900	1,682	1,650
Total	2,152	2,182	2,150
Radioactivity per canister (Ci)[b] (January 1990)	104,300	234,400	137,000
Decay heat per canister (W)[c] (January 1990)	311	709	389

Notes: SS = single shell; Ci = curie(s); W = watt(s).

also assumes that the mechanical impact from the canister drop accident results in fracturing the vitrified HLW and breaking the canister. The glass particles are released from the damaged canister (DF of unity) and are dispersed into the vault. The majority of the glass fragments are too heavy to remain airborne. 1.5E-04 is taken as the fraction of glass being within the respirable range (< 10 μm). The RARF for vitrified glass that has been subjected to a crush/impact accident stress is shown in Table F.3-4. Source term retention by filtration is also shown.

Because stack locations and heights cannot be defined until a conceptual design has been completed, ground-level releases were assumed with both full filtration and loss of filtration. Both of these conditions were used in estimating risk to the public. Worker risk was only calculated for unfiltered releases.

F.3.3 Results

Results for the accident sequences described above were categorized based on importance to risk to the public by using the frequency-weighted dose approach (to the MEI). They were grouped into the four annual frequency categories shown in Table F.2-2. The source term parameters and frequency groups for HLW accidents for all WM PEIS alternatives are shown in Table F.3-5. Detailed releases by radionuclide are provided in the report by ANL (1996a).

F.4 Transuranic Waste

F.4.1 Alternatives and Sites Analyzed

The TRUW WM alternatives in the WM PEIS are summarized in Table F.4-1. Calculated source terms results are discussed herein for the identified sites.

F.4.2 Risk-Dominant Accidents and Modeling Considerations

Selection of accidents for modeling has been based on importance to risk with the general modeling assumptions and related source term parameters described in ANL (1996a,d,e). A hazard unique to TRUW among the WM PEIS waste types is the potential for nuclear criticality due to separation and/or

Table F.3-4. RARF as a Function of Filtration for HLW Storage Facility Accidents[a]

Variable	Loss of Filtration	Partial Filtration	Full Filtration
RARF	1.5E-04	1.5E-07	3E-10

[a] Double banks of HEPA filtration are assumed; for full filtration, efficiency of first bank is 99.9%; efficiency of second bank is 99.8%.

Table F.3-5. Frequencies and Source Term Parameters for WM HLW Accidents Analyzed

			Frequency Bin (per year)				Source Term Parameters			
WM PEIS Alternative	Site	Accident	>1.0E-2	1.0E-4 to 1.0E-2	1.0E-6 to 1.0E-4	<1.0E-6	VMAR (m^3)	MAR (Ci)	DF	Total Release (Ci)
All	Hanford	Glass canister crush, fully filtered release	--	X	--	--	6.2E-01	1.4E+05	1.0E+00	4.1E-05
All	Hanford	Glass canister crush, unfiltered release	--	--	--	X	6.2E-01	1.4E+05	1.0E+00	2.1E+01
All	SRS	Glass canister crush, fully filtered release	--	X	--	--	6.2E-01	2.3E+05	1.0E+00	7.0E-05
All	SRS	Glass canister crush, unfiltered release	--	--	--	X	6.2E-01	2.3E+05	1.0E+00	3.51E+01
All	WVDP	Glass canister crush, fully filtered release	--	X	--	--	6.2E-01	1.1E+05	1.0E+00	3.3E-05
All	WVDP	Glass canister crush, unfiltered release	--	--	--	X	6.2E-01	1.1E+05	1.0E+00	1.7E+01

Notes: VMAR = volume of MAR; -- = not applicable.

accumulation of fissile materials. However, as discussed in Section F.2.4.3, nuclear criticality is not an important contributor to risk and is not further analyzed.

F.4.2.1 Handling Accidents

Handling accidents during the staging and storage of CH waste are expected to dominate the risk of exposure for workers because of the high frequency of such accidents and the proximity of the workers

Table F.4–1. Transuranic Waste Alternatives

Alternative	Number of Sites		Treatment Standard	ANL-E	ETEC	Hanford	INEL	LANL	LBL	LLNL	Mound	NTS	ORR	PGDP	RFETS	SNL-NM	SRS	UofMO	WIPP	WVDP
	CH Treat	RH Treat																		
No Action	11	5	WIPP-WAC	TS	S	TS	TS	TS	TS	TS	TS	S	TS	S	TS	S	TS	TS		S
Decentralized	16	5	WIPP-WAC	TS	T	TS	TS	TS	T	TS	TS	TS	TS	T	TS	T	TS	T		T
Regionalized 1	5	2	Reduced Gas			T[a]	T	T					T[b]		T		T			
Regionalized 2	5	2	LDR			T[a]	T	T					T[b]		T		T			
Regionalized 3	3	2	LDR			T[a]	T						T[b]				T			
Centralized	WIPP	2	LDR			T[c]							T[b]						T	

Notes: T = treatment to one of three standards: process to current waste acceptance criteria at WIPP (WIPP-WAC); shred and grout to reduce potential for gas generation at the repository (Reduced Gas); and treat to meet land disposal restrictions using thermal organic destruction and complete treatment train; S = storage after treatment under No Action and Decentralized Alternatives or store current inventory under No Action Alternative. Blanks indicate that no storage or treatment of TRUW takes place at a site under the specified alternatives.

[a] The Hanford Site treats both contact-handled (CH) and remote-handled waste (RH).

[b] ORR treats RH waste only.

[c] The Hanford Site treats RH waste only.

during hands-on operations. The frequencies of accidents at a given site would be a strong function of waste throughput at that site. The assumption used (see Section F.2.7.1) is that two severe breaches of containment occur per year for each inventory of 10,000 drums handled. It is assumed for the results herein that handling breaches fall in the >0.01/yr frequency category.

Representative radiological accident scenarios assume that a single drum is affected, such that 25% of its contents are rendered airborne (DF = 2.5E-01). The composition of the representative drum is taken as a volume-weighted average of the treatability category compositions (excluding aqueous streams) at each site.

F.4.2.2 Storage Facility Accidents

Accidents and source terms for current storage were not analyzed explicitly. Unlike treatment, which will predominantly use new facilities that will have common characteristics, current (pretreatment) storage will use a variety of predominantly preexisting facilities that vary greatly in the amounts and types of waste inventories stored, the configurations in which they are stored, and the containment or confinement characteristics of the storage buildings or enclosures.

However, current SARs and DOE site EISs predict consequences for a range of selected waste storage accidents of varying frequency. A brief summary of some of these accidents, assumptions used by the sites in preparing the analyses, and release or health effects-related results are shown in Table F.4–2 and discussed below for information.

Table F.4–2 includes accident results from recent analyses such as the LANL *Preliminary Safety Analysis Report for the Retrieval of Transuranic Waste* (PSAR) (Benchmark, 1994) and the INEL SAR for the Waste Storage Facility (EG&G, 1994b). The LANL PSAR analyzed three credible accidents, including drum spill due to failure during handling, puncture of a crate by a forklift, and breaching of multiple drums in storage due to earthquake-caused toppling from storage arrays. In addition, LANL analyzed one beyond-design-basis accident defined as a single drum fire in the retrieval dome. LANL estimates that only about 0.4% of the drums contain a potential source of hydrogen that could lead to a fire or explosion. LANL neither analyzed a fire in the storage dome nor provided a rationale for not doing so. The source terms for accidents involving multiple containers are evaluated, assuming that the contents of the containers are distributed the same as those of the entire population of containers (average drums). The toppling accident due to an earthquake is assumed to only involve drums stacked on the third level. Furthermore, to

Table F.4-2. Representative Accidents and Source Term Parameters From Recent DOE Safety Analysis Documents Relevant to TRUW Storage

Safety Document	Scenario	DF	ARF or RARF	Release	Consequence
LANL PSAR for Retrieval of TRUW (Benchmark, 1994)	1. Drum spill at retrieval dome	5.0E-01	1.0E-03 to 5.0E-05	8.7E-04 PE-Ci	1.7E-02 rem (MEI)
	2. Forklift puncture of crate in storage dome (4 drums)	5.0E-02	1.0E-03 to 5.0E-05	2.9E-04 PE-Ci	6.8E-03 rem (MEI)
	3. Design-basis earthquake in the storage dome with multiple drum spill (3% of 16,655 drums in the facility spilled)	5.0E-01	1.0E-03 to 5.0E-05	1.2E-02 PE-Ci	2.9E-02 rem (MEI)
	4. Drum fire in the retrieval dome (beyond-design-basis accident)	1.0	5.0E-04	1.5E-01 PE-Ci	1.4 rem (MEI)
INEL SAR for Waste Storage Facility (EG&G, 1994b)	1. Drum fire/explosion (maximum credible design basis accident)	1.0	1.0E-03	1.2E-03 Ci	5.0E-02 rem (MEI)
	2. Box spill (1 box = 15 drums)	1.0E-01	1.0E-04	1.8E-03 Ci	4.2 rem (worker)
	3. Beyond design basis tornado with breach of 1,440 drums and 576 boxes	1.0E-01 (drums) 1.0 (boxes)	1.0E-04	1.2 Ci	9.7E-02 rem (MEI)
SRS Draft EIS (DOE, 1995)	1. Drum rupture and fire	Not available	Not available	Not available	7.2E-04 rem (MEI)
	2. Drum fire in culvert	Not available	Not available	Not available	2.4E-01 rem (MEI)
	3. Fire caused by vehicle crash (28 drums)	Not available	Not available	Not available	4.4E-02 rem (MEI)
	4. Drum deflagration in culvert during drum retrieval	Not available	Not available	Not available	5.7E-02 rem (MEI)
ORNL SAR for Waste Storage Facility, Bldg. 7574 (ORNL, 1994)	1. Earthquake with spill of drums (67% of 1,200 drums breached)	25% (10% of inner packages, if doubly packaged)	8.8E-07 to 1.0E-03	Not available	5.0E-01 rem (MEI)
	2. Fire (12 drums)	1.0 (liquid) 0.5 (solid)	1.1E-01 (liquid) to 5.3E-04 (solid)	Not available	1.0E-01 rem (MEI)

Table F.4-2. Representative Accidents and Source Term Parameters From Recent DOE Safety Analysis Documents Relevant to TRUW Storage-Continued

Safety Document	Scenario	DF[a]	ARF or RARF[b]	Release	Consequence
Hazard Classification and Preliminary Safety Evaluation (PSE) for WRAP Module 2 (WHC, 1991a)	Seismic impacts with fire in incoming storage area (size reduction)	1.0	5.3E-04	2.1E-01 PE-Ci	3.0E-01 rem (MEI)
WRAP PSE (WHC, 1991b)	1. Seismic impacts with fire in shipping and receiving area (19% of 100 drums and 4 boxes)	1.9E-01 0.5 (1st drum) 0.25 (2nd drum)	5.3E-04 1.0E-04 (1.0E-07 if filtered)	5.9E-01 PE-Ci 3.7E-06 PE-Ci	Not available 6.0E-03 rem (MEI)
	2. Drum/package spill (2 drums)				
INEL EIS (EG&G, 1994a)	1. Lava flow in TSA (52,000 stored drums and 5.5E+04 m^3 soil covered)	0.25 to 0.75	1.0E-04 to 1.0E-07	2.7 Ci	Not available
	2. Aircraft crash into HFEF WIPP waste (46 drums)	5.0E-01	2.5E-04	1.4E-02Ci	Not available
RWMC SAR (EG&G, 1993b)	1. Earthquake-initiated breach at TSA (65,443 drums)	1.0E-02	1.0E-03	7.4E-01 Ci	1.8E+00 rem (MEI)
	2. Fuel air explosion and fire at TSA	2.01E-01 (explosion) 5.0E-02 (fire)	1.0E-03 (explosion) 5.0E-04 (combustibles) 1.0E-05 (noncombustibles)	1.3E+01 Ci	3.2E+01 rem (MEI)
	3. Medium fire at ASB II caused by propane pipe leak (9,455 drums)	1.0E-02	5.0E-04 (combustibles) 1.0E-05 (noncombustibles)	2.0E-02 Ci	4.8E-02 rem (MEI)
	4. Helicopter crash causing a large fire at ASB II (9,455 drums)	5.0E-02	5.0E-04 (combustibles) 1.0E-05 (noncombustibles)	9.7E-02 Ci	2.3E-01 rem (MEI)
WIPP SEIS-II (DOE, 1996)	1. Container puncture, drop, and lid failure 2. Single 55-gallon drum fire	0.1 (2 drums) 0.25 (3rd drum)	1.0E-07 (based on LPF of 1.0E-03)	3.6E-06 PE-Ci	From 4.0E-06 rem (MEI) at SRS to 5.1E-04 rem (MEI) at ORNL
	3. Beyond-design-basis earthquake with facility collapse	0.5	3.1E-07 (based on LPF of 1.0E-03)	1.2E-05 PE-Ci	From 1.5E-05 rem (MEI) at SRS to 2.3E-03 rem (MEI) at ORNL
		0.25 of total facility inventory	5.0E-05	Site-dependent	From 3.2 rem (MEI) at SRS to 150 rem (MEI) at RFETS

Notes: DF = damage fraction; ARF = airborne release fraction; RARF = respirable airborne release fraction; PE-Ci = Pu-239-equivalent curies; MEI = Maximally exposed individual off site; TSA = TRUW Storage Area; HFEF = Hot Fuel Examination Facility at ANL-W; ASB II = Air Support Building II; LPF = leak path factor. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

determine the number of drums at risk, the number of containers stacked at the third level is reduced by almost 90% due to interferences in the storage dome. Throughout the PSAR, inventories are expressed in terms of Pu-239-equivalent curies (PE-Ci). Consequences to the MEI at the site boundary were as follows: 1.7E-02, 6.8E-03, 2.9E-02, and 1.4 rem for drum spill, forklift puncture in crate, multiple drum spill caused by earthquake, and drum fire, respectively. The drum spill and forklift puncture in the crate were considered to be anticipated accidents with frequencies greater than 1.0E-02/yr. The earthquake accident was considered to be unlikely, with a frequency range between 1.0E-02 and 1.0E-04/yr. The beyond-design-basis drum fire was not considered credible, with a frequency of less than 1.0E-06/yr.

The INEL SAR for the Waste Storage Facility identifies three bounding accidents, including a drum fire and explosion, a box spill, and a tornado causing the breach of a large number of waste containers. An earthquake accident is identified but judged to be bounded by the tornado accident. The average concentration of the drums was 0.16 Ci/ft^3 (total drum activity of 1.176 Ci). However, for the box spill accident, the content is taken to be 10 times higher. It is estimated that 99% of the boxes at INEL are below this value (a box is equivalent to 15 drums in volume). A box spill accident is estimated to have a frequency of 1.2E-01/yr. The drum fire and explosion accident is considered to be the maximum bounding accident within design basis and is estimated to have a frequency of 2.0E-06/yr. The tornado accident is considered to be a beyond-design-basis accident with a frequency of 1.0E-07/yr. The consequence to the MEI at the site boundary for a tornado accident is estimated to be 9.7E-02 rem.

The accidents considered in the DOE Programmatic Spent Nuclear Fuel and INEL Environmental Restoration and Waste Management EIS (EG&G 1994a) involving TRUW were a lava flow over the entire RWMC and an aircraft crash. The molten lava flow caused by a volcanic eruption was determined to be a reasonable foreseeable bounding accident with an estimated frequency of 2.0E-05/yr. Although the RWMC includes waste management operations involving LLMW, LLW, and TRUW, the results shown in Table F.4–2 are for CH-TRUW stored in the Transuranic Storage Area (TSA) inside the inflated Air Support Weather Shield buildings. TRUW at TSA consists of approximately 10,400 m^3 stored in drums (52,000 drums) and 55,000 m^3 of soil-covered waste. The waste is assumed to come into direct contact with the lava. A two-phased release is assumed to take place. In the first phase, the combustible fraction of the waste is assumed to burn with a release fraction similar to a sustained fire. In the second phase, the remaining waste (noncombustible) is assumed to be mixed with the molten lava resulting in a release similar to off-gassing from a vitrification process. The aircraft accident in the INEL EIS assumes that a large commercial jet crashes into the Hot Fuel Examination Facility (HFEF) at ANL-W. This accident is considered to be the bounding externally initiated event because it could cause a major breach of barriers,

involve large MAR, and have a high-energy impact followed by fire. The frequency of this accident is estimated to be in the range of 1.0E-06 to 1.0E-08 per year. The waste present in the HFEF includes 20 fresh fuel assemblies, 50 stored subassemblies, and 46 drums of WIPP TRUW. However, the results presented in Table F.4–2 are pertinent to WIPP TRUW only. The number of drums affected by the crash is assumed to be 23 with an ARF of 5.0E-04 and RF of 5.0E-01.

The SRS EIS (DOE, 1995) identifies four representative bounding accidents associated with management of TRUW. These accidents include an internally induced drum rupture and fire, a drum fire in the culvert, a vehicle crash causing a drum fire, and a deflagration event in the culvert during TRUW retrieval activities involving a single drum. The SRS EIS reports consequence results for these accidents but does not include releases and source term parameters such as DFs, ARF, and RARF. All these accidents except the vehicle crash involve a single drum on the basis of the assumption that the other drums are sealed with a gasket and the lids are secured with metal ring clamps, and, therefore, the fire would not propagate to these drums. The internally induced drum rupture and fire is assumed to occur because of overpressurization due to gas buildup from radiolytic decomposition of cellulosic waste and the ignition of the generated hydrogen. The frequency of such an accident is estimated to be 2.1E-02/yr. The drum fire in the culvert is also assumed to be caused by hydrogen gas generated through radiolytic decomposition of organic waste and is estimated to have a frequency of 8.1E-04/yr. The vehicle crash with resulting fire at the TRUW storage pads is assumed to involve 28 drums with an estimated frequency of 6.5E-05/yr. The drum deflagration in the culvert is assumed to be caused by a flammable gas mixture of hydrogen and air that could exist inside a drum as the result of radiolysis of polyethylene wrappings. This accident is estimated to have a frequency of 1.0E-02/yr.

The ORNL SAR for the Waste Storage Facility, Building 7574 (ORNL, 1994) identifies two events as the worst-case bounding accidents: spill of drums caused by earthquake and fire inside the building affecting a stack of drums. Building 7574 at ORNL is used to store TRUW and solid LLW. The waste may contain liquids and powders. Some of the waste may be placed in plastic liners inside the drums. The maximum number of drums that can be stored in the building is 1,200. These drums are stored in an array of four drums per pallet and stacked three pallets high. In the earthquake accident, only 67% of the total number of drums is assumed to be breached (the second and third levels). Twenty-five percent of the drum content is assumed to be spilled. If the waste is placed in a plastic liner, then only 10% is assumed to be spilled. The frequency of an earthquake causing waste containers to fall is considered to be in the range of 1.0E-02 to 1.0E-04 per year. The consequence to an individual at the boundary of the site is estimated to be less than 0.5 rem for this accident. The fire accident inside the building is assumed to affect up to one stack of

12 drums. Liquid waste is considered to be flammable and to burn completely. The remainder of the waste is assumed to be 50% combustible. The frequency of a fire accident is considered to be in the range of 1.0E-02 to 1.0E-04/yr. The consequence from such an accident to the individual at the boundary of the site is estimated to be less than 0.1 rem. Release in terms of curies is not reported in this SAR.

The WRAP facilities, as originally configured, were designed to be constructed as a series of modules including units to process contact handled (Module 1) and remote handled (Module 2) TRUW waste. A subsequent project reconfiguration resulted in redefinition of the module missions such that module 2 would have been intended to handle and treat radioactive mixed waste (as discussed below). A Hazard Classification and Preliminary Safety Evaluation (WHC, 1991a) identified and analyzed a set of accident scenarios to characterize the range of potential hazards for WRAP Module 1 operation. Consistent with DOE guidance on hazard class determination, the range of accidents analyzed included worst case scenarios resulting in completely unmitigated releases. The accident scenarios addressed both waste treatment and packaged waste lag storage and included drum spill, metal box drop and breach, liquid spill from waste pump, drop of a failed HWVP melter, and the most applicable one to the WM PEIS, a design basis earthquake (DBE). The applicable portion of the WRAP 2 scenario is the earthquake-initiated fire in the size reduction area (the Incoming Storage area). A release fraction of 5.3E-04 is assumed for the fire affecting 30 drums in the lag storage area. A maximally exposed offsite individual is estimated to receive a dose of 0.3 rem with an accident frequency of 1.0E-03/yr. No credit is taken in for HEPA filtration.

In a precursor report (WHC, 1991b), the prototype concept of a WRAP facility was analyzed for the effects of a DBE. In the preconceptual design phase, the WRAP I module was scoped to handle and process contact-handled TRUW. The Shipping and Receiving area was scoped to provide lag storage for 100 drums and 4 boxes. The waste packages are damaged by falling girders and portions of the roof. Based on estimates of debris and geometry of the storage array, 19% of the waste packages are estimated to be breached. The resulting fire is assumed to result in a release fraction of 5.3E-04. Aggregate dose consequences were estimated for the total facility release, but no estimates were provided for the contribution from Lag Storage.

The WIPP SEIS-II (DOE, 1996) calculates accidents based on generic radiological airborne source terms that are a function of the accident type only. Site-specific meteorology and population data are applied for six TRUW sites (Hanford, INEL, LANL, RFETS, ORNL, and SRS). Three representative bounding accidents associated with storage of TRUW are identified. These accidents include a drum spill, internally induced drum rupture and fire, and a beyond-design-basis earthquake that results in collapse of the storage

facility. The drum spill is assumed to occur due to operator error and would result in puncture of two drums and lid failure for a third drum, each containing 80 plutonium equivalent curies (PE-Ci). It is assumed that 10 percent of the TRUW spills out of the two punctured drums and 25 percent of the waste spills out of the third lidless container. An airborne release fraction of 1.0E-03 is applied in the analyses, with a respirable fraction of 0.1, and credit is taken for HEPA filtration (LPF of 1.0E-03). The frequency of this accident is stated to be 1.0E-02 per year, and negligible offsite impacts are estimated.

The internally induced drum rupture and fire event affects a single drum containing 80 PE-Ci, 50 percent of which is postulated to be consumed by the fire. It is assumed that 5E-04 of the radioactive materials are suspended as respirable particles, and that 60 percent are deposited within the facility prior to release through HEPA filtration (LPF of 1.0E-03). The frequency of this accident is stated to be 1.0E-04 per year, and negligible offsite impacts are estimated.

The earthquake scenario assumes a beyond-design-basis seismic event that results in collapse of the structure onto the waste containers, which breaches 25 percent of the drum inventory. An average of 25 percent of the drum contents are assumed to spill from the breached drums, with a respirable airborne release fraction of 1.0E-04 and 50 percent deposition within the facility prior to release. The amount of material that would be affected by this scenario is site dependent and not reported in this EIS. The estimated maximum annual frequency is stated to be 1.0E-07, with the consequence to the MEI at the site boundary ranging from 3.2 rem at SRS to 150 rem at RFETS. The number of latent cancer fatalities in the offsite population ranged from 6 at ORNL to 200 at Hanford and 300 at RFETS. The high number of fatalities predicted for this accident scenario at RFETS and Hanford may be attributable to very conservative underlying assumptions used in developing the source term.

In reviewing the cited analyses, it was observed that there is considerable variation in the assumptions used by the various DOE sites to develop accidents and associated source term parameters. However, it appears from the analyses that overall, the risks to the public health resulting from storage facility accidents would be small, although the predicted releases are greater than those from LLMW accidents (see Section F.6).

It should be noted that explicitly analyzing risks from storage would not help to discriminate among alternatives because of the assumption used in the WM PEIS for estimating the treatment throughputs that dictate the inventories to be stored before treatment. This assumption is that all sites will accumulate or at least not reduce these inventories for roughly 10 years, at which time complexwide treatment will begin.

Thus, all sites will achieve their maximum inventories (leading to maximum potential releases during a storage facility accident) independent of alternative.

F.4.2.3 Treatment Facility Accidents

Assessments have shown that incineration is the treatment technology most likely to dominate risk to facility and site staff, as well as to the surrounding general populations. Severe radiological accidents investigated herein focus on sequences involving fire and explosions capable of producing large airborne releases of the highly dispersible ash present in storage or in the filtration systems of incinerators.

A generic treatment facility, consisting of a series of linked process modules, each providing a specific treatment process, was defined to assess releases from treatment accidents (see Section F.2.6.3). A DOE Hazard Category of 2 and concomitant structural performance requirements on its systems were assumed. Double HEPA filtration systems were assumed to be in place (see Section F.2.6.3). The inventory was based on the facility throughput at each site. Volumetric inventories and physical and radiological compositions for each waste treatability category were considered at each site for each alternative.

Accidents investigated included operation-induced facility fires and external-event-induced fires and explosions. Treatment facility accident sequences analyzed include:

- A fire in the baghouse area of an incineration facility causing a complete failure of the filtration systems (LPF = 1) with a damage fraction of 3.0E–02 of the total amount of ash existing in the facility available for release (DF = 3.0E–02);
- A rotary kiln explosion caused by combustible gas buildup that affects the ash existing in the rotary kiln (a damage fraction of 1.2E–01 of the total in the facility available for release; DF = 1.2E–01) and partially degrades the filtration system of the facility (LPF = 1.0E–03); and
- External events leading to a fire. External-event source term parameters vary according to the particular sequence.

All accidents are assumed to be ground level releases without filtration with the exception of the rotary kiln explosion accident where a stack emission and partial HEPA filtration is assumed with a remaining efficiency of 99.9% (LPF = 1.0E–03).

F.4.3 RESULTS

Preliminary results for the accident sequences described above were reviewed to determine risk for risk-dominant sequences using the frequency-weighted dose to the MEI. The results were then grouped into four annual frequency categories: likely (>1.0E-02), unlikely (between 1.0E-02 and 1.0E-04), extremely unlikely (between 1.0E-04 and 1.0E-06), and not credible (<1.0E-06). Representative source terms for the important sequences were then selected as the bases for health effects calculations. Of the treatment technologies, only source terms for incineration facility accidents are provided because incineration facility accidents were found to bound other treatment accidents, including wet-air oxidation.

Table F.4–3 gives the WM TRUW facility accidents that were considered for analysis. The cases analyzed are described as follows:

- Case 6 (*Regionalized 2*). Five sites (Hanford, INEL, LANL, RFETS, and SRS) treat CH-TRUW to LDR levels. Disposal of treated TRUW is at WIPP.
- Case 8 (*Regionalized 3*). Three sites (Hanford, INEL, and SRS) treat CH-TRUW to LDR levels. Disposal of treated TRUW is at WIPP.
- Case 9 (*Centralized*). One site (WIPP) treats CH-TRUW to LDR levels. Disposal of treated TRUW is at WIPP.
- Case 15 (*Remote-handled*). Two sites (Hanford and ORR) treat RH-TRUW to LDR levels. Disposal of treated TRUW is at WIPP.

Table F.4–4 summarizes the radiological source terms and frequencies for drum handling accidents at TRUW facilities. Table F.4–5 summarizes the radiological source terms and frequencies for incineration facility accidents. Detailed radionuclide releases are provided in ANL (1996c).

F.5 Low-Level Waste

F.5.1 ALTERNATIVES AND SITES ANALYZED

The LLW WM alternatives in the WM PEIS are summarized in Table F.5–1. Source term results for the alternatives are discussed in the following sections.

Table F.4–3. Summary of WM TRUW Accidents Analyzed[a]

Function	WM PEIS Alternative	Site	Operational Events			External Events		
			Handling Breaches	Facility Fire	Facility Explosion	Seismic	Large Aircraft	Small Aircraft
Drum handling	All	ANL-W	X	--	--	--	--	--
	All	Hanford	X	--	--	--	--	--
	All	INEL	X	--	--	--	--	--
	All	LANL	X	--	--	--	--	--
	All	LLNL	X	--	--	--	--	--
	All	Mound	X	--	--	--	--	--
	All	ORNL	X	--	--	--	--	--
	All	RFETS	X	--	--	--	--	--
	All	SRS	X	--	--	--	--	--
α-Incineration[b]	6	Hanford	--	X	X	X	--	--
	6	INEL	--	X	X	X	--	--
	6	LANL	--	X	X	X	--	--
	6	RFETS	--	X	X	X	--	--
	6	SRS	--	X	X	X	--	--
	8	Hanford	--	X	X	X	--	--
	8	INEL	--	X	X	X	--	--
	8	SRS	--	X	X	X	--	--
	9	WIPP	--	X	X	X	--	--
r-Incineration[c]	15	Hanford	--	X	X	X	--	--
	15	ORNL	--	X	X	X	--	--

Notes: -- = not applicable.

[a] Only one source term, generally corresponding to the risk-dominant sequence for each accident initiator, was considered.

- Case 6 (*Regionalized 2*). Five sites (Hanford, INEL, LANL, RFETS, and SRS) treat CH-TRUW to LDR levels. Disposal of treated TRUW is at WIPP.
- Case 8 (*Regionalized 3*). Three sites (Hanford, INEL, and SRS) treat CH-TRUW to LDR levels. Disposal of treated TRUW is at WIPP.
- Case 9 (*Centralized*). One site (WIPP) treats CH-TRUW to LDR levels. Disposal of treated TRUW is at WIPP.
- Case 15 (*Remote-handled*). Two sites (Hanford and ORR) treat RH-TRUW to LDR levels. Disposal of treated TRUW is at WIPP.

[b] α-incineration refers to incineration of waste categorized as alpha-emitting.

[c] r-incineration refers to incineration of RH waste.

Greater than Class C (GTCC) wastes are a special case as discussed below in this section. The DOE program for GTCC LLW consists of three phases: (1) continuation of limited interim storage of (primarily) sealed sources, (2) provision of an interim centralized dedicated storage facility until an NRC-licensed facility is available, and (3) final disposal in either a HLW repository or a separate NRC-licensed facility. The dedicated and interim storage phases could be merged, depending on commercial reactor decommissioning decisions. Nuclear utility volumes of GTCC will be needed to define phase 2 centralized storage requirements, potential packaging and treatment requirements, and fee specifications. Because the DOE has not yet initiated efforts on an NRC-licensed interim facility, the current program assumes disposal in the HLW repository.

Table F.4–4. Frequencies and Source Term Parameters for WM TRUW Drum Handling Accidents

WM PEIS Alternative	Site	Frequency Bin (/yr)				Source Term Parameters			Total Release (Ci)
		>1.0E–0.2	1.0E–0.4 to 1.0E–0.2	1.0E–0.6 to 1.0E–0.4	<1.0E–0.6	VMAR (m^3)	MAR (Ci)	DF	
All	ANL-W	X	--	--	--	2.0E–01	1.2E+00	0.25	2.0E–04
All	Hanford	X	--	--	--	2.0E–01	3.0E+00	0.25	4.2E–04
All	LANL	X	--	--	--	2.0E–01	3.6E+00	0.25	7.9E–04
All	LLNL	X	--	--	--	2.0E–01	4.0E+00	0.25	1.0E–03
All	RFETS	X	--	--	--	2.0E–01	6.1E+00	0.25	1.4E–03
All	SRS	X	--	--	--	2.0E–01	2.2E+01	0.25	2.7E–03

Notes: -- = not applicable

Table F.4-5. Frequencies and Source Term Parameters for WM TRUW Incineration Facility Accidents

Site	Accident	VMAR (m^3)	MAR (Ci)	TRF	Total Release (Ci)	Frequency (/yr)	Frequency Class
Case 6 (Regionalized 2)							
Hanford	Explosion in the rotary kiln	1.9E-01	7.4E+01	8.4E-06	6.2E-04	1.5E-02	I
Hanford	Fire in the baghouse area	1.9E-01	7.4E+01	1.8E-06	1.3E-04	1.0E-03	II
Hanford	Earthquake with fireball blasting HEPA filters	1.9E-01	7.4E+01	4.6E-04	3.4E-02	1.2E-05	III
INEL	Explosion in the rotary kiln	1.0E+00	2.1E+02	8.4E-06	1.8E-03	1.5E-02	I
INEL	Fire in the baghouse area	1.0E+00	2.1E+02	1.8E-06	3.8E-04	1.0E-03	II
INEL	Earthquake with fireball blasting HEPA filters	1.0E+00	2.1E+02	4.6E-04	9.7E-02	1.2E-05	III
LANL	Explosion in the rotary kiln	6.2E-01	2.1E+02	8.4E-06	1.7E-03	1.5E-02	I
LANL	Fire in the baghouse area	6.2E-01	2.1E+02	1.8E-06	3.7E-04	1.0E-03	II
LANL	Earthquake with fireball blasting HEPA filters	6.2E-01	2.1E+02	4.6E-04	9.5E-02	1.2E-05	III
RFETS	Explosion in the rotary kiln	8.8E-02	5.3+01	8.4E-06	4.4E-04	1.5E-02	I
RFETS	Fire in the baghouse area	8.8E-02	5.3+01	1.8E-06	9.5E-05	1.0E-03	II
RFETS	Earthquake with fireball blasting HEPA filters	8.8E-02	5.3+01	4.6E-04	2.4E-02	1.2E-05	III
SRS	Explosion in the rotary kiln	1.6E-02	1.1E+00	8.4E-06	9.2E-06	1.5E-02	I
SRS	Fire in the baghouse area	1.6E-02	1.1E+00	1.8E-06	2.0E-06	1.0E-03	II
SRS	Earthquake with fireball blasting HEPA filters	1.6E-02	1.1E+00	4.6E-04	5.0E-04	1.2E-05	III
Case 8 (Regionalized 3)							
Hanford	Explosion in the rotary kiln	1.9E-01	7.4E+01	8.4E-06	6.2E-04	1.5E-02	I
Hanford	Fire in the baghouse area	1.9E-01	7.4E+01	1.8E-06	1.3E-04	1.0E-03	III
Hanford	Earthquake with fireball blasting HEPA filters	1.9E-01	7.4E+01	4.6E-04	3.4E-02	1.2E-05	II
INEL	Explosion in the rotary kiln	1.7E+00	4.7E+02	8.4E-06	4.0E-03	1.5E-02	I
INEL	Fire in the baghouse area	1.7E+00	4.7E+02	1.8E-06	8.5E-04	1.0E-03	III
INEL	Earthquake with fireball blasting HEPA filters	1.7E+00	4.7E+02	4.6E-04	2.2E-01	1.2E-05	II
SRS	Explosion in the rotary kiln	1.6E-02	1.1E+00	8.4E-06	9.2E-06	1.5E-02	I
SRS	Fire in the baghouse area	1.6E-02	1.1E+00	1.8E-06	2.0E-06	1.0E-03	III
SRS	Earthquake with fireball blasting HEPA filters	1.6E-02	1.1E+00	4.6E-04	5.0E-04	1.2E-05	II
Case 9 (Centralized)							
WIPP	Explosion in the rotary kiln	1.9E+00	5.5E+02	8.4E-06	4.6E-03	1.5E-02	I
WIPP	Fire in the baghouse area	1.9E+00	5.5E+02	1.8E-06	9.9E-04	1.0E-03	II
WIPP	Earthquake with fireball blasting HEPA filters	1.9E+00	5.5E+02	4.6E-04	2.5E-01	1.2E-05	III
Case 15 (Remote-handled)							
Hanford	Explosion in the rotary kiln	4.6E-03	1.7E+00	8.4E-06	1.5E-05	1.5E-02	I
Hanford	Fire in the baghouse area	4.6E-03	1.7E+00	1.8E-06	3.1E-06	1.0E-03	II
Hanford	Earthquake with fireball blasting HEPA filters	4.6E-03	1.7E+00	4.6E-04	8.0E-04	1.2E-05	III
ORNL	Explosion in the rotary kiln	4.2E-02	3.4E+01	8.4E-06	2.8E-04	1.5E-02	I
ORNL	Fire in the baghouse area	4.2E-02	3.4E+01	1.8E-06	6.0E-05	1.0E-03	II
ORNL	Earthquake with fireball blasting HEPA filters	4.2E-02	3.4E+01	4.6E-04	1.5E-02	1.2E-05	III

[a] Frequency categories are defined in Table F.2-2. I = likely, II = unlikely, III = extremely unlikely, and IV = not credible.

Table F.5-1. Low-Level Waste Alternatives

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	Treat	Dispose																
No Action	10*	6				TD	TD	D	T	D	TD	T			T		TD	
Decentralized		16	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Regionalized 1		12			D	D	D	D	D	D	D	D	D	D	D		D	
Regionalized 2	11	12			TD	TD	TD	TD	TD	D	TD	TD	TD	TD	TD		TD	
Regionalized 3		6				D	D	D		D	D						D	
Regionalized 4	7	6				TD	TD	TD		D	TD			T	T		TD	
Regionalized 5	4	6				TD	TD	D		D	TD						TD	
Regionalized 6		2				D											D	
Regionalized 7		2								D							D	
Centralized 1		1				D												
Centralized 2		1								D								
Centralized 3	7	1				TD	T	T			T			T	T		T	
Centralized 4	7	1				T	T	T		D	T			T	T		T	
Centralized 5	1	1				TD												

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification.
All sites would do "minimum treatment," in all alternatives which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment.
D = dispose. Each of the 6-site disposal alternatives uses the 6 same sites; each of the 12-site disposal alternatives uses the same 12 sites. Blanks indicate that a site does not treat or dispose LLW under the specified alternative.
[a] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, RMI, and Mound) not listed as major sites above include volume reduction facilities.

The WM PEIS considers the following alternatives for continued interim storage of sealed sources:

- *No Action.* Continue to store limited quantities of commercial GTCC at Hanford, Fernald Environmental Management Project (FEMP), INEL, LANL, Oak Ridge Reservation (ORR), and SRS in existing and approved storage facilities.
- *Decentralization.* Continue the No Action alternative, and either expand existing or establish new interim storage facilities at DOE sites as may be required for additional limited commercial quantities (for example, in response to an emergency request by the NRC).
- *Regionalization.* Same as decentralization, except ship and store at a limited number of DOE sites (probably between two and five) until an appropriate disposal facility is available.
- *Centralization.* Same as decentralization, except ship and store at one DOE site until an appropriate disposal facility is available.

Current projected volumes of sealed sources are on the order of a few cubic meters and constitute a small fraction of the overall volume of low-level waste. The mix of source compositions that will be received from utilities is uncertain. Independent of the composition mix of sealed sources, the facility accident potential will be small because the source material form is physically and chemically stable, most sources are doubly encapsulated in stainless steel, quantities are relatively small, and the sources will probably be stored in their shipping packages. Because these packages will meet U.S. Department of Transportation (DOT) and NRC requirements, the packages will already be designed to withstand severe accidents.

Because of (1) the overall programmatic uncertainties, (2) the fact that utility waste inventories will undoubtedly dictate future facility accident impacts, and (3) the relatively small contribution of sealed source storage accidents to risk, accident source terms for the continued DOE interim storage of sealed sources were not developed.

F.5.2 Risk-Dominant Accidents and Modeling Considerations

Accident selection has been based on importance to risk, with the general modeling assumptions and related source term parameters described in Section F.2.2. LLW is generally rags, papers, filters, discharged protective clothing, and other materials contaminated with small amounts of radioactivity that are susceptible to fire-initiated events. The general modeling assumptions and related parameters for radiological source terms are detailed in Section F.2.5.1.

The results are based on the underlying assumption that all sites will accumulate, or at least not reduce, waste inventories for at least 10 years, at which time complexwide treatment will begin. Thus, all sites attain their maximum inventory of LLW in about 10 years.

F.5.2.1 Handling Accidents

Storage or staging operations and related handling accidents were investigated because they are expected to dominate the exposure risk to workers due to their frequency and to the proximity of the workers to waste in hands-on operations. Representative handling accidents involve a single drum and assume that 25% of the drum inventory is affected and subject to stresses capable of rendering the contents airborne.

The inventories, physical forms, and radiological compositions of waste stored at each site were characterized in the WM PEIS and stored in a database. However, compilation of detailed information for individual operations and facilities on each site was beyond the scope of the WM PEIS. Accordingly, handling accidents assume a single site-dependent radiological and physical composition derived by volume-weighting the inventories of the treatability categories within each waste type. The composition is based on waste generation and inventory data at each site. Since each site is assumed to store only its own waste, the source terms associated with these handling accidents will not change from one alternative to another.

F.5.2.2 Storage Facility Accidents

Accidents and source terms for current storage were not analyzed explicitly. Unlike treatment, which will predominantly use new facilities that will have common characteristics, current (pretreatment) storage will use a variety of predominantly preexisting facilities that vary greatly in the amounts and types of waste inventories stored, the configurations in which they are stored, and the containment or confinement characteristics of the storage buildings or enclosures. Recent DOE safety reports and NEPA information are cited in Section F.6 to provide guidance on the potential risk impacts applicable to LLMW storage facility accidents. This same information can be used to evaluate the anticipated risks of LLW storage facility accidents. Based on the available information, this risk for LLW storage accidents should be very low.

It should be noted that explicitly analyzing risks from storage would not help to discriminate among alternatives because of the assumption used in the WM PEIS for estimating the treatment throughputs that dictate the inventories to be stored before treatment. This assumption is that all sites will accumulate or at least not reduce these inventories for roughly 10 years, at which time complexwide treatment will begin. Thus, all sites will achieve their maximum inventories (leading to maximum potential releases during a storage facility accident) independent of alternative.

F.5.2.3 Treatment Facility Accidents

Evaluations have shown that incineration is the thermal treatment technology most likely to dominate risk to facility and site staff, as well as to the surrounding general populations. Radiological accidents investigated here in are focused on sequences involving fire and explosions capable of producing large airborne releases of the highly dispersible ash present in storage or in the filtration systems of incinerators.

A generic treatment facility, consisting of a series of linked process modules, each providing a specific treatment process, was defined to assess releases from treatment accidents (see Section F.2.6.3). A DOE Hazard Category of 2 and concomitant structural performance requirements on its systems were assumed. Double HEPA filtration systems were assumed to be in place. The inventory was based on the facility throughput at each site. Volumetric inventories and physical and radiological compositions for each waste treatability category were considered at each site for each alternative.

Accidents investigated included operation-induced facility fires and external-event-induced fires and explosions. Treatment facility accident sequences analyzed include:

- A fire in the baghouse area of the incineration facility causing a complete failure of the filtration systems (LPF = 1) with a damage fraction of 3.0E-02 of the total amount of ash existing in the facility at that time (DF = 3.0E-02)
- A rotary kiln explosion caused by combustible gas buildup that affects the ash existing in the rotary kiln (a damage fraction of 1.2E-01 of the total in the facility at the time; DF = 1.2E-01) and partially degrades the filtration system of the facility (LPF = 1.0E-03)
- External events leading to a fire. External-event source term parameters vary according to the sequence

All accidents are assumed to be ground releases without filtration with the exception of the rotary kiln explosion accident where a stack emission and partial HEPA filtration is assumed with a remaining efficiency of 99.9% (LPF = 1.0E-03). This sequence is used to estimate impacts for facility workers.

F.5.2.4 Disposal Facility Accidents

Disposal accidents were not evaluated because of the lack of details of ultimate disposal. However, except for dedicated centralized repositories such as Yucca Mountain or WIPP, disposal sites would generally lack a concentrated volume of material at risk being stored in a configuration susceptible to phenomena such as fires and explosions capable of causing significant releases. These repositories have accident analyses performed as part of their site-specific EISs. Although seismic events could breach in-ground containers, leading to airborne releases, such events would be bounded by accidents breaching the concentrated volumes of waste being held in a treatment or storage facility. The available safety literature does not indicate any credible accident sequence in which the risk from airborne releases in a low-level waste disposal facility would be sufficiently significant to rule out a site from consideration and thereby serve as a discriminator among disposal alternatives.

F.5.3 RESULTS

Preliminary results of the accident sequences described above for various site consolidation cases within each WM PEIS alternative were reviewed for risk dominance using the frequency-weighted dose to the MEI. The results were then grouped into four annual frequency categories: likely ($>$ 1.0E-02), unlikely (between 1.0E-02 and 1.0E-04), extremely unlikely (between 1.0E-04 and 1.0E-06), and not credible ($<$ 1.0E-06). Representative source terms for the important sequences were then selected as the bases for health effects calculations. Of the thermal treatment technologies, only source terms for incineration facility accidents are provided because they were found to bound other treatment accidents, including potential vitrification facilities. Accident sequences for vitrification facilities result in atmospheric releases much lower than analogous incineration accidents in incineration facilities.

The WM LLW accidents analyzed here are listed in Table F.5-2. Fourteen cases are considered for analysis. Cases 12 (Regionalized 5), 14 (Centralized 3), and 14a (Centralized 4) involve treatment at seven sites with various disposal sites. These cases are equivalent with respect to the risk-dominant treatment technologies and amount of waste throughput at each site; therefore, only Case 12 was analyzed.

The WM PEIS cases analyzed are described as follows:

- *Case 1 (No Action).* All sites treat LLW by using existing, planned, and approved treatment facilities and dispose of LLW at the 6 current disposal sites in accordance with current arrangements. Two sites (INEL and SRS) incinerate.

Table F.5-2. Summary of WM LLW Accidents Analyzed[a]

Function	WM PEIS[b] Alternative Case	Site	Operational Events: Handling Breaches	Operational Events: Facility Fire	Operational Events: Facility Explosion	External Events: Seismic	External Events: Large Aircraft	External Events: Small Aircraft
Drum Handling[c]								
	All	Hanford	X	--	--	--	--	--
	All	INEL	X	--	--	--	--	--
	All	LANL	X	--	--	--	--	--
	All	LLNL	X	--	--	--	--	--
	All	ORR	X	--	--	--	--	--
	All	PGDP	X	--	--	--	--	--
	All	Pantex	X	--	--	--	--	--
	All	PORTS	X	--	--	--	--	--
	All	RFETS	X	--	--	--	--	--
	All	SRS	X	--	--	--	--	--
Incineration	1	INEL	--	X	X	X	X	--
	1	SRS	--	X	X	X	X	--
	9	FEMP	--	X	X	X	--	--
	9	Hanford	--	X	X	X	X	--
	9	INEL	--	X	X	X	X	--
	9	LANL	--	X	X	X	--	--
	9	LLNL	--	X	X	X	--	--
	9	ORR	--	X	X	X	--	--
	9	Pantex	--	--	--	--	--	--
	9	PORTS	--	X	X	X	--	--
	9	PGDP	--	X	X	X	--	X
	9	SRS	--	X	X	X	X	--
α-Incineration[d]	9	RFETS	--	X	X	X	--	X
Incineration	12	Hanford	--	X	X	X	X	--
	12	INEL	--	X	X	X	X	--
	12	LANL	--	X	X	X	--	--
	12	ORR	--	X	X	X	--	--
	12	PORTS	--	X	X	X	--	X
	12	RFETS	--	X	X	X	--	X
	12	SRS	--	X	X	X	X	--
α-Incineration[d]	12	RFETS	--	X	X	X	--	X
Incineration	19	Hanford	--	X	X	X	X	--
	19	INEL	--	X	X	X	X	--
	19	ORR	--	X	X	X	--	--
	19	SRS	--	X	X	X	X	--
α-Incineration[d]	19	INEL	--	X	X	X	X	--
Incineration	21	Hanford	--	X	X	X	X	--
α-Incineration[d]	21	Hanford	--	X	X	X	X	--

Notes: -- = not applicable.

[a] Only one source term, generally corresponding to the risk-dominant sequence for each accident initiator, was considered.

[b] The WM PEIS cases analyzed are described as follows:

- *Case 1 (No Action).* All sites treat LLW by using existing, planned, and approved treatment facilities and dispose of LLW at the 6 current disposal sites in accordance with current arrangements. Two sites (INEL and SRS) incinerate.
- *Case 9 (Regionalized 2).* Eleven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 12 sites (Hanford, INEL, NTS, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS).
- *Case 12 (Regionalized 4).* Seven sites (Hanford, INEL, LANL, ORR, PORTS, RFETS, and SRS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 6 sites (Hanford, INEL, NTS, LANL, ORR, and SRS).
- *Case 19 (Regionalized 5).* Four sites (Hanford, INEL, ORR, and SRS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 6 sites (Hanford, INEL, NTS, LANL, ORR, and SRS).
- *Case 21 (Centralized 5).* One site (Hanford) incinerates, supercompacts, reduces the size of, and grouts volume-reducible waste; all sites minimally treat other waste; disposal is at 1 site (Hanford).

[c] The 10 major storage sites were selected for handling accidents; FEMP is not included here because it is an ER site.

[d] α-Incineration refers to incineration of waste categorized as alpha-emitting.

- *Case 9 (Regionalized 2).* Eleven sites (Hanford, INEL, LANL, Oak Ridge Reservation [ORR], SRS, Portsmouth Gaseous Diffusion Plant (PORTS), Paducah Gaseous Diffusion Plant [PGDP], FEMP, Lawrence Livermore National Laboratory [LLNL], Pantex Plant [Pantex], and RFETS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 12 sites (Hanford, INEL, Nevada Test Site [NTS], LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS).

- *Case 12 (Regionalized 4).* Seven sites (Hanford, INEL, LANL, ORR, PORTS, RFETS, and SRS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 6 sites (Hanford, INEL, NTS, LANL, ORR, and SRS).
- *Case 19 (Regionalized 5).* Four sites (Hanford, INEL, ORR, and SRS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 6 sites (Hanford, INEL, NTS, LANL, ORR, and SRS).
- *Case 21 (Centralized 5).* One site (Hanford) incinerates, supercompacts, reduces the size of, and grouts volume-reducible waste; all sites minimally treat other waste; disposal is at 1 site (Hanford).

Tables F.5–3 and F.5–4 summarize the radiological source term parameters and frequency bins assigned for each of the accidents. Separate incineration facilities were assumed for treating alpha- and nonalpha-contaminated waste. Detailed radionuclide releases are provided in ANL (1996a).

F.6 Low-Level Mixed Waste

F.6.1 Alternatives and Sites Analyzed

The LLMW WM alternatives in the WM PEIS are summarized in Table F.6–1. Calculational source term results are discussed herein for the identified sites.

One of the assumptions underlying the analysis is that the site will continue to accumulate or at least not reduce inventories of LLMW for about 10 years, at which time complexwide treatment will begin. Thus, all sites will achieve their maximum inventory in about 10 years.

F.6.2 Risk-Dominant Accidents and Modeling Considerations

The selection of accidents considers the importance to risk of both radiological and chemical hazards. The general modeling assumptions and related parameters for radiological source terms are detailed in Section F.2.5.1. Review of the hazardous contents of the wastes and their concentrations suggests that spills of organic liquids (WM PEIS treatment codes [TCs] 3 through 6), followed by evaporation or combustion reactions (or both), are the events most likely to lead to the airborne release of chemically hazardous

Table F.5–3. Frequencies and Source Term Parameters for WM LLW Drum Handling Accidents

WM PEIS Alternative	Site	Frequency Bin (/yr)				Source Term Parameters			Total Release (Ci)
		>1.0E–02	1.0E–04 to 1.0E–02	1.0E–06 to 1.0E–04	<1.0E–6	VMAR (m^3)	MAR (Ci)	DF	
All	Hanford	X	--	--	--	2.0E–01	3.0E–01	0.25	4.3E–04
All	INEL	X	--	--	--	2.0E–01	2.1E–01	0.25	5.3E–05
All	LANL	X	--	--	--	2.0E–01	1.5E+00	0.25	2.1E+00*
All	LLNL	X	--	--	--	2.0E–01	2.1E+00	0.25	5.2E+00*
All	ORR	X	--	--	--	2.0E–01	7.1E–01	0.25	1.9E–03*
All	PGDP	X	--	--	--	2.0E–01	6.0E–05	0.25	1.8E–08
All	Pantex	X	--	--	--	2.0E–01	7.1E–05	0.25	1.7E–05*
All	PORTS	X	--	--	--	2.0E–01	2.8E–06	0.25	6.4E–09
All	RFETS	X	--	--	--	2.0E–01	1.1E–03	0.25	1.2E–06
All	SRS	X	--	--	--	2.0E–01	6.1E–01	0.25	4.8E–02*

Notes: -- = not applicable; * = mainly H-3 released.

Table F.5–4. Frequencies and Source Term Parameters for WM LLW Incineration Facility Accidents

WM PEIS Alternative[a]	Site	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E-02	1.0E-04 - 1.0E-02	1.0E-06 - 1.0E-04	<1.0E-06	VMAR (m^3)	MAR (Ci)	DF	RARF[b]	LPF[b]	
1	INEL	Explosion in the rotary kiln	X	--	--	--	4.3E-01	1.5E-01	1.2E-01	1.0E-01	1.0E-03	1.8E-06
1	INEL	Fire in the baghouse area	--	X	--	--	4.3E-01	1.5E-01	3.0E-02	1.0E-02	1.0E-00	4.6E-05
1	INEL	Earthquake followed by fire and explosion	--	--	X	--	4.3E-01	1.5E-01	2.0E-01	1.0E-01	1.0E-00	3.1E-03
1	INEL	Large aircraft impact with fire and explosion	--	--	--	X	4.3E-01	1.5E-01	3.0E-01	1.0E-01	1.0E-00	4.6E-03
1	SRS	Explosion in the rotary kiln	X	--	--	--	3.6E-01	1.1E+00	1.2E-01	1.0E-01	1.0E-03	1.3E-05
1	SRS	Fire in the baghouse area	--	X	--	--	3.6E-01	1.1E+00	3.0E-02	1.0E-02	1.0E-00	3.3E-04
1	SRS	Earthquake followed by fire and explosion	--	--	X	--	3.6E-01	1.1E+00	2.0E-01	1.0E-01	1.0E-00	2.2E-02
1	SRS	Large aircraft impact with fire and explosion	--	--	--	X	3.6E-01	1.1E+00	3.0E-01	1.0E-01	1.0E-00	3.3E-02
9	FEMP	Explosion in the rotary kiln	X	--	--	--	1.9E-01	2.8E-05	1.2E-01	1.0E-01	1.0E-03	3.3E-10
9	FEMP	Fire in the baghouse area	--	X	--	--	1.9E-01	2.8E-05	3.0E-02	1.0E-02	1.0E-00	8.3E-09
9	FEMP	Earthquake followed by fire and explosion	--	--	X	--	1.9E-01	2.8E-05	2.0E-01	1.0E-01	1.0E-00	5.6E-07
9	Hanford	Explosion in the rotary kiln	X	--	--	--	9.7E-04	5.3E-02	1.2E-01	1.0E-01	1.0E-03	6.3E-07
9	Hanford	Fire in the baghouse area	--	X	--	--	9.7E-04	5.3E-02	3.0E-02	1.0E-02	1.0E-00	1.6E-05
9	Hanford	Earthquake followed by fire and explosion	--	--	X	--	9.7E-04	5.3E-02	2.0E-01	1.0E-01	1.0E-00	1.1E-03
9	Hanford	Large aircraft impact with fire and explosion	--	--	--	X	9.7E-04	5.3E-02	3.0E-01	1.0E-01	1.0E-00	1.6E-03
9	INEL	Explosion in the rotary kiln	X	--	--	--	4.3E-01	1.5E-01	1.2E-01	1.0E-01	1.0E-03	1.8E-06
9	INEL	Fire in the baghouse area	--	X	--	--	4.3E-01	1.5E-01	3.0E-02	1.0E-02	1.0E-00	4.6E-05
9	INEL	Earthquake followed by fire and explosion	--	--	X	--	4.3E-01	1.5E-01	2.0E-01	1.0E-01	1.0E-00	3.1E-03
9	INEL	Large aircraft impact with fire and explosion	--	--	--	X	4.3E-01	1.5E-01	3.0E-01	1.0E-01	1.0E-00	4.6E-05
9	LANL	Explosion in the rotary kiln	X	--	--	--	1.4E+00	9.6E+00	1.2E-01	1.0E-01	1.0E-03	1.2E-04
9	LANL	Fire in the baghouse area	--	X	--	--	1.4E+00	9.6E+00	3.0E-02	1.0E-02	1.0E-00	2.9E-03
9	LANL	Earthquake followed by fire and explosion	--	--	X	--	1.4E+00	9.6E+00	2.0E-01	1.0E-01	1.0E-00	1.9E-01
9	LLNL	Explosion in the rotary kiln	X	--	--	--	6.9E-03	9.8E-01	1.2E-01	1.0E-01	1.0E-03	1.2E-05
9	LLNL	Fire in the baghouse area	--	X	--	--	6.9E-03	9.8E-01	3.0E-02	1.0E-02	1.0E-00	2.9E-04
9	LLNL	Earthquake followed by fire and explosion	--	--	X	--	6.9E-03	9.8E-01	2.0E-01	1.0E-01	1.0E-00	2.0E-02
9	ORR	Explosion in the rotary kiln	X	--	--	--	1.5E+00	1.1E-01	1.2E-01	7.0E-02	1.0E-03	9.4E-07
9	ORR	Fire in the baghouse area	--	X	--	--	1.5E+00	1.1E-01	3.0E-02	6.0E-05	1.0E-00	2.0E-07
9	ORR	Earthquake followed by fire and explosion	--	--	X	--	1.5E+00	1.1E-01	2.0E-01	7.0E-05	1.0E-00	1.6E-03
9	PORTS	Explosion in the rotary kiln	X	--	--	--	3.5E-01	1.8E-04	1.2E-01	1.0E-01	1.0E-03	2.1E-09
9	PORTS	Fire in the baghouse area	--	X	--	--	3.5E-01	1.8E-04	3.0E-02	1.0E-02	1.0E-00	5.3E-08
9	PORTS	Earthquake followed by fire and explosion	--	--	X	--	3.5E-01	1.8E-04	2.0E-01	1.0E-01	1.0E-00	3.5E-06
9	PGDP	Explosion in the rotary kiln	X	--	--	--	1.3E-01	1.5E-03	1.2E-01	1.0E-01	1.0E-03	1.8E-08
9	PGDP	Fire in the baghouse area	--	X	--	--	1.3E-01	1.5E-03	3.0E-02	1.0E-02	1.0E-00	4.6E-07
9	PGDP	Earthquake followed by fire and explosion	--	--	X	--	1.3E-01	1.5E-03	2.0E-01	1.0E-01	1.0E-00	3.0E-05
9	PGDP	Small aircraft impact with fire and explosion	--	--	--	X	1.3E-01	1.5E-03	5.0E-02	1.0E-01	1.0E-00	7.6E-06
9α[c]	RFETS	Explosion in the rotary kiln	X	--	--	--	7.0E-01	1.5E-01	1.2E-01	1.0E-01	1.0E-03	1.8E-06
9α	RFETS	Fire in the baghouse area	--	X	--	--	7.0E-01	1.5E-01	3.0E-02	1.0E-02	1.0E-00	4.6E-05
9α	RFETS	Earthquake followed by fire and explosion	--	--	X	--	7.0E-01	1.5E-01	2.0E-01	1.0E-01	1.0E-00	3.1E-03
9α	RFETS	Small aircraft impact with fire and explosion	--	--	--	X	7.0E-01	1.5E-01	5.0E-02	1.0E-01	1.0E-00	7.7E-04

Table F.5-4. Frequencies and Source Term Parameters for WM LLW Incineration Facility Accidents—Continued

WM PEIS Alternative[a]	Site	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E-02	1.0E-04 - 1.0E-02	1.0E-06 - 1.0E-04	<1.0E-06	VMAR (m^3)	MAR (Ci)	DF	RARF[b]	LPF[b]	
9	SRS	Explosion in the rotary kiln	X	--	--	--	3.6E-01	1.1E+00	1.2E-01	1.0E-01	1.0E-03	1.3E-05
9	SRS	Fire in the baghouse area	--	X	--	--	3.6E-01	1.1E+00	3.0E-02	1.0E-02	1.0E-00	3.3E-04
9	SRS	Earthquake followed by fire and explosion	--	--	X	--	3.6E-01	1.1E+00	2.0E-01	1.0E-01	1.0E-00	2.2E-02
9	SRS	Large aircraft impact with fire and explosion	--	--	--	X	3.6E-01	1.1E+00	3.0E-01	1.0E-01	1.0E-00	3.3E-02
12	Hanford	Explosion in the rotary kiln	X	--	--	--	7.8E-03	1.0E+00	1.2E-01	1.0E-01	1.0E-03	1.2E-05
12	Hanford	Fire in the baghouse area	--	X	--	--	7.8E-03	1.0E+00	3.0E-02	1.0E-02	1.0E+00	3.1E-04
12	Hanford	Earthquake followed by fire and explosion	--	--	X	--	7.8E-03	1.0E+00	2.0E-01	1.0E-01	1.0E+00	2.1E-02
12	Hanford	Large aircraft impact with fire and explosion	--	--	--	X	7.8E-03	1.0E+00	3.0E-01	1.0E-01	1.0E+00	3.1E-02
12	INEL	Explosion in the rotary kiln	X	--	--	--	4.3E-01	1.5E-01	1.2E-01	1.0E-01	1.0E-03	1.8E-06
12	INEL	Fire in the baghouse area	--	X	--	--	4.3E-01	1.5E-01	3.0E-02	1.0E-02	1.0E+00	4.6E-05
12	INEL	Earthquake followed by fire and explosion	--	--	X	--	4.3E-01	1.5E-01	2.0E-01	1.0E-01	1.0E+00	3.1E-03
12	INEL	Large aircraft impact with fire and explosion	--	--	--	X	4.3E-01	1.5E-01	3.0E-01	1.0E-01	1.0E+00	4.6E-03
12	LANL	Explosion in the rotary kiln	X	--	--	--	1.4E+00	9.6E+00	1.2E-01	1.0E-01	1.0E-03	1.2E-04
12	LANL	Fire in the baghouse area	--	X	--	--	1.4E+00	9.6E+00	3.0E-02	1.0E-02	1.0E+00	2.9E-03
12	LANL	Earthquake followed by fire and explosion	--	--	X	--	1.4E+00	9.6E+00	2.0E-01	1.0E-01	1.0E+00	1.9E-01
12	ORR	Explosion in the rotary kiln	X	--	--	--	1.5E+00	1.1E-01	1.2E-01	7.0E-02	1.0E-03	9.4E-07
12	ORR	Fire in the baghouse area	--	X	--	--	1.5E+00	1.1E-01	3.0E-02	6.0E-05	1.0E+00	2.0E-07
12	ORR	Earthquake followed by fire and explosion	--	--	X	--	1.5E+00	1.1E-01	2.0E-01	7.0E-02	1.0E+00	1.6E-03
12	PORTS	Explosion in the rotary kiln	X	--	--	--	2.3E-01	3.2E-05	1.2E-01	1.0E-01	1.0E-03	3.9E-10
12	PORTS	Fire in the baghouse area	--	X	--	--	2.3E-01	3.2E-05	3.0E-02	1.0E-02	1.0E+00	9.6E-09
12	PORTS	Earthquake followed by fire and explosion	--	--	X	--	2.3E-01	3.2E-05	2.0E-01	1.0E-01	1.0E+00	6.4E-07
12	PORTS	Small aircraft impact with fire and explosion	--	--	--	X	2.3E-01	3.2E-05	5.0E-02	1.0E-01	1.0E+00	1.6E-07
12	RFETS	Explosion in the rotary kiln	X	--	--	--	1.0E-03	2.2E-04	1.2E-01	1.0E-01	1.0E-03	2.6E-09
12	RFETS	Fire in the baghouse area	--	X	--	--	1.0E-03	2.2E-04	3.0E-02	1.0E-02	1.0E+00	6.6E-08
12	RFETS	Earthquake followed by fire and explosion	--	--	X	--	1.0E-03	2.2E-04	2.0E-01	1.0E-01	1.0E+00	4.4E-06
12	RFETS	Small aircraft impact with fire and explosion	--	--	--	X	1.0E-03	2.2E-04	5.0E-02	1.0E-01	1.0E+00	1.1E-06
12	SRS	Explosion in the rotary kiln	X	--	--	--	3.6E-01	1.1E+00	1.2E-01	1.0E-01	1.0E-03	1.3E-05
12	SRS	Fire in the baghouse area	--	X	--	--	3.6E-01	1.1E+00	3.0E-02	1.0E-02	1.0E+00	3.3E-04
12	SRS	Earthquake followed by fire and explosion	--	--	X	--	3.6E-01	1.1E+00	2.0E-01	1.0E-01	1.0E+00	2.2E-02
12	SRS	Large aircraft impact with fire and explosion	--	--	--	X	3.6E-01	1.1E+00	3.0E-01	1.0E-01	1.0E+00	3.3E-02
12α	RFETS	Explosion in the rotary kiln	X	--	--	--	7.0E-01	1.5E-01	1.2E-01	1.0E-01	1.0E-03	1.8E-06
12α	RFETS	Fire in the baghouse area	--	X	--	--	7.0E-01	1.5E-01	3.0E-02	1.0E-02	1.0E-00	4.6E-05
12α	RFETS	Earthquake followed by fire and explosion	--	--	X	--	7.0E-01	1.5E-01	2.0E-01	1.0E-01	1.0E-00	3.1E-03
12α	RFETS	Small aircraft impact with fire and explosion	--	--	--	X	7.0E-01	1.5E-01	5.0E-02	1.0E-01	1.0E+00	7.7E-04
19	Hanford	Explosion in the rotary kiln	X	--	--	--	7.8E-03	1.0E+00	1.2E-01	1.0E-01	1.0E-03	1.2E-05
19	Hanford	Fire in the baghouse area	--	X	--	--	7.8E-03	1.0E+00	3.0E-02	1.0E-02	1.0E-00	3.1E-04
19	Hanford	Earthquake followed by fire and explosion	--	--	X	--	7.8E-03	1.0E+00	2.0E-01	1.0E-01	1.0E-00	2.1E-02
19	Hanford	Large aircraft impact with fire and explosion	--	--	--	X	7.8E-03	1.0E+00	3.0E-01	1.0E-01	1.0E-00	3.1E-02

Table F.5-4. Frequencies and Source Term Parameters for WM LLW Incineration Facility Accidents—Continued

WM PEIS Alternative[a]	Site	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E-02	1.0E-04 - 1.0E-02	1.0E-06 - 1.0E-04	<1.0E-06	VMAR (m^3)	MAR (Ci)	DF	RARF[b]	LPF[b]	
19	INEL	Explosion in the rotary kiln	X	--	--	--	1.8E+00	9.8E+00	1.2E-01	1.0E-01	1.0E-03	1.2E-04
19	INEL	Fire in the baghouse area	--	X	--	--	1.8E+00	9.8E+00	3.0E-02	1.0E-02	1.0E-00	2.9E-01
19	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.8E+00	9.8E+00	2.0E-01	1.0E-01	1.0E-00	2.0E-01
19	INEL	Large aircraft impact with fire and explosion	--	--	--	X	1.8E+00	9.8E+00	3.0E-01	1.0E-01	1.0E-00	2.9E-01
19α	INEL	Explosion in the rotary kiln	X	--	--	--	7.0E-01	1.5E-01	1.2E-01	1.0E-01	1.0E-03	1.8E-06
19α	INEL	Fire in the baghouse area	--	X	--	--	7.0E-01	1.5E-01	3.0E-02	1.0E-02	1.0E-00	4.6E-05
19α	INEL	Earthquake followed by fire and explosion	--	--	X	--	7.0E-01	1.5E-01	2.0E-01	1.0E-01	1.0E-00	3.1E-03
19α	INEL	Large aircraft impact with fire and explosion	--	--	--	X	7.0E-01	1.5E-01	3.0E-01	1.0E-01	1.0E-00	4.6E-05
19	ORR	Explosion in the rotary kiln	X	--	--	--	1.7E+00	4.9E-01	1.2E-01	7.0E-02	1.0E-03	4.1E-06
19	ORR	Fire in the baghouse area	--	X	--	--	1.7E+00	4.9E-01	3.0E-02	6.0E-05	1.0E-00	8.8E-07
19	ORR	Earthquake followed by fire and explosion	--	--	X	--	1.7E+00	4.9E-01	2.0E-01	7.0E-02	1.0E-00	6.9E-03
19	SRS	Explosion in the rotary kiln	X	--	--	--	3.6E-01	1.1E+00	1.2E-01	1.0E-01	1.0E-03	1.3E-05
19	SRS	Fire in the baghouse area	--	X	--	--	3.6E-01	1.1E+00	3.0E-02	1.0E-02	1.0E-00	3.3E-04
19	SRS	Earthquake followed by fire and explosion	--	--	X	--	3.6E-01	1.1E+00	2.0E-01	1.0E-01	1.0E-00	2.2E-02
19	SRS	Large aircraft impact with fire and explosion	--	--	--	X	3.6E-01	1.1E+00	3.0E-01	1.0E-01	1.0E-00	3.3E-02
21	Hanford	Fire in the baghouse area	--	X	--	--	2.9E+00	1.2E+01	3.0E-02	1.0E-02	1.0E-00	3.6E-03
21	Hanford	Earthquake followed by fire and explosion	--	--	X	--	2.9E+00	1.2E+01	2.0E-01	1.0E-01	1.0E-00	2.4E-01
21	Hanford	Large aircraft impact with fire and explosion	--	--	--	X	2.9E+00	1.2E+01	3.0E-01	1.0E-01	1.0E-00	3.6E-01
21α	Hanford	Explosion in the rotary kiln	X	--	--	--	7.0E-01	1.5E-01	1.2E-01	1.0E-01	1.0E-03	1.8E-06
21α	Hanford	Fire in the baghouse area	--	X	--	--	7.0E-01	1.5E-01	3.0E-02	1.0E-02	1.0E-00	4.6E-05
21α	Hanford	Earthquake followed by fire and explosion	--	--	X	--	7.0E-01	1.5E-01	2.0E-01	1.0E-01	1.0E-00	3.1E-03
21α	Hanford	Large aircraft impact with fire and explosion	--	--	--	X	7.0E-01	1.5E-01	3.0E-01	1.0E-01	1.0E-00	4.6E-03

Notes: -- = not applicable.

[a] The WM PEIS cases analyzed are described as follows:

- *Case 1 (No Action)*. All sites treat LLW by using existing, planned, and approved treatment facilities and dispose of LLW at the 6 current disposal sites in accordance with current arrangements. Two sites (INEL and SRS) incinerate.
- *Case 9 (Regionalized 2)*. Eleven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 12 sites (Hanford, INEL, NTS, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS).
- *Case 12 (Regionalized 4)*. Seven sites (Hanford, INEL, LANL, ORR, PORTS, RFETS, and SRS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 6 sites (Hanford, INEL, NTS, LANL, ORR, and SRS).
- *Case 19 (Regionalized 5)*. Four sites (Hanford, INEL, ORR, and SRS) incinerate, supercompact, reduce the size of, and grout volume-reducible waste; all sites minimally treat other waste; disposal is at 6 sites (Hanford, INEL, NTS, LANL, ORR, and SRS).
- *Case 21 (Centralized 5)*. One site (Hanford) incinerates, supercompacts, reduces the size of, and grouts volume-reducible waste; all sites minimally treat other waste; disposal is at 1 site (Hanford).

[b] Values shown are for particulate (nonvolatile) solids such as U-235 or Pu-238; see Appendix D.

[c] α refers to treatment of waste categorized as alpha-emitting.

Table F.6-1. Low-Level Mixed Waste Alternatives

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	CH Non-Alpha Treat	Dispose																
No Action	3	0	S	S	S	S	TS	S	S	S	TS	S	S	S	S	S	TS	S
Decentralized	37	16	TD	TD	TD	TD	TD∝	TD∝	TD∝	D∝	TD	TD	TD	TD	TD∝	TD	TD∝	TD
Regionalized 1	11	12			TD	TD	TD∝	TD∝	TD∝	D∝	TD	TD	TD	TD	TD∝		TD∝	
Regionalized 2	7	6				TD	TD∝	TD∝		D∝	TD			T	T∝		TD∝	
Regionalized 3	7	1				T	T∝			D∝	T			T	T∝		T∝	
Regionalized 4	4	6				TD	TD∝	D∝		D∝	TD						TD∝	
Centralized	1	1				TD∝												

Notes: T = treatment to meet land disposal restrictions; D = disposal; S = indefinite storage. Blanks indicate that no treatment, storage, or disposal takes place at a site under the specified alternative. All sites have wastewater treatment capability as needed. Blanks indicate that a site does not treat, store, or dispose of LLMW under the specified alternative.

[a] The actions shown are for contact-handled wastes. Remote-handled (RH) wastes would be treated and disposed onsite at the Hanford Site, INEL, ORR, and SRS in all alternatives except No Action. RH waste would be stored under No Action.

[b] Facilities with the ∝ symbol treat or dispose of both contact-handled alpha and non-alpha waste.

substances. The possibility of fires is strongest in the waste streams containing a large fraction of combustible organic substances. Table F.6–2 summarizes the chemical release characteristics developed for the accidents (ANL, 1996a).

F.6.2.1 Handling Accidents

Handling accidents during the staging and storage of CH waste are expected to dominate the risk of exposure for workers because of the high frequency of such accidents and the proximity of the workers during hands-on operations. The frequencies of accidents at a given site would be a strong function of waste

Table F.6–2. Chemical Releases Analyzed for LLMW

Scenario	Toxic Gases Released	Mass of Waste	Release Rate
Spill of aqueous nonhalogenated organic liquids (TC 4)	Acetone; butanone; methanol	160 lb/drum	2-3 lb/min[a]
Spill of aqueous halogenated organic liquid (TC 3)	Trichloroethanes; other chlorohydrocarbons	6 lb/drum	0.1 lb/min
Spill of "pure" halogenated organic liquids (TC 5)	Trichloroethanes Tetrachloroethanes	50 lb/drum 10 lb/drum	0.5 lb/min 0.1 lb/min
Spill of "pure" nonhalogenated organic liquids (TC 6)	Acetone; butanone; methanol BTX	60 lb/drum 200 lb/drum	1 lb/min[a] 2 lb/min[a]
Spill of "pure" nonhalogenated organic liquids (TC 6) followed by fire	BTX CO Cd fumes Cr compounds Soot	10 lb/drum 200 lb/drum 0.5 lb/drum 0.5–1.0 lb/drum 80 lb/drum	0.3 lb/min 7 lb/min 0.02 lb/min 0.02 lb/min 2.7 lb/min
Incinerator staging area fire involvement of TC 12 (organic sludges), 19 (combustible debris), organic liquid (intermediate), and organic particulates (intermediate)	CO HCl	40–50% of mass of drum 60% of mass of Cl-containing compounds in the stream	7 lb/min/drum 2 lb/min/drum
	BTX fumes Soot Cd fumes (condensing to very small particles) Cr compounds	5% of mass of BTX present 40% of mass of BTX plus 10% of total mass 100% of mass of Cd present 250% of mass of Cr present	0.3 lb/min/drum 3 lb/min/drum 0.02 lb/min/drum 0.02 lb/min/drum

Notes: BTX = benzene, toluene, and xylene; Cd = cadmium; Cr = chromium.
[a] An approximation to this release rate can be estimated from Salazar and Lane (1992):

$$QR = \frac{0.106\ \mu^{0.78}\ (MW)^{0.667}\ (A)\ VP}{R\ (t + 273)}\ ,$$

where

QR = release rate lb/min,
MW = molecular weight (g/mol),
A = surface area (ft^2),
VP = effective vapor pressure (mm Hg),
R = 82.05 atm cm^3/mol K,
t = temperature (°C), and
μ = wind speed (m/s).

The assumed options are that t = 30 °C, A = 220 ft^2, and wind speed = 2 m/s. For acetone TC 4, MW = 58 g/mol, and VP = 0.36 × 285 mm Hg. For acetone in TC 6, VP = 0.14 × 285 mm Hg. For benzene in TC 6, MW = 78 g/mol, and VP = 0.44 × 120 mm Hg.

throughput at that site. The assumption used (see Section F.2.7.1) is that two severe breaches of containment occur per year for each 10,000 drums handled. It is assumed for the results herein that handling breaches fall in the >0.01/yr frequency category.

In determining radiological source terms for representative radiological accident scenarios, it is assumed that a single drum is affected, such that 25% of its contents are released (DF = 2.5E-01). The composition of the representative drum is taken as a volume-weighted average of the treatability category compositions (excluding aqueous streams) at each site.

Representative chemical releases assume a single drum with 100% (DF = 1.0E+00) of its contents spilled. The release characteristics for spills are described in the report by ANL (1996a).

F.6.2.2 Storage Facility Accidents

Accidents and source terms for current storage were not analyzed explicitly. Unlike treatment, which will predominantly use new facilities that will have common characteristics, current (pretreatment) storage will use a variety of predominantly preexisting facilities that vary greatly in the amounts and types of waste inventories stored, the configurations in which they are stored, and the containment or confinement characteristics of the storage buildings or enclosures. However, because recent DOE safety or NEPA information on storage facility accidents provides guidance on the potential risk impacts applicable to storage, this information is discussed herewith.

Current SARs predict consequences for a range of selected waste storage accidents of varying frequency. Sometimes these accidents involve facilities which store primarily LLMW. A brief summary of some of these accidents involving LLMW, assumptions used by the sites in preparing the analyses, and release or health effect results are shown in Table F.6-3.

The INEL SAR for the RWMC identifies three bounding accidents involving LLMW. All of these accidents occur at or involve in some manner the Air Support Building II (ASB-II), the facility which stores most of the LLMW at INEL. An accident with fire was identified as occurring at ASB-II. It is caused by a propane leak in the fuel line supplying the heat and inflation unit within the facility. This accident would involve only the waste stored at ASB-II and results in an exposure of 2.0E-02 rem (MEI). A second accident analyzed was initiated by an earthquake, sufficiently severe to damage all of the buildings (ASB-II included)

at the RWMC. The radiological release and consequences listed in Table F.6-3 for this accident (i.e., 0.041 Ci and 0.75 rem) are due primarily to wastes stored in buildings other than ASB-II. The third accident, a fuel-air explosion originating in ASB-II, has the potential to release hazardous materials due primarily to the explosion and subsequent fire. However, a similar fuel-air explosion originating in the Certified and Segregated (C&S) Facility with the subsequent fire impacting all TSA facilities at the RWMC will bound the consequences of the fuel-air explosion originating at ASB-II. Because of this bounding condition the consequence analysis for the ASB-II accident was not performed. Table F.6-3 lists the parameters and results for the similar C&S bounding accident.

The RFETS SAR for the Central Waste Storage Facility (Building 906) identifies three accidents associated with LLMW. Each of these accidents assumes 8,300 drums of waste as the material at risk with each drum filled with waste to 50% of total volume. The void space is assumed to contain dust (at 100 mg/m^3) which is vented to the air upon breaching of the drum. Other variables of each accident type are given in Table F.6-3.

The PSE conducted for WRAP (Module 2) at Hanford identifies a bounding accident scenario which is an earthquake, including waste spills and fire. This event leads to a release of 0.041 Ci with a consequence of 3.9E-05 rem (MEI) with an accident frequency of 1.0E-03/yr (see Table F.6-3).

The International Technology Corporation (IT) has calculated the risks associated with the treatment, storage, and disposal of many types of LLMW. They have looked at many kinds of accidents related to the treatment, storage, and handling of these wastes. An example of a storage accident scenario is a fire within a container in the storage facility that might cause waste particulates to resuspend and be inhaled by workers. Members of the public might also be exposed to airborne effluents if building ventilation fails. IT Corporation has used a system analysis methodology to accumulate risk across different management options rather than breaking out the consequences and contaminant releases associated with a particular accident as the SARs usually do. This different approach to the problem has made comparison difficult with the more conventional approach of calculating the consequences of each separate accident. In general, IT has tended to look at sets of accidents of relatively high frequency with low consequences rather than the more standard approach of surveying accidents of lower frequency but with higher consequences (EG&G, 1993a).

Table F.6-3. Representative Accidents and Source Term Parameters From Recent DOE Safety Analysis Documents Relevant to LLMW

Safety Document	Scenario	DF	ARF or RARF	Release (Ci)	Consequence (MEI-rem)
RWMC SAR (EG&G, 1993b)	1. Propane line leak at ASB II Medium fire	1.0E-02	5.0E-04 (combustible) 1.0E-02 (noncombustible)	2.0E-02	2.0E-02
	2. Earthquake initiating breach in CH LLW pit and involving ASB II	1.0E-03	1.0E-03	4.1E-02	7.5E-01
	3. Fuel air explosion in ASB II, bounded by same type event in C&S Facility	2.0E-01	1.0E-03 (numbers for a C&S event)	1.3E+01	3.2
Building 906 SAR Central Waste Storage Facility					
(RFETS, 1994)	1. Earthquake and spill (collapsed building) Void space volume of 8,300 drums (MAR) (assume drum ½ full)	1.0	1.0	3.37E-05 g Pu-239	2E-06
	2. Spill from impacts 100% void space vented (8,300 drums)	1.0	1.0	100 mg/m^3 particulate loading in void space	NA[e]
	3. Fire ruptures all exposed containers	100% burn of combustibles 18% ablation of noncombustibles	5.0E-04 particulate 1.0E-05 metals 1.0 liquids	Varies with assumptions about fire	NA[e]
Hazard Classification and Preliminary Safety Evaluation (PSE) for WRAP Module 2 (WHC, 1991a)	1. Earthquake and spill of dry waste and fire	1.0	5.3E-04	4.1E-02	3.9E-05

Notes: DF = damage fraction; ARF = airborne release fraction; RARF = respirable airborne release fraction; MEI = maximally exposed individual offsite; C&S = Certified and Segregated Facility; NA = not available. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

In reviewing the cited analyses, it was observed that there is considerable variation in the assumptions used by the various DOE sites to develop accidents and estimate associated source term parameters. However, it appears from the analyses that overall, the risks to the public health resulting from LLMW storage facility accidents would be small.

It should be noted that explicitly analyzing risks from storage would not help to discriminate among alternatives because of the assumption used in the WM PEIS for estimating the treatment throughputs that dictate the inventories to be stored before treatment. This assumption is that all sites will accumulate or at least not reduce these inventories for roughly 10 years, at which time complexwide treatment will begin. Thus, all sites will achieve their maximum inventories (leading to maximum potential releases during a storage facility accident) independent of alternative.

F.6.2.3 Treatment Facility Accidents

Evaluations have shown that incineration is the thermal treatment technology most likely to be important to risk for facility workers and the public. Radiological accident sequences involve severe fires and explosions that produce large airborne releases of the ash present in the incinerator area or in the filtration systems. A generic treatment facility, consisting of a series of linked treatment process modules, is described in Section F.2.6.3. A DOE Hazard Category of 2, concomitant system performance requirements, and double HEPA filtration systems were assumed. For each alternative, each waste treatability category at each site has a unique volumetric inventory and physical, chemical and radiological composition. Each incineration facility was assumed to have 1% of its annual incinerable LLMW throughput at the time of the accident.

Accidents investigated included operation-induced facility fires and explosions, and external-event-induced fires and explosions. Treatment facility accident sequences analyzed include:

- A fire in the baghouse area of the incineration facility dispersing the dry ash in the filters with a damage of 3% of the facility inventory (DF = 3.0E-02) and failing the filtration systems completely (LPF = 1),
- An incinerator explosion resulting from combustible gas buildup that disperses the ash in the rotary kiln with a damage of 12% of facility inventory (DF = 1.2E-01) and partially degrades the filtration system (LPF = 1.0E-03), and
- External events leading to a fire. External-event source term parameters vary according to the particular sequence.

All accidents are assumed to be ground releases without filtration, with the exception of the incinerator explosion where partial HEPA filtration and a stack emission are assumed. The LPF of 1.0E-03 results in the source term that produces the greater worker risk.

Wet-air oxidation was also analyzed because of the high treatment volumes at some of the sites. A rupture with a subsequent violent pressurized and unfiltered release to the atmosphere of the entire vessel contents was postulated as the only plausible sequence capable of producing any measurable consequences to site staff or the public. An earthquake that simultaneously breached the containment building was defined as the most likely initiator. Calculations were specifically performed for a limited set of alternatives and the resulting risk was found to be significantly lower than that for the incineration accidents. As a result, source terms for wet-air oxidation accidents were not used for health effects calculations.

Frequencies of accidents are consistent with those for the LLW analysis. The frequency of 1.5E-02/yr for explosions in the rotary kiln assembly and the secondary combustion chamber, respectively, provide the basis for the internal fire frequencies. The frequencies of aircraft-initiated accidents depend on the site. The annual frequency of a seismic event exceeding the design basis for a Hazard Category 2 facility is 1.0E-03/yr with the conditional probability of rupturing containment and initiating a fire estimated to equal 5.0E-02. Screening calculations of airplane accidents for the LLMW treatment facilities were performed and the risks were found to be much lower than the risk of an earthquake, or negligible. As a result, source terms for airplane accidents were not provided for health effects calculations.

The limiting chemical accident is assumed to be an operational fire in the feedstock staging area, which includes waste in processing and lag storage. The MAR was assumed to be 1% of annual throughput of the incineration facility as established by the WM PEIS alternative. A DF of 1.0E-01 was assumed to account for the presence of noncombustible material and the distribution of the combustible materials in areas other than the feedstock area. Because of the high frequency of internal fires compared with those caused by external events, only the internal, operational fire was analyzed.

F.6.2.4 Disposal Facility Accidents

Disposal accidents were not evaluated because of the lack of details of ultimate disposal. However, except for dedicated centralized repositories such as Yucca Mountain or WIPP, disposal sites would generally lack a concentrated volume of material at risk being stored in a configuration susceptible to phenomena such as fires and explosions capable of causing significant releases. These repositories have accident analyses performed as part of their site-specific EISs. Although seismic events could breach in-ground containers, leading to airborne releases, such events would be bounded by accidents breaching the concentrated volumes of waste being held in a treatment or storage facility. The available safety literature does not

indicate any credible accident sequence in which the risk from airborne releases in a low-level mixed waste disposal facility would be sufficiently significant to rule out a site from consideration and thereby serve as a discriminator among disposal alternatives.

F.6.3 RESULTS

Preliminary results of the radiological accident sequences described above for various site consolidation cases within each WM PEIS alternative were reviewed for risk dominance using the frequency-weighted dose to the MEI, and then grouped into four annual frequency categories: likely ($>1.0E-02$), unlikely (between 1.0E-02 and 1.0E-04), extremely unlikely (between 1.0E-04 and 1.0E-06), and not credible ($<1.0E-06$). Representative source terms for the risk-dominant sequences were then selected as the bases for health effects calculations. Of the treatment technologies, only source terms for incineration facility accidents are provided because they were found to bound other treatment accidents, including wet-air oxidation, which resulted in atmospheric releases much lower than analogous incineration accidents. Chemical accident releases were also calculated.

No radiological source terms were estimated for the representative treatment facility chemical accident because they were determined to be unimportant to overall risk compared with radiological source terms for the reference radiological accident. Specifically, the radionuclide concentrations and dispersibility of the ash in the filter fire are much greater than for the feedstock fire and precludes the need for radiological source term calculations for the latter.

Similarly, no chemical source terms have been produced for the reference radiological accident because of their insignificance compared with the reference chemical accidents. Specifically, the concentrations of toxic chemical released in the incinerator feedstock fire are much higher than they are in the ash dispersed in the reference radiological accidents, precluding the need to calculate chemical source terms for the latter accident.

The waste management LLMW facility accidents analyzed here are summarized in Table F.6-4. Eight cases are considered for WM LLMW alternatives, including Cases 1, 2, 4, 7, 10, 15, 17 and 26. Case 7 (Regionalized 2: 7 sites treat, 6 sites dispose) and 10 (Regionalized 3: 7 sites treat, 1 site disposes) are equivalent with respect to the risk-dominant treatment technologies and the amount of waste at each site; therefore, only Case 7 was analyzed.

Table F.6–4. Summary of WM LLMW Radiological Accidents Analyzed[a]

			Operational Events			External Events		
Function	WM PEIS Alternative[b]	Site	Handling Breaches	Facility Fire	Facility Explosion	Seismic	Large Aircraft	Small Aircraft
Drum Handling	All	Ames	×	--	--	--	--	--
	All	ANL-W	×	--	--	--	--	--
	All	Bettis	×	--	--	--	--	--
	All	BCL	×	--	--	--	--	--
	All	BNL	×	--	--	--	--	--
	All	Charleston	×	--	--	--	--	--
	All	Colonie	×	--	--	--	--	--
	All	ETEC	×	--	--	--	--	--
	All	FEMP	×	--	--	--	--	--
	All	GA	×	--	--	--	--	--
	All	GJPO	×	--	--	--	--	--
	All	Hanford	×	--	--	--	--	--
	All	INEL	×	--	--	--	--	--
	All	ITRI	×	--	--	--	--	--
	All	KAPL-S	×	--	--	--	--	--
	All	KCP	×	--	--	--	--	--
	All	KAPL-K	×	--	--	--	--	--
	All	KAPL-W	×	--	--	--	--	--
	All	LANL	×	--	--	--	--	--
	All	LBL	×	--	--	--	--	--
	All	LEHR	×	--	--	--	--	--
	All	LLNL	×	--	--	--	--	--
	All	Mare Is	×	--	--	--	--	--
	All	Mound	×	--	--	--	--	--
	All	Norfolk	×	--	--	--	--	--
	All	NTS	×	--	--	--	--	--
	All	ORR	×	--	--	--	--	--
	All	PGDP	×	--	--	--	--	--
	All	Pantex	×	--	--	--	--	--
	All	Pearl H	×	--	--	--	--	--
	All	Ports Nav	×	--	--	--	--	--
	All	PORTS	×	--	--	--	--	--
	All	PPPL	×	--	--	--	--	--
	All	Puget So	×	--	--	--	--	--
	All	RFETS	×	--	--	--	--	--
	All	RMI	×	--	--	--	--	--
	All	SNL-NM	×	--	--	--	--	--
	All	SNL-CA	×	--	--	--	--	--
	All	SRS	×	--	--	--	--	--
	All	UofMO	×	--	--	--	--	--
	All	WVDP	×	--	--	--	--	--
Incineration	1	INEL	--	×	×	×	--	--
	1	ORR	--	×	×	×	--	--
	1	SRS	--	×	×	×	--	--
	2	Ames	--	×	×	×	--	--
	2	ANL-E	--	×	×	×	--	--
	2	Bettis	--	×	×	×	--	--
	2	BCL	--	×	×	×	--	--
	2	BNL	--	×	×	×	--	--
	2	Charleston	--	×	×	×	--	--
	2	Colonie	--	×	×	×	--	--
	2	ETEC	--	×	×	×	--	--
	2	FEMP	--	×	×	×	--	--
	2	GA	--	×	×	×	--	--
	2	GJPO	--	×	×	×	--	--
	2	Hanford	--	×	×	×	--	--
	2	INEL	--	×	×	×	--	--
	2	ITRI	--	×	×	×	--	--
	2	KAPL-S	--	×	×	×	--	--
	2	KCP	--	×	×	×	--	--
	2	KAPL-K	--	×	×	×	--	--

Table F.6–4. Summary of WM LLMW Radiological Accidents Analyzed[a]—Continued

Function	WM PEIS Alternative[b]	Site	Operational Events: Handling Breaches	Operational Events: Facility Fire	Operational Events: Facility Explosion	External Events: Seismic	External Events: Large Aircraft	External Events: Small Aircraft
	2	KAPL-W	--	×	×	×	--	--
	2	LANL	--	×	×	×	--	--
	2	LBL	--	×	×	×	--	--
	2	LEHR	--	×	×	×	--	--
	2	LLNL	--	×	×	×	--	--
	2	Mare Is	--	×	×	×	--	--
	2	Norfolk	--	×	×	×	--	--
	2	NTS	--	×	×	×	--	--
	2	ORR	--	×	×	×	--	--
	2	PGDP	--	×	×	×	--	--
	2	Pantex	--	×	×	×	--	--
	2	Pearl H	--	×	×	×	--	--
	2	Ports Nav	--	×	×	×	--	--
	2	PORTS	--	×	×	×	--	--
	2	PPPL	--	×	×	×	--	--
	2	Puget So	--	×	×	×	--	--
	2	RMI	--	×	×	×	--	--
	2	SNL-NM	--	×	×	×	--	--
	2	SRS	--	×	×	×	--	--
	4	ETEC	--	×	×	×	--	--
	4	FEMP	--	×	×	×	--	--
	4	Hanford	--	×	×	×	--	--
	4	INEL	--	×	×	×	--	--
	4	LANL	--	×	×	×	--	--
	4	LLNL	--	×	×	×	--	--
	4	ORNL	--	×	×	×	--	--
	4	PGDP	--	×	×	×	--	--
	4	Pantex	--	×	×	×	--	--
	4	PORTS	--	×	×	×	--	--
	4	RFETS	--	×	×	×	--	--
	4	SRS	--	×	×	×	--	--
	7	Hanford	--	×	×	×	--	--
	7	INEL	--	×	×	×	--	--
	7	LANL	--	×	×	×	--	--
	7	ORNL	--	×	×	×	--	--
	7	PORTS	--	×	×	×	--	--
	7	RFETS	--	×	×	×	--	--
	7	SRS	--	×	×	×	--	--
	15	Hanford	--	×	×	×	--	--
	15	INEL	--	×	×	×	--	--
	15	ORR	--	×	×	×	--	--
	15	SRS	--	×	×	×	--	--
	17	Hanford	--	×	×	×	--	--
	26	Hanford	--	×	×	×	--	--
	26	INEL	--	×	×	×	--	--
	26	ORR	--	×	×	×	--	--
	26	SRS	--	×	×	×	--	--
α-Incineration[c]	2	INEL	--	×	×	×	--	--
	2	LANL	--	×	×	×	--	--
	2	LLNL	--	×	×	×	--	--
	2	RFETS	--	×	×	×	--	--
	2	SRS	--	×	×	×	--	--
	4	INEL	--	×	×	×	--	--
	4	LANL	--	×	×	×	--	--
	4	LLNL	--	×	×	×	--	--
	4	RFETS	--	×	×	×	--	--
	4	SRS	--	×	×	×	--	--
	7	INEL	--	×	×	×	--	--
	7	LANL	--	×	×	×	--	--
	7	RFETS	--	×	×	×	--	--
	7	SRS	--	×	×	×	--	--
	15	INEL	--	×	×	×	--	--
	15	SRS	--	×	×	×	--	--
	17	Hanford	--	×	×	×	--	--
	26	INEL	--	×	×	×	--	--

Footnotes on next page

Table F.6–4. Summary of WM LLMW Radiological Accidents Analyzed[a]—Continued

Notes: -- = not applicable; Ames = Ames Laboratory; Bettis = Bettis Atomic Power Plant; BCL = Battelle Columbus Laboratories; BNL = Brookhaven National Laboratory; Charleston = Charleston Naval Shipyard; GA = General Atomics; GJPO = Grand Junctions Project Office; ITRI = Inhalations Toxicology Research Institute; KAPL-K = Knolls Atomic Power Laboratory (Kesselring); KAPL-S = Knolls Atomic Power Laboratory (Schenectady); KAPL-W = Knolls Atomic Power Laboratory (Windsor); KCP = Kansas City Plant; LBL = Lawrence Berkeley National Laboratory; LEHR = Laboratory for Energy-Related Health Research; Mare Is = Mare Island Naval Shipyard; Mound = Mound Plant; Norfolk = Norfolk Naval Shipyard; Pearl H = Pearl Harbor Naval Shipyard; Ports Nav = Portsmouth Naval Shipyard; PPPL = Princeton Plasma Physics Laboratory; Puget So = Puget Sound Naval Shipyard; RMI = Reactive Metals, Inc.; SNL-NM = Sandia National Laboratories (New Mexico); SNL-CA = Sandia National Laboratories (California); and UofMO = University of Missouri.

[a] Only one source term, generally corresponding to the risk-dominant sequence for each accident initiator, was selected for transmittal to ORR.

[b] The WM PEIS cases analyzed are described as follows:

- *Case 1 (No Action).* Three sites (INEL, ORR, and SRS) treat and store, all remaining sites store.
  Case 2 (Decentralized). Forty-nine sites treat, and 16 sites dispose.
- *Case 4 (Regionalized 1).* Eleven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS) treat, and 12 sites dispose.
- *Case 7 (Regionalized 2).* Seven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, and RFETS) treat, and 6 sites dispose.
- *Case 15 (Regionalized 4).* Four sites (Hanford, INEL, ORR, and SRS) treat, and 6 sites dispose.
- *Case 17 (Centralized).* One site treats (Hanford), and 1 site disposes.
- *Case 26 (Remote-handled).* Four sites (Hanford, INEL, ORR, and SRS) treat and dispose (RH).

[c] α-incineration refers to incineration of waste categorized as alpha-emitting.

The WM PEIS cases analyzed are described as follows:

- Case 1 (No Action). Three sites (INEL, ORR, and SRS) treat and store, all remaining sites store.
- Case 2 (Decentralized). Forty-nine sites treat, and 16 sites dispose.
- Case 4 (Regionalized 1). Eleven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS) treat, and 12 sites dispose.
- Case 7 (Regionalized 2). Seven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, and RFETS) treat, and 6 sites dispose.
- Case 15 (Regionalized 4). Four sites (Hanford, INEL, ORR, and SRS) treat, and 6 sites dispose.
- Case 17 (Centralized). One site treats (Hanford), and 1 site disposes.
- Case 26 (Remote-handled). Four sites (Hanford, INEL, ORR, and SRS) treat and dispose (RH).

Tables F.6–5 through F.6–7 summarize the radiological source term parameters and frequency groups for the accidents. Separate incineration facilities were assumed for treating alpha and nonalpha contaminated waste. Detailed radionuclide releases and chemical source terms for accidents are provided in ANL (1996a).

Table F.6–5. Frequencies and Radiological Source Term Parameters for WM LLMW Drum Handling Accidents

WM PEIS Alternative	Site[a]	Frequency Bin (/yr) >1.0E–02	1.0E–04 to 1.0E–02	1.0E–06 to 1.0E–04	<1.0E–06	Source Term Parameters VMAR (m^3)	MAR (Ci)	DF	Total Release (Ci)
All	Ames	X	--	--	--	2.0E-01	1.1E-03	0.25	2.4E-07
All	ANL-W	X	--	--	--	2.0E-01	7.3E+00	0.25	1.6E-01
All	Bettis	X	--	--	--	2.0E-01	6.1E-01	0.25	3.5E-03
All	BCL	X	--	--	--	2.0E-01	1.1E-03	0.25	5.4E-08
All	BNL	X	--	--	--	2.0E-01	1.5E-01	0.25	2.8E-04
All	Charleston	X	--	--	--	2.0E-01	7.3E+00	0.25	1.5E-01
All	Colonie	X	--	--	--	2.0E-01	1.1E-03	0.25	5.0E-08
All	ETEC	X	--	--	--	2.0E-01	1.5E-01	0.25	3.7E-04
All	FEMP	X	--	--	--	2.0E-01	1.1E-03	0.25	4.5E-07
All	GA	X	--	--	--	2.0E-01	1.1E-03	0.25	2.6E-07
All	GJPO	X	--	--	--	2.0E-01	1.1E-03	0.25	1.8E-06
All	Hanford	X	--	--	--	2.0E-01	6.1E-01	0.25	3.1E-03
All	INEL	X	--	--	--	2.0E-01	3.5E+00	0.25	2.9E-02
All	ITRI	X	--	--	--	2.0E-01	5.5E-01	0.25	1.3E-01
All	KAPL-S	X	--	--	--	2.0E-01	7.0E+00	0.25	8.2E-02
All	KCP	X	--	--	--	2.0E-01	7.3E+00	0.25	1.6E-01
All	KAPL-K	X	--	--	--	2.0E-01	7.0E+00	0.25	7.3E-02
All	KAPL-W	X	--	--	--	2.0E-01	7.1E+00	0.25	1.1E-01
All	LANL	X	--	--	--	2.0E-01	5.4E-01	0.25	1.3E-01
All	LBL	X	--	--	--	2.0E-01	1.3E+01	0.25	3.1E+00
All	LEHR	X	--	--	--	2.0E-01	1.5E-01	0.25	3.2E-04
All	LLNL	X	--	--	--	2.0E-01	1.2E+01	0.25	3.1E+00
All	Mare Is.	X	--	--	--	2.0E-01	7.1E+00	0.25	9.4E-02
All	Mound	X	--	--	--	2.0E-01	1.3E+01	0.25	3.1E+00
All	Norfolk	X	--	--	--	2.0E-01	7.3E+00	0.25	1.6E-01
All	NTS	X	--	--	--	2.0E-01	1.5E-01	0.25	3.0E-04
All	ORR	X	--	--	--	2.0E-01	1.5E-01	0.25	3.0E-04
All	PGDP	X	--	--	--	2.0E-01	3.8E-01	0.25	2.5E-05
All	Pantex	X	--	--	--	2.0E-01	5.3E-01	0.25	1.3E-01
All	Pearl H	X	--	--	--	2.0E-01	7.3E+00	0.25	1.6E-01
All	Ports Nev	X	--	--	--	2.0E-01	7.3E+00	0.25	1.6E-01
All	PORTS	X	--	--	--	2.0E-01	2.8E-04	0.25	6.1E-08
All	PPPL	X	--	--	--	2.0E-01	1.3E+01	0.25	3.1E+00
All	Puget So	X	--	--	--	2.0E-01	7.3E+00	0.25	1.6E-01
All	RFETS	X	--	--	--	2.0E-01	5.2E-03	0.25	1.8E-06
All	RMI	X	--	--	--	2.0E-01	1.1E-03	0.25	3.0E-07

Table F.6–5. Frequencies and Radiological Source Term Parameters for WM LLMW Drum Handling Accidents—Continued

WM PEIS Alternative	Site[a]	Frequency Bin (/yr) >1.0E–02	1.0E–04 to 1.0E–02	1.0E–06 to 1.0E–04	<1.0E–06	Source Term Parameters VMAR (m^3)	MAR (Ci)	DF	Total Release (Ci)
All	SNL-NM	X	--	--	--	2.0E–01	9.6E–01	0.25	1.1E–01
All	SNL-CA	X	--	--	--	2.0E–01	1.3E+01	0.25	3.1E+00
All	SRS	X	--	--	--	2.0E–01	9.2E–01	0.25	1.0E–01
All	UofMO	X	--	--	--	2.0E–01	5.2E–03	0.25	1.3E–06
All	WVDP	X	--	--	--	2.0E–01	6.1E–01	0.25	3.7E–03

Note: -- = not applicable.
[a] See Table F.6–4 footnote for spelled out versions of acronyms.

Table F.6–6. Frequencies and Radiological Source Term Parameters for WM LLMW Non-Alpha Incineration Facility Accidents

WM PEIS Alternative[a]	Site[b]	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E–02	1.0E–04 to 1.0E–02	1.0E–06 to 1.0E–04	<1.0E–06	VMAR (m^3)	MAR (Ci)	DF	RARF[c]	LPF[c]	
1	INEL	Explosion in the rotary kiln	X	—	—	—	6.0E–02	2.1E+00	1.2E–01	1.0E–01	1.0E–03	2.6E–05
1	INEL	Fire in the baghouse area	—	X	—	—	6.0E–02	2.1E+00	3.0E–02	1.0E–02	1.0E+00	6.5E–04
1	INEL	Earthquake followed by fire and explosion	—	—	X	—	6.0E–02	2.1E+00	2.0E–01	1.0E–01	1.0E+00	4.3E–02
1	ORR	Explosion in the rotary kiln	X	—	—	—	1.1E+00	2.2E+00	1.2E–01	1.0E–01	1.0E–03	2.6E–05
1	ORR	Fire in the baghouse area	—	X	—	—	1.1E+00	2.2E+00	3.0E–02	1.0E–02	1.0E+00	6.5E–04
1	ORR	Earthquake followed by fire and explosion	—	—	X	—	1.1E+00	2.2E+00	2.0E–01	1.0E–01	1.0E+00	4.3E–02
1	SRS	Explosion in the rotary kiln	X	—	—	—	1.3E–01	3.0E+00	1.2E–01	1.0E–01	1.0E–03	3.6E–05
1	SRS	Fire in the baghouse area	—	X	—	—	1.3E–01	3.0E+00	3.0E–02	1.0E–02	1.0E+00	9.0E–04
1	SRS	Earthquake followed by fire and explosion	—	—	X	—	1.3E–01	3.0E+00	2.0E–01	1.0E–01	1.0E+00	6.0E–02
2	Ames	Explosion in the rotary kiln	X	—	—	—	3.3E–05	3.5E–07	1.2E–01	1.0E–01	1.0E–03	4.2E–12
2	Ames	Fire in the baghouse area	—	X	—	—	3.3E–05	3.5E–07	3.0E–02	1.0E–02	1.0E+00	1.0E–10
2	Ames	Earthquake followed by fire and explosion	—	—	X	—	3.3E–05	3.5E–07	2.0E–01	1.0E–01	1.0E+00	7.0E–09
2	ANL-E	Explosion in the rotary kiln	X	—	—	—	1.1E–02	1.4E–02	1.2E–01	7.0E–02	1.0E–03	1.1E–07
2	ANL-E	Fire in the baghouse area	—	X	—	—	1.1E–02	1.4E–02	3.0E–02	6.0E–05	1.0E+00	2.4E–08
2	ANL-E	Earthquake followed by fire and explosion	—	—	X	—	1.1E–02	1.4E–02	2.0E–01	7.0E–02	1.0E+00	1.9E–04
2	Bettis	Explosion in the rotary kiln	X	—	—	—	2.5E–04	7.5E–03	1.2E–01	1.0E–01	1.0E–03	8.9E–08
2	Bettis	Fire in the baghouse area	—	X	—	—	2.5E–04	7.5E–03	3.0E–02	1.0E–02	1.0E+00	2.2E–06
2	Bettis	Earthquake followed by fire and explosion	—	—	X	—	2.5E–04	7.5E–03	2.0E–01	1.0E–01	1.0E+00	1.5E–04
2	BCL	Explosion in the rotary kiln	X	—	—	—	6.3E–06	6.4E–08	1.2E–01	1.0E–01	1.0E–03	7.7E–13
2	BCL	Fire in the baghouse area	—	X	—	—	6.3E–06	6.4E–08	3.0E–02	1.0E–02	1.0E+00	1.9E–11
2	BCL	Earthquake followed by fire and explosion	—	—	X	—	6.3E–06	6.4E–08	2.0E–01	1.0E–01	1.0E+00	1.3E–09
2	BNL	Explosion in the rotary kiln	X	—	—	—	1.7E–02	3.3E–02	1.2E–01	1.0E–01	1.0E–03	3.9E–07
2	BNL	Fire in the baghouse area	—	X	—	—	1.7E–02	3.3E–02	3.0E–02	1.0E–02	1.0E+00	9.7E–06
2	BNL	Earthquake followed by fire and explosion	—	—	X	—	1.7E–02	3.3E–02	2.0E–01	1.0E–01	1.0E+00	6.5E–04
2	Charleston	Explosion in the rotary kiln	X	—	—	—	2.1E–04	6.8E–02	1.2E–01	1.0E–01	1.0E–03	8.2E–07
2	Charleston	Fire in the baghouse area	—	X	—	—	2.1E–04	6.8E–02	3.0E–02	1.0E–02	1.0E+00	2.0E–05
2	Charleston	Earthquake followed by fire and explosion	—	—	X	—	2.1E–04	6.8E–02	2.0E–01	1.0E–01	1.0E+00	1.4E–03
2	Colonie	Explosion in the rotary kiln	X	—	—	—	2.4E–04	1.5E–05	1.2E–01	1.0E–01	1.0E–03	1.7E–10
2	Colonie	Fire in the baghouse area	—	X	—	—	2.4E–04	1.5E–05	3.0E–02	1.0E–02	1.0E+00	4.4E–09
2	Colonie	Earthquake followed by fire and explosion	—	—	X	—	2.4E–04	1.5E–05	2.0E–01	1.0E–01	1.0E+00	2.9E–07
2	ETEC	Explosion in the rotary kiln	X	—	—	—	1.6E–01	1.2E–01	1.2E–01	1.0E–01	1.0E–03	1.5E–06
2	ETEC	Fire in the baghouse area	—	X	—	—	1.6E–01	1.2E–01	3.0E–02	1.0E–02	1.0E+00	3.6E–05
2	ETEC	Earthquake followed by fire and explosion	—	—	X	—	1.6E–01	1.2E–01	2.0E–01	1.0E–01	1.0E+00	2.4E–03
2	FEMP	Explosion in the rotary kiln	X	—	—	—	1.6E–01	8.5E–04	1.2E–01	1.0E–01	1.0E–03	1.0E–08
2	FEMP	Fire in the baghouse area	—	X	—	—	1.6E–01	8.5E–04	3.0E–02	1.0E–02	1.0E+00	2.6E–07
2	FEMP	Earthquake followed by fire and explosion	—	—	X	—	1.6E–01	8.5E–04	2.0E–01	1.0E–01	1.0E+00	1.7E–05
2	GA	Explosion in the rotary kiln	X	—	—	—	1.0E–03	5.7E–06	1.2E–01	1.0E–01	1.0E–03	6.8E–11
2	GA	Fire in the baghouse area	—	X	—	—	1.0E–03	5.7E–06	3.0E–02	1.0E–02	1.0E+00	1.7E–09
2	GA	Earthquake followed by fire and explosion	—	—	X	—	1.0E–03	5.7E–06	2.0E–01	1.0E–01	1.0E+00	1.1E–07

Table F.6–6. Frequencies and Radiological Source Term Parameters for WM LLMW Non-Alpha Incineration Facility Accidents—Continued

WM PEIS Alternative[a]	Site[b]	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E–02	1.0E–04 to 1.0E–02	1.0E–06 to 1.0E–04	<1.0E–06	VMAR (m^3)	MAR (Ci)	DF	RARF[c]	LPF[c]	
2	GJPO	Explosion in the rotary kiln	X	--	--	--	6.8E–05	3.3E–07	1.2E–01	1.0E–01	1.0E–03	4.0E–12
2	GJPO	Fire in the baghouse area	--	X	--	--	6.8E–05	3.3E–07	3.0E–02	1.0E–02	1.0E+00	1.0E–10
2	GJPO	Earthquake followed by fire and explosion	--	--	X	--	6.8E–05	3.3E–07	2.0E–01	1.0E–01	1.0E+00	6.7E–09
2	Hanford	Explosion in the rotary kiln	X	--	--	--	1.6E+00	4.3E+00	1.2E–01	1.0E–01	1.0E–03	5.2E–05
2	Hanford	Fire in the baghouse area	--	X	--	--	1.6E+00	4.3E+00	3.0E–02	1.0E–02	1.0E+00	1.3E–03
2	Hanford	Earthquake followed by fire and explosion	--	--	X	--	1.6E+00	4.3E+00	2.0E–01	1.0E–01	1.0E+00	8.6E–02
2	INEL	Explosion in the rotary kiln	X	--	--	--	1.3E–01	4.3E+00	1.2E–01	1.0E–01	1.0E–03	5.1E–05
2	INEL	Fire in the baghouse area	--	X	--	--	1.3E–01	4.3E+00	3.0E–02	1.0E–02	1.0E+00	1.3E–03
2	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.3E–01	4.3E+00	2.0E–01	1.0E–01	1.0E+00	8.6E–02
2	ITRI	Explosion in the rotary kiln	X	--	--	--	8.5E–05	6.5E–05	1.2E–01	1.0E–01	1.0E–03	7.9E–10
2	ITRI	Fire in the baghouse area	--	X	--	--	8.5E–05	6.5E–05	3.0E–02	1.0E–02	1.0E+00	2.0E–08
2	ITRI	Earthquake followed by fire and explosion	--	--	X	--	8.5E–05	6.5E–05	2.0E–01	1.0E–01	1.0E+00	1.3E–06
2	KAPL–S	Explosion in the rotary kiln	X	--	--	--	2.3E–03	3.1E–01	1.2E–01	1.0E–01	1.0E–03	3.7E–06
2	KAPL–S	Fire in the baghouse area	--	X	--	--	2.3E–03	3.1E–01	3.0E–02	1.0E–02	1.0E+00	9.2E–05
2	KAPL–S	Earthquake followed by fire and explosion	--	--	X	--	2.3E–03	3.1E–01	2.0E–01	1.0E–01	1.0E+00	6.1E–03
2	KCP	Explosion in the rotary kiln	X	--	--	--	9.0E–05	1.2E–02	1.2E–01	1.0E–01	1.0E–03	1.4E–07
2	KCP	Fire in the baghouse area	--	X	--	--	9.0E–05	1.2E–02	3.0E–02	1.0E–02	1.0E+00	3.6E–06
2	KCP	Earthquake followed by fire and explosion	--	--	X	--	9.0E–05	1.2E–02	2.0E–01	1.0E–01	1.0E+00	2.4E–04
2	KAPL–K	Explosion in the rotary kiln	X	--	--	--	6.6E–03	2.0E–01	1.2E–01	1.0E–01	1.0E–03	2.4E–06
2	KAPL–K	Fire in the baghouse area	--	X	--	--	6.6E–03	2.0E–01	3.0E–02	1.0E–02	1.0E+00	6.0E–05
2	KAPL–K	Earthquake followed by fire and explosion	--	--	X	--	6.6E–03	2.0E–01	2.0E–01	1.0E–01	1.0E+00	4.0E–03
2	KAPL–W	Explosion in the rotary kiln	X	--	--	--	1.0E–03	1.3E–01	1.2E–01	1.0E–01	1.0E–03	1.6E–06
2	KAPL–W	Fire in the baghouse area	--	X	--	--	1.0E–03	1.3E–01	3.0E–02	1.0E–02	1.0E+00	4.0E–05
2	KAPL–W	Earthquake followed by fire and explosion	--	--	X	--	1.0E–03	1.3E–01	2.0E–01	1.0E–01	1.0E+00	2.7E–03
2	LANL	Explosion in the rotary kiln	X	--	--	--	5.9E–03	4.5E–03	1.2E–01	1.0E–01	1.0E–03	5.4E–08
2	LANL	Fire in the baghouse area	--	X	--	--	5.9E–03	4.5E–03	3.0E–02	1.0E–02	1.0E+00	1.4E–06
2	LANL	Earthquake followed by fire and explosion	--	--	X	--	4.5E–03	4.6E–02	2.0E–01	1.0E–01	1.0E+00	9.1E–04
2	NTS	Explosion in the rotary kiln	X	--	--	--	1.4E+00	1.1E+00	1.2E–01	7.0E–02	1.0E–03	9.1E–06
2	NTS	Fire in the baghouse area	--	X	--	--	1.4E+00	1.1E+00	3.0E–02	6.0E–05	1.0E+00	1.9E–06
2	NTS	Earthquake followed by fire and explosion	--	--	X	--	1.4E+00	1.1E+00	2.0E–01	7.0E–02	1.0E+00	1.5E–02
4	LLNL	Explosion in the rotary kiln	X	--	--	--	4.1E–03	4.7E–01	1.2E–01	1.0E–01	1.0E–03	5.7E–06
4	LLNL	Fire in the baghouse area	--	X	--	--	4.1E–03	4.7E–01	3.0E–02	1.0E–02	1.0E+00	1.4E–04
4	LLNL	Earthquake followed by fire and explosion	--	--	X	--	4.1E–03	4.7E–01	2.0E–01	1.0E–01	1.0E+00	9.5E–03
4	ORR	Explosion in the rotary kiln	X	--	--	--	2.2E+00	4.3E+00	1.2E–01	1.0E–01	1.0E–03	5.1E–05
4	ORR	Fire in the baghouse area	--	X	--	--	2.2E+00	4.3E+00	3.0E–02	1.0E–02	1.0E+00	1.3E–03
4	ORR	Earthquake followed by fire and explosion	--	--	X	--	2.2E+00	4.3E+00	2.0E–01	1.0E–01	1.0E+00	8.6E–02

Table F.6–6. Frequencies and Radiological Source Term Parameters for WM LLMW Non-Alpha Incineration Facility Accidents—Continued

WM PEIS Alternative[a]	Site[b]	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E–02	1.0E–04 to 1.0E–02	1.0E–06 to 1.0E–04	<1.0E–06	VMAR (m^3)	MAR (Ci)	DF	RARF[c]	LPF[c]	
4	PGDP	Explosion in the rotary kiln	X	—	—	—	1.3E-02	2.3E-01	1.2E-01	1.0E-01	1.0E-03	2.7E-06
4	PGDP	Fire in the baghouse area	—	X	—	—	1.3E-02	2.3E-01	3.0E-02	1.0E-02	1.0E+00	6.9E-05
4	PGDP	Earthquake followed by fire and explosion	—	—	X	—	1.3E-02	2.3E-01	2.0E-01	1.0E-01	1.0E+00	4.6E-03
4	Pantex	Explosion in the rotary kiln	X	—	—	—	8.3E-02	3.4E-02	1.2E-01	1.0E-01	1.0E-03	4.1E-07
4	Pantex	Fire in the baghouse area	—	X	—	—	8.3E-02	3.4E-02	3.0E-02	1.0E-02	1.0E+00	1.0E-05
4	Pantex	Earthquake followed by fire and explosion	—	—	X	—	8.3E-02	3.4E-02	2.0E-01	1.0E-01	1.0E+00	6.9E-04
4	PORTS	Explosion in the rotary kiln	X	—	—	—	7.3E-02	4.9E-01	1.2E-01	1.0E-01	1.0E-03	5.8E-06
4	PORTS	Fire in the baghouse area	—	X	—	—	7.3E-02	4.9E-01	3.0E-02	1.0E-02	1.0E+00	1.5E-04
4	PORTS	Earthquake followed by fire and explosion	—	—	X	—	7.3E-02	4.9E-01	2.0E-01	1.0E-01	1.0E+00	9.7E-03
4	RFETS	Explosion in the rotary kiln	X	—	—	—	6.8E-05	3.3E-07	1.2E-01	1.0E-01	1.0E-03	4.0E-12
4	RFETS	Fire in the baghouse area	—	X	—	—	6.8E-05	3.3E-07	3.0E-02	1.0E-02	1.0E+00	1.0E-10
4	RFETS	Earthquake followed by fire and explosion	—	—	X	—	6.8E-05	3.3E-07	2.0E-01	1.0E-01	1.0E+00	6.7E-09
4	SRS	Explosion in the rotary kiln	X	—	—	—	2.5E-01	6.0E+00	1.2E-01	1.0E-01	1.0E-03	7.2E-05
4	SRS	Fire in the baghouse area	—	X	—	—	2.5E-01	6.0E+00	3.0E-02	1.0E-02	1.0E+00	1.8E-03
4	SRS	Earthquake followed by fire and explosion	—	—	X	—	2.5E-01	6.0E+00	2.0E-01	1.0E-01	1.0E+00	1.2E-01
7	Hanford	Explosion in the rotary kiln	X	—	—	—	1.6E+00	4.3E+00	1.2E-01	1.0E-01	1.0E-03	5.2E-05
7	Hanford	Fire in the baghouse area	—	X	—	—	1.6E+00	4.3E+00	3.0E-02	1.0E-02	1.0E+00	1.3E-03
7	Hanford	Earthquake followed by fire and explosion	—	—	X	—	1.6E+00	4.3E+00	2.0E-01	1.0E-01	1.0E+00	8.6E-02
7	INEL	Explosion in the rotary kiln	X	—	—	—	1.3E-01	4.3E+00	1.2E-01	1.0E-01	1.0E-03	5.1E-05
7	INEL	Fire in the baghouse area	—	X	—	—	1.3E-01	4.3E+00	3.0E-02	1.0E-02	1.0E+00	1.3E-03
7	INEL	Earthquake followed by fire and explosion	—	—	X	—	1.3E-01	4.3E+00	2.0E-01	1.0E-01	1.0E+00	8.6E-02
7	LANL	Explosion in the rotary kiln	X	—	—	—	8.7E-02	8.0E-02	1.2E-01	1.0E-01	1.0E-03	9.6E-07
7	LANL	Fire in the baghouse area	—	X	—	—	8.7E-02	8.0E-02	3.0E-02	1.0E-02	1.0E+00	2.4E-05
7	LANL	Earthquake followed by fire and explosion	—	—	X	—	8.7E-02	8.0E-02	2.0E-01	1.0E-01	1.0E+00	1.6E-03
7	ORR	Explosion in the rotary kiln	X	—	—	—	3.4E-01	2.5E+00	1.2E-01	1.0E-01	1.0E-03	3.0E-05
7	ORR	Fire in the baghouse area	—	X	—	—	3.4E-01	2.5E+00	3.0E-02	1.0E-02	1.0E+00	7.4E-04
7	ORR	Earthquake followed by fire and explosion	—	—	X	—	3.4E-01	2.5E+00	2.0E-01	1.0E-01	1.0E+00	4.9E-02
7	PORTS	Explosion in the rotary kiln	X	—	—	—	8.2E-01	8.6E-01	1.2E-01	1.0E-01	1.0E-03	1.0E-05
7	PORTS	Fire in the baghouse area	—	X	—	—	8.2E-01	8.6E-01	3.0E-02	1.0E-02	1.0E+00	2.6E-04
7	PORTS	Earthquake followed by fire and explosion	—	—	X	—	8.2E-01	8.6E-01	2.0E-01	1.0E-01	1.0E+00	1.7E-02
7	RFETS	Explosion in the rotary kiln	X	—	—	—	9.0E-05	1.2E-02	1.2E-01	1.0E-01	1.0E-03	1.4E-07
7	RFETS	Fire in the baghouse area	—	X	—	—	9.0E-05	1.2E-02	3.0E-02	1.0E-02	1.0E+00	3.6E-06
7	RFETS	Earthquake followed by fire and explosion	—	—	X	—	9.0E-05	1.2E-02	2.0E-01	1.0E-01	1.0E+00	2.4E-04
7	SRS	Explosion in the rotary kiln	X	—	—	—	2.5E-01	6.0E+00	1.2E-01	1.0E-01	1.0E-03	7.2E-05
7	SRS	Fire in the baghouse area	—	X	—	—	2.5E-01	6.0E+00	3.0E-02	1.0E-02	1.0E+00	1.8E-03
7	SRS	Earthquake followed by fire and explosion	—	—	X	—	2.5E-01	6.0E+00	2.0E-01	1.0E-01	1.0E+00	1.2E-01

Table F.6-6. Frequencies and Radiological Source Term Parameters for WM LLMW Non-Alpha Incineration Facility Accidents—Continued

WM PEIS Alternative[a]	Site[b]	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E-02	1.0E-04 to 1.0E-02	1.0E-06 to 1.0E-04	<1.0E-06	VMAR (m^3)	MAR (Ci)	DF	RARF[c]	LPF[c]	
15	Hanford	Explosion in the rotary kiln	X	--	--	--	1.6E+00	4.3E+00	1.2E-01	1.0E-01	1.0E-03	5.2E-05
15	Hanford	Fire in the baghouse area	--	X	--	--	1.6E+00	4.3E+00	3.0E-02	1.0E-02	1.0E+00	1.3E-03
15	Hanford	Earthquake followed by fire and explosion	--	--	X	--	1.6E+00	4.3E+00	2.0E-01	1.0E-01	1.0E+00	8.6E-02
15	INEL	Explosion in the rotary kiln	X	--	--	--	1.4E-01	4.3E+00	1.2E-01	1.0E-01	1.0E-03	5.1E-05
15	INEL	Fire in the baghouse area	--	X	--	--	1.4E-01	4.3E+00	3.0E-02	1.0E-02	1.0E+00	1.2E-03
15	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.4E-01	4.3E+00	2.0E-01	1.0E-01	1.0E+00	8.6E-02
15	ORR	Explosion in the rotary kiln	X	--	--	--	2.7E+00	4.7E+00	1.2E-01	1.0E-01	1.0E-03	5.7E-05
15	ORR	Fire in the baghouse area	--	X	--	--	2.7E+00	4.7E+00	3.0E-02	1.0E-02	1.0E+00	1.4E-03
15	ORR	Earthquake followed by fire and explosion	--	--	X	--	2.7E+00	4.7E+00	2.0E-01	1.0E-01	1.0E+00	9.5E-02
15	SRS	Explosion in the rotary kiln	X	--	--	--	2.5E-01	6.0E+00	1.2E-01	1.0E-01	1.0E-03	7.2E-05
15	SRS	Fire in the baghouse area	--	X	--	--	2.5E-01	6.0E+00	3.0E-02	1.0E-02	1.0E+00	1.8E-03
15	SRS	Earthquake followed by fire and explosion	--	--	X	--	2.5E-01	6.0E+00	2.0E-01	1.0E-01	1.0E+00	1.2E-01
17	Hanford	Explosion in the rotary kiln	X	--	--	--	3.5E+00	1.0E+01	1.2E-01	1.0E-01	1.0E-03	1.2E-04
17	Hanford	Fire in the baghouse area	--	X	--	--	3.5E+00	1.0E+01	3.0E-02	1.0E-02	1.0E+00	3.1E-03
17	Hanford	Earthquake followed by fire and explosion	--	--	X	--	3.5E+00	1.0E+01	2.0E-01	1.0E-01	1.0E+00	2.1E-01
26	Hanford	Explosion in the rotary kiln	X	--	--	--	6.5E-05	9.9E-03	1.2E-01	1.0E-01	1.0E-03	1.2E-07
26	Hanford	Fire in the baghouse area	--	X	--	--	6.5E-05	9.9E-03	3.0E-02	1.0E-02	1.0E+00	3.0E-06
26	Hanford	Earthquake followed by fire and explosion	--	--	X	--	6.5E-05	9.9E-03	2.0E-01	1.0E-01	1.0E+00	2.0E-04
26	INEL	Explosion in the rotary kiln	X	--	--	--	1.9E-01	1.8E+01	1.2E-01	1.0E-01	1.0E-03	2.2E-04
26	INEL	Fire in the baghouse area	--	X	--	--	1.9E-01	1.8E+01	3.0E-02	1.0E-02	1.0E+00	5.5E-03
26	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.9E-01	1.8E+01	2.0E-01	1.0E-01	1.0E+00	3.7E-01
26	ORR	Explosion in the rotary kiln	X	--	--	--	1.1E-02	3.0E+00	1.2E-01	1.0E-01	1.0E-03	3.6E-05
26	ORR	Fire in the baghouse area	--	X	--	--	1.1E-02	3.0E+00	3.0E-02	1.0E-02	1.0E+00	9.1E-04
26	ORR	Earthquake followed by fire and explosion	--	--	X	--	1.1E-02	3.0E+00	2.0E-01	1.0E-01	1.0E+00	6.1E-02
26	SRS	Explosion in the rotary kiln	X	--	--	--	7.8E-04	8.3E-02	1.2E-01	1.0E-01	3.0E-03	1.0E-06
26	SRS	Fire in the baghouse area	--	X	--	--	7.8E-04	8.3E-02	3.0E-02	1.0E-02	1.0E+00	2.5E-05
26	SRS	Earthquake followed by fire and explosion	--	--	X	--	7.8E-04	8.3E-02	2.0E-01	1.0E-01	1.0E+00	1.7E-03

Note: -- = not applicable.

[a] The WM PEIS cases analyzed are described as follows:

- *Case 1 (No Action).* Three sites (INEL, ORR, and SRS) treat and store, all remaining sites store.
- *Case 2 (Decentralized).* Forty-nine sites treat, and 16 sites dispose.
- *Case 4 (Regionalized 1).* Eleven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS) treat, and 12 sites dispose.
- *Case 7 (Regionalized 2).* Seven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, and RFETS) treat, and 6 sites dispose.
- *Case 15 (Regionalized 4).* Four sites (Hanford, INEL, ORR, and SRS) treat, and 6 sites dispose.
- *Case 17 (Centralized).* One site treats (Hanford), and 1 site disposes.
- *Case 26 (Remote-handled).* Four sites (Hanford, INEL, ORR, and SRS) treat and dispose (RH) and dispose.

[b] Values shown are for (nonvolatile) solids such as U-235 or Pu-238; see Appendix D.

[c] See Table F.6-4 for facility acronyms.

Table F.6–7. Frequencies and Radiological Source Term Parameters for WM LLMW Alpha Incineration Facility Accidents

WM PEIS Alternative[a]	Site[b]	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E–02	1.0E–04 to 1.0E–02	1.0E–06 to 1.0E–04	<1.0E–06	VMAR (m^3)	MAR (Ci)	DF	RARF[c]	LPF[c]	
2	INEL	Explosion in the rotary kiln	X	--	--	--	1.5E-01	9.3E+00	1.2E-01	1.0E-01	1.0E-03	1.1E-04
2	INEL	Fire in the baghouse area	--	X	--	--	1.5E-01	9.3E+00	3.0E-02	1.0E-02	1.0E+00	2.8E-03
2	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.5E-01	9.3E+00	2.0E-01	1.0E-01	1.0E+00	1.9E-01
2	LANL	Explosion in the rotary kiln	X	--	--	--	2.9E-02	4.0E-02	1.2E-01	1.0E-01	1.0E-03	4.8E-07
2	LANL	Fire in the baghouse area	--	X	--	--	2.9E-02	4.0E-02	3.0E-02	1.0E-02	1.0E+00	1.2E-05
2	LANL	Earthquake followed by fire and explosion	--	--	X	--	2.9E-02	4.0E-02	2.0E-01	1.0E-01	1.0E+00	8.1E-04
2	LLNL	Explosion in the rotary kiln	X	--	--	--	2.0E-02	1.7E-02	1.2E-01	1.0E-01	1.0E-03	2.0E-07
2	LLNL	Fire in the baghouse area	--	X	--	--	2.0E-02	1.7E-02	3.0E-02	1.0E-02	1.0E+00	5.0E-06
2	LLNL	Earthquake followed by fire and explosion	--	--	X	--	2.0E-02	1.7E-02	2.0E-01	1.0E-01	1.0E+00	3.4E-04
2	RFETS	Explosion in the rotary kiln	X	--	--	--	1.6E-01	1.4E-02	1.2E-01	1.0E-01	1.0E-03	1.7E-07
2	RFETS	Fire in the baghouse area	--	X	--	--	1.6E-01	1.4E-02	3.0E-02	1.0E-02	1.0E+00	4.2E-06
2	RFETS	Earthquake followed by fire and explosion	--	--	X	--	1.6E-01	1.4E-02	2.0E-01	1.0E-01	1.0E+00	2.8E-04
2	SRS	Explosion in the rotary kiln	X	--	--	--	2.1E-01	4.8E-01	1.2E-01	1.0E-01	1.0E-03	5.7E-06
2	SRS	Fire in the baghouse area	--	X	--	--	2.1E-01	4.8E-01	3.0E-02	1.0E-02	1.0E+00	1.4E-04
2	SRS	Earthquake followed by fire and explosion	--	--	X	--	2.1E-01	4.8E-01	2.0E-01	1.0E-01	1.0E+00	9.5E-03
4	INEL	Explosion in the rotary kiln	X	--	--	--	1.5E-01	9.3E+00	1.2E-01	1.0E-01	1.0E-03	1.1E-04
4	INEL	Fire in the baghouse area	--	X	--	--	1.5E-01	9.3E+00	3.0E-02	1.0E-02	1.0E+00	2.8E-03
4	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.5E-01	9.3E+00	2.0E-01	1.0E-01	1.0E+00	1.9E-01
4	LANL	Explosion in the rotary kiln	X	--	--	--	2.9E-02	4.0E-02	1.2E-01	1.0E-01	1.0E-03	4.8E-07
4	LANL	Fire in the baghouse area	--	X	--	--	2.9E-02	4.0E-02	3.0E-02	1.0E-02	1.0E+00	1.2E-05
4	LANL	Earthquake followed by fire and explosion	--	--	X	--	2.9E-02	4.0E-02	2.0E-01	1.0E-01	1.0E+00	8.1E-04
4	LLNL	Explosion in the rotary kiln	X	--	--	--	2.0E-02	1.7E-02	1.2E-01	1.0E-01	1.0E-03	2.0E-07
4	LLNL	Fire in the baghouse area	--	X	--	--	2.0E-02	1.7E-02	3.0E-02	1.0E-02	1.0E+00	5.0E-06
4	LLNL	Earthquake followed by fire and explosion	--	--	X	--	2.0E-02	1.7E-02	2.0E-01	1.0E-01	1.0E+00	3.4E-04
4	RFETS	Explosion in the rotary kiln	X	--	--	--	1.6E-01	1.4E-02	1.2E-01	1.0E-01	1.0E-03	1.7E-07
4	RFETS	Fire in the baghouse area	--	X	--	--	1.6E-01	1.4E-02	3.0E-02	1.0E-02	1.0E+00	4.2E-06
4	RFETS	Earthquake followed by fire and explosion	--	--	X	--	1.6E-01	1.4E-02	2.0E-01	1.0E-01	1.0E+00	2.8E-04
4	SRS	Incineration ash explosion	X	--	--	--	2.1E-01	4.8E-01	1.2E-01	1.0E-01	1.0E-03	5.7E-06
4	SRS	Fire in the baghouse area	--	X	--	--	2.1E-01	4.8E-01	3.0E-02	1.0E-02	1.0E+00	1.4E-04
4	SRS	Earthquake followed by fire and explosion	--	--	X	--	2.1E-01	4.8E-01	2.0E-01	1.0E-01	1.0E+00	9.5E-03
7	INEL	Explosion in the rotary kiln	X	--	--	--	1.5E-01	9.3E+00	1.2E-01	1.0E-01	1.0E-03	1.1E-04
7	INEL	Fire in the baghouse area	--	X	--	--	1.5E-01	9.3E+00	3.0E-02	1.0E-02	1.0E+00	2.8E-03
7	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.5E-01	9.3E+00	2.0E-01	1.0E-01	1.0E+00	1.9E-01

Table F.6–7. Frequencies and Radiological Source Term Parameters for WM LLMW Alpha Incineration Facility Accidents—Continued

WM PEIS Alternative[a]	Site[b]	Accident	Frequency Bin (/yr)				Source Term Parameters					Total Release (Ci)
			>1.0E–02	1.0E–04 to 1.0E–02	1.0E–06 to 1.0E–04	<1.0E–06	VMAR (m^3)	MAR (Ci)	DF	RARF[c]	LPF[c]	
7	LANL	Explosion in the rotary kiln	X	--	--	--	2.9E-02	4.0E-02	1.2E-01	1.0E-01	1.0E-03	4.8E-07
7	LANL	Fire in the baghouse area	--	X	--	--	2.9E-02	4.0E-02	3.0E-02	1.0E-02	1.0E+00	1.2E-05
7	LANL	Earthquake followed by fire and explosion	--	--	X	--	2.9E-02	4.0E-02	2.0E-01	1.0E-01	1.0E+00	8.1E-04
7	RFETS	Fire in the baghouse area	--	X	--	--	1.6E-01	1.4E-02	3.0E-02	1.0E-02	1.0E+00	4.2E-06
7	RFETS	Earthquake followed by fire and explosion	--	--	X	--	1.6E-01	1.4E-02	2.0E-01	1.0E-01	1.0E+00	2.8E-04
7	SRS	Explosion in the rotary kiln	X	--	--	--	2.1E-01	4.8E-01	1.2E-01	1.0E-01	1.0E-03	5.7E-06
7	SRS	Fire in the baghouse area	--	X	--	--	2.1E-01	4.8E-01	3.0E-02	1.0E-02	1.0E+00	1.4E-04
7	SRS	Earthquake followed by fire and explosion	--	--	X	--	2.1E-01	4.8E-01	2.0E-01	1.0E-01	1.0E+00	9.5E-03
15	INEL	Explosion in the rotary kiln	X	--	--	--	1.5E-01	9.3E+00	1.2E-01	1.0E-01	1.0E-03	1.1E-04
15	INEL	Fire in the baghouse area	--	X	--	--	1.5E-01	9.3E+00	3.0E-02	1.0E-02	1.0E+00	2.8E-03
15	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.5E-01	9.3E+00	2.0E-01	1.0E-01	1.0E+00	1.9E-01
15	SRS	Explosion in the rotary kiln	X	--	--	--	2.1E-01	4.8E-01	1.2E-01	1.0E-01	1.0E-03	5.7E-06
15	SRS	Fire in the baghouse area	--	X	--	--	2.1E-01	4.8E-01	3.0E-02	1.0E-02	1.0E+00	1.4E-04
15	SRS	Earthquake followed by fire and explosion	--	--	X	--	2.1E-01	4.8E-01	2.0E-01	1.0E-01	1.0E+00	9.5E-03
17	Hanford	Explosion in the rotary kiln	X	--	--	--	1.6E-01	1.4E-02	1.2E-01	1.0E-01	1.0E-03	1.7E-07
17	Hanford	Fire in the baghouse area	--	X	--	--	1.6E-01	1.4E-02	3.0E-02	1.0E-02	1.0E+00	4.3E-06
17	Hanford	Earthquake followed by fire and explosion	--	--	X	--	1.6E-01	1.4E-02	2.0E-01	1.0E-01	1.0E+00	2.8E-04
26	INEL	Explosion in the rotary kiln	X	--	--	--	1.4E-04	1.5E-02	1.2E-01	1.0E-01	1.0E-03	1.8E-07
26	INEL	Fire in the baghouse area	--	X	--	--	1.4E-04	1.5E-02	3.0E-02	1.0E-02	1.0E+00	4.4E-06
26	INEL	Earthquake followed by fire and explosion	--	--	X	--	1.4E-04	1.5E-02	2.0E-01	1.0E-01	1.0E+00	2.9E-04

[a] The WM PEIS cases analyzed are described as follows:
- *Case 1 (No Action).* Three sites (INEL, ORR, and SRS) treat and store, all remaining sites store.
- *Case 2 (Decentralized).* Forty-nine sites treat, and 16 sites dispose.
- *Case 4 (Regionalized 1).* Eleven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, PGDP, FEMP, LLNL, Pantex, and RFETS) treat, and 12 sites dispose.
- *Case 7 (Regionalized 2).* Seven sites (Hanford, INEL, LANL, ORR, SRS, PORTS, and RFETS) treat, and 6 sites dispose.
- *Case 15 (Regionalized 4).* Four sites (Hanford, INEL, ORR, and SRS) treat, and 6 sites dispose.
- *Case 17 (Centralized).* One site treats (Hanford), and 1 site disposes.
- *Case 26 (Remote-handled).* Four sites (Hanford, INEL, ORR, and SRS) treat and dispose (RH) and dispose

[b] See Table F.6–4 for determination of facility acronyms.

[c] Values shown are for particulate (nonvolatile) solids such as U-235 or Pu-238; see Appendix D.

F.7 Hazardous Waste

F.7.1 Alternatives and Sites Analyzed

The WM alternatives considered in the WM PEIS are summarized in Table F.7-1. The associated waste treatment categories are described in Table F.7-2. Calculational source term results for these alternatives are discussed herein.

A single site centralized alternative for the management of HW was not evaluated in the WM PEIS because the associated cost and risk, regulatory constraints, and practical considerations of attempting to manage all the diverse DOE waste classified as hazardous.

F.7.2 Risk-Dominant Accidents and Modeling Assumptions

The analysis herein develops distinct risk-dominant accident sequences and associated source terms for handling accidents, storage facility accidents, and treatment facility accidents. Accident scenarios involving chemical wastes that can (a) produce potentially life-threatening health effects and (b) have the potential for adverse health effects, were selected. Potential for adverse effects excluded carcinogenesis. Developing a category for carcinogenic effects alone would lead to accidents of negligible consequences, considering the specific chemicals present in the storage facilities. Consequently, only two categories of accidents were analyzed. The HW constituents of concern were chosen from the DOT list of poison inhalation hazards (PIHs) and from toxicological analyses for the determination of chemical wastes representative of potentially life-threatening health effects (Hartmann et al., 1994). Eleven sites that accept over 90% of the HW from the DOE complex were selected as representative of the DOE sites. Inventory data for the selected sites were taken from 1992 DOE HW shipment records. Because information on chemical concentrations is usually not given in HW inventory data, concentrations in industrial-grade products were assumed when modeling the source term from a release.

Table F.7-1. Hazardous Waste Alternatives

Alternative	Treat	ANL-E	FERMI	Hanford	INEL	KCP	LANL	LLNL	ORR	Pantex	SNL-NM	SRS
No Action	2				T				T			
Decentralized	3						T		T			T
Regionalized 1	5			T	T		T		T			T
Regionalized 2	2				T				T			

Note: T=Treatment. Blanks indicate that a site does not treat HW under the specified alternative.

Accidents were divided into three general categories, each having subcategories and including potentially life-threatening and any-adverse-effects end points:

- Spills resulting in partial vaporization of the waste ("pill only")
- Spills followed by ignition of the waste ("spill plus fire")
- "Other event combinations," which include
  - Spills followed by ignition of the waste and an induced explosion in a waste container ("spill plus fire plus explosion")
  - Facility fires resulting in a waste container breach ("fire only")
  - Mechanical failure of a compressed gas container resulting in an explosion ("spill and explosion")
  - Explosion from exposure of reactive material to air followed by fire ("fire and explosion")

Table F.7-3 lists the representative accidents chosen to serve as surrogates for all risk-dominant sequences and also lists associated mass of spill, release rate to the atmosphere, and annual frequency. Thirteen accidents involve the release of potentially life-threatening toxic gases. Five accidents (1e through 1g and 2e through 2f) involve the release of materials not considered potentially life-threatening but are analyzed for possible adverse effects. The development of the analysis is for these accidents took into account the following:

- The location proximity of classes of chemicals to each other in the storage facilities
- The typical designs of the storage facilities and the required separation of such groups of chemicals as flammable liquids, acids, caustics, combustibles, oxidizers, etc.
- The 90-day residence limit for RCRA HW in a storage facility, as it affects the MAR

Table F.7-2. Generic HW Treatment Categories and Descriptions

Treatment Capability	Abbreviation	Description
Organic destruction	ORDST	Destruction of organic liquids and solids by a broad spectrum of thermal and nonthermal technologies. Examples include incineration, vitrification, plasma hearth, molten metal, chemical oxidation, electron beam, and silent discharge plasma. Some of these technologies also apply to the STABL and METRC categories.
Aqueous liquids (wastewater treatment for organics)	WWTOR	Treatment technologies for oxidation of organics contained in predominantly aqueous media. Examples include wet oxidation, catalyzed wet oxidation, and supercritical water oxidation.
Metal removal	METRM	Metal ion and particulate removal from liquids by settling, filtration, precipitation, ion exchange, carbon adsorption, etc.
Stabilization	STABL	All immobilization and microencapsulation technologies (for example, cementation, vitrification, polymer encapsulation).
Metal recovery	METRC	Methods for separation and collection of metals from waste streams for reuse. Examples include sorting, melting, and decontamination.
Mercury separation	HGSEP	All Hg separation, collection, and immobilization methods. Examples include gravitational, thermal, and chemical techniques to separate Hg for recycling or for immobilization by amalgamation.
Decontamination	DECON	Extractive, mechanical, hydraulic, thermal, and electrochemical techniques used to remove contaminants from substrate materials.
Neutralization	NEUTR	Acid or base additions to neutralize waste streams.
Deactivation	DEACT	Appropriate technologies to deactivate reactive materials (such as sodium or uranium metal) or cyanides before disposal.

Table F.7-3. Airborne Release Assumptions for Representative HW Accidents

Scenario	Toxic Gas Released	Mass of Waste Spilled (lb)	Release Rate Functional Form (lb/min)	Annual Frequency (per Container-Handling[a] Operation)	Concentration Limit[b] PAEC Value	Concentration Limit[b] PLC Value
Spill						
(1a) Alkaline waste spill (i.e., NH_4OH) releasing moderately toxic by-products	NH_3	210 lb of 28% NH_4OH (59 lb)	0-10 min: 3 lb/min; 10-150 min: $3e^{-k_1(t-10)}$, c	2.0E-04	24.5	560
(1b) Acid waste spill (i.e., HCl) releasing moderately toxic vapor	HCl	450 lb of 37% HCl (166 lb)	0-10 min: 2 lb/min; 10-600 min: $2e^{-k_2(t-10)}$	2.0E-04	0.8	100
(1c) Acid waste spill (i.e., HF) releasing highly toxic vapor	HF	30 lb of 50% HF (15 lb)	0-10 min: 2 lb/min; 10-600 min: $2e^{-k_3(t-10)}$	2.0E-04	1	24
(1d) Fuming acid waste spill (i.e., HNO_3) releasing moderately toxic by-products	NO_x	30 lb of 70% HNO_3 (21 lb)	0-10 min: 1 lb/min; 10-100 min: $1e^{-k_4(t-10)}$	2.0E-04	0.41	350
(1e) Acid waste spill (i.e., $C_2H_4O_2$) releasing mildly toxic vapor	$C_2H_4O_2$	30 lb of 100% C_2H_4O2	0-10 min: 0.3 lb/min; 10-900 min: $0.3e^{-k_6(t-10)}$	2.0E-04	15	NA[d]
(1f) Volatile liquid spill (i.e., CS_2) releasing toxic vapor	CS_2	18 lb of 100% CS_2	0-3 min: 0.5 lb/min; 3-60 min: $0.5e^{-k_7(t-10)}$	2.0E-04	0.55	NA
(1g) Liquid spill (i.e., 1,1,1-trichloroethane) releasing mildly toxic vapor	1,1,1-trichloroethane	100 lb of 100% 1,1,1-trichloroethane	0-10 min: 40 lb/min	2.0E-04	31.2	NA
Spill Plus Fire[c]						
(2a) Spill of aromatic hydrocarbon (i.e., BTX) results in burning pool; polyaromatic hydrocarbon (PAH) soot and unburnt hydrocarbon (HC) become airborne	PAH soot and unburnt HC	250 lb of benzene (12% raw, 40% soot, and 48% Co_x)	0-120 min: 2.1 lb/min	2.0E-05	18.0	3,000
(2b) Spill of flammable liquid (e.g., toluene/acetone), which ignites (with help of $CaCl_2O_2$), and fire spreads to HF container	HF	10 lb of 50% HF (5 lb)	0-1 min: 5 lb/min (puff)	2.0E-05 probability of HF present	1	24
(2c) Spills and ignition of flammable liquid, engulfing nearby H_2SO_4, KCN, and NaCN containers, releasing only toxic HCN fumes	HCN	40 lb of organic solvents; 20 lb of H_2SO_4; 40 lb of KCN and NaCN	0-1 min: 40 lb/min (puff)	2.0E-05 probability of KCN present	1 mg/m^3	5 mg/m^3
(2d) Spills and ignition of flammable liquid, accelerated by $Na_2S_2O_8$ and NH_4NO_3, releasing Hg vapor from discarded Hg cells	Hg vapor	2,000 lb of naphtha; 630 lb of oxidizing agent; 50 lb of Hg cells	0-180 min: 2.8 lb/min	2.0E-05 probability of Hg present	0.01 mg/m^3	0.1 mg/m^3

Table F.7-3. Airborne Release Assumptions for Representative HW Accidents—Continued

Scenario	Toxic Gas Released	Mass of Waste Spilled (lb)	Release Rate Functional Form (lb/min)	Annual Frequency (per Container-Handling[a] Operation)	Concentration Limit[b] PAEC Value	Concentration Limit[b] PLC Value
(2e) Spills and ignition of flammable liquid, breaching nearby containers with Cd-containing compounds (i.e., Cd salts or Ni:Cd batteries)	Cd fumes	300 lb of CdO (17.5 lb of Cd fumes)	0-30 min: 10 lb/min (for fires of 950 °C)	2.0E-05 probability of Cd present	0.075 ppm	NA
(2f) Spills and ignition of flammable liquid, breaching nearby containers with dichromate salts (i.e., $Na_2Cr_2O_7$ or $K_2Cr_2O_7$)	Dust from burnt and unburnt dichromate salts	30 lb of dichromate dust	1-5 min: 6 lb/min	2.0E-05 × 1.2E-01 probability of dichromate salt present	0.1 mg/m^3	NA
Other						
(3a) Spills and ignition of flammable liquids; heat from fire causes explosion in compressed gas cylinder, venting NH_3	NH_3	Flammable liquid, 30.5 lb; compressed NH_3	0-5 min: 12 lb/min (puff)	2.0E-05 × 1.0E-02 probability of NH_3 present	24.5	560
(3b) Accidental confinement of oxidizing and reducing agents; reaction generates heat, igniting packaging and breaching nearby container	NH_3 or contents of any other nearby gas cylinder	NH_3 (60 lb)	0-5 min: 12 lb/min	3.0E-03 × probability of both agents present[f]	24.5	560
(3c) Accidental confinement of water with alkali-metal bases or alkali-earth oxides (i.e., Na_2O, K_2O, CaO); reaction generates heat, igniting packaging and breaching nearby containers	NH_3 or any other nearby gas cylinder	NH_3 (60 lb)	0-5 min: 12 lb/min	3.0E-03 × probability of both agents present[f]	24.5	560
(3d) Accidental rupture of compressed gas (NO_x; flammable) cylinder due to valve failure, releasing toxic gas	NH_3	Compressed gas (100 lb/container)	0-5 min: 100 lb/min	2.0E-05[g]	24.5	560
(3e) Accidental explosion (without previous spill) of diethyl ether peroxides formed by exposure to air; remaining diethyl ether ignites, spreading to nearby container	NH_3 or contents of any other nearby gas cylinder	Diethyl ether, 2 lb; 210 lb of NH_4OH (60 lb)	0-5 min: 12 lb/min	3.0E-03[h]	24.5	560

Notes: $CaCl_2$ = calcium hypochlorite; CaO = calcium oxide; CdO = cadmium oxide; $C_2H_4O_2$ = acetic acid; CS_2 = carbon disulfide; HCN = hydrogen cyanide; HF = hydrogen fluoride; HNO_3 = nitric acid; H_2SO_4 = sulfuric acid; KCN = potassium cyanide; $Na_2Cr_2O_7$ = sodium dichromate; Na_2O = sodium oxide; $Na_2S_2O_8$ = sodium persulfate; NH_3 = ammonia; NH_4NO_3 = ammonium nitrate; NH_4OH = ammonium hydroxide; and Ni = nickel.

[a] Number of containers at each site varies.

[b] Limits apply for a 15-minute exposure and are in parts per million (ppm) unless otherwise specified. PAEC = potential adverse effect concentration; and PLC = potential life-threatening concentration.

[c] Read as 3 × exp [-k (t-10)]; k_1 = 0.0145, k_2 = 0.0043, k_3 = 0.20, k_4 = 0.0494, k_6 = 0.0111, and k_7 = 0.2131; t = time (min).

[d] NA = not available.

[e] The assumption is that 1 in 10 spills will be ignited by a nearby spark (a conservative value) for an outdoor storage facility. When an accident scenario requires a number of initiating steps, involving more than one type of waste, the probability that all of the necessary constituents would be present at the same time must be included.

[f] The frequency of improper mixing of stored HW containers is approximately 3.0E-03 (according to Sasser [1992]).

[g] The value for the probability of compressed gas container breach is 1.0E-04 per container-handling operation; the value for breaching secondary containment is 1.0E-01.

[h] The frequency of improperly loading a container containing diethyl ether (allowing air to enter the container) is 3.0E-03 (according to Sasser [1992]).

The accident scenarios include a range from high-probability low-consequence accidents to high-consequence low-probability accidents. In general, the scenarios involve chemical or physical change in stored materials subsequent to an initial incident. Equations were written to represent the changes anticipated to occur during the accidents. Toxic gaseous products were identified, and the masses generated during an event were estimated from the mass of the reactants and the stoichiometry of the reactions. The annual frequency of accidents includes both the spill frequency and, where appropriate, the probability that all of the agents are present at the same time. Rates of releases were estimated based on the engineering judgement and the recognition that such rates usually decay exponentially with time. Obviously, the exact course of an accident is shaped by a multitude of factors, including (but not limited to) temperature, humidity, pooling versus spreading of spills, the exact composition and concentration of reactive materials (often unknown), and the proximity and nature of nearby reactive materials (including packaging, shelving, and flooring). Appendix H in ANL (1996a) provides details on the selection of the accident scenarios, on the chemistry involved in their progress, and on the estimation of the rates of release of the toxic gases.

The probability of an accident depends on the throughput of the waste type or types involved. The subsequent progression of some accident scenarios requires specific additional waste types to be in proximity to the initiating container; for instance, accident subcategory 2d is dependent on the probability that flammable liquids, accelerants, and Hg cells are being stored near one another.

A release is defined as some form of airborne release in terms of vapor, gas, aerosol, or particulates from the original chemical or the reaction product. Recall that all hazardous chemical releases were placed into one of 18 subcategories, depending on the category of accident (for example, spill or spill plus fire), the range of accidents within the category, and the particular health end point. Many chemicals in the inventory of each site pose no risk from release and therefore did not need to be considered further. The HW inventories for FY 1992 for 12 DOE sites (the 11 referred to earlier and NTS) were analyzed to determine the most representative set. Detailed chemical knowledge and engineering judgment were used to assign chemicals to categories. Accident risk during storage is dependent on the number of drums and the average masses of the chemicals placed in each category. Once each accident category was defined, the mass of a released chemical, the elapsed time for release, and the release rates were determined by the use of mass balance equations and consideration of vapor pressure and heat of vaporization at room temperature (ANL, 1996a).

F.7.2.1 Packaged Waste Storage and Handling Operations

Hazardous wastes are first accumulated in drums or laboratory packs at the source (laboratory or shop) and then are shipped to a centralized storage facility. Handling accidents during storage or staging operations are expected to dominate the risk of chemical releases to workers because of the frequency of handling and the proximity of the workers. Ignition or explosion of containers due to chemical reactions originating from container-loading errors have also been considered in handling accidents for HW.

F.7.2.1.1 *Material at Risk and Damage Fraction*

Because storage packages are typically plastic-lined, carbon steel 55-gal drums, the MAR for handling-accident scenarios is assumed to be one drum. Double containment with an intervening packing of absorbent material is typical of packaged chemically hazardous liquids; however, consistent with previous analyses, the assumption is made that the liquid is completely spilled (that is, DF = 1.0E+00) upon breach of the waste package (Salazar and Lane, 1992; ORNL, 1993).

F.7.2.1.2 *Spill Scenario Frequencies*

The frequency of container breaches is on the order of 1.0E–04 per handling operation (see Section F.2.7.1). Because HW storage facilities are allowed to hold materials for 90 days as a maximum, all of the containers that arrive at a facility are assumed to be shipped out within 90 days. Two handling operations per container of waste stored at the facility (one loading and one unloading) were assumed. Consistent with the discussion in Section F.2.7.1, the annual frequency for a spill from a container breach for chemical x due to a handling accident can then be given by

$$f_{sx} = 0.0002\, n_x \ , \qquad \text{(F.7–1)}$$

where n_x is the number of waste containers of chemical x received annually at the facility.

F.7.2.1.3 *Spill Plus Fire Scenario Frequencies*

The frequency of occurrence for subcategory 3a (the spill, ignition, and atmospheric release of chemical x) is given by

$$f_{sfx} = f_{sx} P_f \ , \qquad \text{(F.7-2)}$$

where P_f is the conditional probability of ignition (1E-01 for outdoor storage pads and 2E-01 for enclosed facilities) (Section F.2). The frequency of occurrence in accident subcategories 2b through 2f (the spill and ignition of a flammable chemical, followed by fire propagation and release of chemical y) depends on the concurrent presence of the flammable initiator and the container with the toxic chemical contents:

$$f_{sty} = 0.0002\, n_f P_f P_{fy} + 0.0002\, n_y P_f \ , \qquad \text{(F.7-3)}$$

where n_f is the number of flammable chemical containers, and P_{fy} is the conditional probability that fires involving the flammable chemicals propagate to and ignite the contents of drums containing chemical y. The expression P_{fy} is approximated by the ratio of the number of drums of chemical y to the total number of containers. The second term in the expression is added only if chemical y is also flammable.

F.7.2.1.4 *Frequencies of Other Event Combinations*

Accident subcategory 3a involves a spill and subsequent fire, which then induces an explosion. One SAR (EG&G, 1990) lists a value of 2.0E-02 for the annual probability of a fire-induced explosion sufficient to rupture the end walls of a facility. The reference scenario herein assumes the explosion of a compressed gas cylinder engulfed in fire. The frequency is given by

$$f_{sfey} = 0.0002\, n_f P_f P_{fy} P_e \ , \qquad \text{(F.7-4)}$$

where the probability P_{fy} of a drum or cylinders being engulfed is estimated as the approximate fraction of drums containing compressed gas cylinders and where P_e, the conditional probability that the engulfed gas canister will explode, is assumed conservatively to be 1.0E+00.

Fire-only scenarios 3b and 3c involve the inadvertent mixing of incompatible wastes. Human error probabilities between 1.0E–03 and 3.0E–03 are reported (Trusty et al., 1989; Sasser, 1992) for loading or sorting a chemical in the wrong place. Subsequent chemical reactions then generate enough heat to ignite the packaging material with a frequency estimated by

$$f_{frc} = 0.003\, n_{rc} \ , \qquad \text{(F.7–5)}$$

where n_{rc} is the number of containers containing potentially reactive chemical *rc* (or its equivalent) that are received annually at the facility. The surrogate toxic gas assumed to be released during the accident is ammonia (NH_3).

The fire may then spread to other containers and result in a release of toxic chemicals; however, the probability that a reaction among incompatible wastes will generate enough heat to ignite nearby combustible material (that is, paper or cardboard) is expected to be relatively small. The combustible material closest to the containers is usually a cardboard pallet, which requires temperatures of over 232 °C to ignite. Furthermore, the frequency with which containers of toxic waste are stored in proximity to the potential fire needs to be considered. Given the combination of events needed to result in other toxic gas releases, only the NH_3 release is treated herein.

Accident subcategory 3d involves a mechanical breach and subsequent explosion of cylinders of compressed gases. Such cylinders are expected to be stored inside drums, thus providing double-walled storage of the compressed gas. The annual frequency of double-walled container breach per unit handling operation is estimated as 1.0E–05, implying an order of magnitude credit for the second containment, which is probably conservative, given that conditional breach probabilities after a drop are estimated at 1.0E–02. Thus, the frequency of a handling accident resulting in an explosion of compressed gas cylinder x is conservatively estimated as

$$f_{secg} = 0.00002\, n_{cg} \ , \qquad \text{(F.7–6)}$$

where n_{cg} is the number of drums with compressed gas containers received annually at the facility.

The spontaneous fire and explosion scenario 3e corresponds to a waste fire and explosion induced by an error in the loading of the waste containers. Some chemicals react violently on contact and must be

segregated. The gases produced by such reactions may produce enough pressure inside containers to cause explosions, with resulting container failure. The frequency of this scenario is

$$f_{ferx} = 0.003\, n_{rx} \ , \qquad \text{(F.7-7)}$$

where n_{rx} is the number of containers containing potentially reactive chemical rx (or its equivalent) that are received annually at the facility. The spontaneous formation of peroxides upon exposure of ether to air (and the later ignition of those peroxides) is considered here to be an error in loading. In reality, ether should never be stored for extended periods because of this very problem.

F.7.2.2 Storage Facility Accidents

Hazardous wastes are generally packaged in 55-gal drums and stored in RCRA-compliant staging areas or weather protection sheds before offsite shipment for commercial treatment and disposal. A HWSF typically houses over 100 different chemicals, which may include chlorinated solvents, acids, bases, photographic chemicals, ignitable solids and liquids, compressed gases, metal salts, polychlorinated biphenyls, asbestos, and other regulated wastes. Because explosives are generally prohibited, the important hazard characteristics include volatility, flammability, dispersibility, and toxicity. The HW is characterized and segregated on the basis of toxicity, corrosivity, reactivity, and ignitability. Most HWSFs have containment berm areas and individual storage cells that permit waste segregation per RCRA and EPA criteria; some HWSFs have fire detection and suppression capability, and some have forced ventilation. Because of the great diversity of storage facility designs among the DOE sites, a generic facility with segregated storage (Figure F.2-5) was assumed in the analyses.

A facility-wide fire has been chosen as the representative internal accident. This fire is the type of accident scenario considered as the maximum reasonably foreseeable accident in the INEL HWSF SAR (EG&G, 1990). The fire would engulf a large fraction of the facility, could include secondary explosions and fire propagation from one area to another, and would consume numerous chemicals that vent hazardous substances on combustion or heating.

Externally initiated events have also been evaluated. The relevant chemicals identified in the operational accidents are assumed to be involved in the facility accident, with the amount of each chemical in facility sequences assumed to be proportional to the numbers of drums that, on average, are present at the facility.

A facility fire is the dominant sequence for aircraft impacts; a large spill resulting from numerous breached containers is the dominant sequence for earthquakes.

The chemicals in the facility fire source term are those identified as particularly hazardous in spills with fire (Table F.7-3). The sum of the amounts of these particularly hazardous chemicals defines the MAR, with the release rate and duration for each chemical the same as those for the individual drum fires. The DF is assumed to be 1.0E+00 because the accident scenario assumes no mitigation. In the representative seismic event, the assumption is that 1% of the containers fall and break (DF of 1.0E-02), leading to a large spill of varied chemicals. The externally induced fires (large- and small-aircraft impacts) result in a combined MAR that includes the hazardous releases in a facility-wide fire plus the hazardous releases due to explosions caused by fires or impacts. The representative chemicals in these accidents are shown in Table F.7-3. As in the case of facility fires, the DF for aircraft-induced accidents is taken as 1.0E+00.

Conditional probabilities for ignition and fire attendant upon violent breach of packages of flammable liquid are estimated to lie between 1.0E-01 and 1.0E+00 (ORNL, 1993). An initiating event frequency of 1.0E-02/yr for a fire involving local propagation is assumed here. A frequency of 1.0E-02 for failure of the segregation design, the fire suppression systems, or manual procedures is assumed, yielding a resulting facility-wide fire frequency of 1.0E-04/yr.

The frequencies of the external initiators are dependent on the site, as discussed in Section F.2.6. A conditional probability of container breach of 1.0E+00 has been used for large-airplane impacts and 9.0E-01 for small-airplane impacts, consistent with the LLW storage facility analysis (LLW and HW are both generally packaged in DOT 55-gal drums). For earthquakes, the best estimate (Kennedy et al., 1990) of the annual frequency of events with a peak ground acceleration exceeding 0.15 g at the different sites is taken as the frequency of seismic initiation. A ground acceleration of 0.15 g is assumed to be the minimum acceleration required to topple drums in the upper rows of a storage array. A conditional probability of 2.0E-01 for subsequent drum breach and spill, consistent with the LLW event tree analysis, has been used.

F.7.2.3 Treatment Facility Accidents

Evaluations show that incineration is also the risk-dominant thermal treatment technology for HW. Because SARs for both radioactive waste incinerators and commercial HW incinerators assign a high frequency to

kiln explosions, the representative accident is taken to be an explosion that initiates a fire in the waste in the feedstock area. Three externally initiated events (large- and small-aircraft impacts and seismic events) that ignite a feedstock fire are also analyzed. A generic treatment facility, consisting of a series of linked treatment process modules, was described in Section F.2.6.3. A DOE Hazard Category of 2, concomitant performance of its systems, and double HEPA filtration systems were assumed.

The representative source term chemicals are those that were identified as particularly hazardous in case of a fire. The MAR is a fraction of the annual throughput of the incineration facility as established by the WM PEIS alternative. Information from commercial facilities indicates that only a few containers (a few hours' worth of throughput) are kept in the feedstock area. Therefore, 1% of the annual throughput was assumed to be in the staging area. This fraction represents the amount of waste in processing and lag storage. The DF depends on the magnitude of the initiator and is assumed to be 1.0E–01 for internal explosions, 2.0E–01 for seismic events and small-airplane crashes, and 3.0E–01 for large-airplane impacts. These values were assumed because of the scattered physical locations of the waste in the treatment facility and the fact that only some of the chemicals in the feedstock area were identified as airborne release hazards in Table F.7–3.

Estimates (discussed in Section F.2.7.3.5) of an annual frequency of 1.5E–02/yr for explosions in the rotary kiln assembly and in the SCC agree with the experience of commercial incineration operators and provide the basis for the internal fire frequencies used herein. The frequencies of aircraft-initiated accidents are dependent on the site. The frequencies were obtained in the same manner as those for the storage facilities. The conditional probabilities of containment and confinement rupture and fire initiation are consistent with those in the LLW accident analysis: 4.5E–01 and 1.0E–02 for large- and small-airplane crashes, respectively. The annual frequency of a seismic event exceeding the design basis for a Category 2 facility is 1.0E–03/yr. As in the LLW facility accident analysis, the conditional probability of rupturing containment and initiating a fire is estimated at 5.0E–02.

F.7.3 RESULTS

The airborne release parameters for all accident types were shown in Table F.7–3. Table F.7–4 summarizes the estimated frequencies for the different handling accidents in the no-action decentralized, regionalized alternatives for each DOE site on the basis of the appropriate surrogate chemical inventories. Single-drum inventories are assumed for the handling accidents.

Table F.7-4. Site-Dependent Annual Frequencies of Representative HW Handling Accidents

Site/Event[a]	Decentralized Alternative						
Spill	(1a)	(1b)	(1c)	(1d)	(1e)	(1f)	(1g)
ANL-E	1.00E-03	3.00E-03	8.00E-04	6.80E-03	4.00E-04	2.00E-04	1.20E-03
Fermi	0	0	0	8.00E-04	0	0	2.00E-04
Hanford	1.80E-03	1.00E-03	4.00E-04	7.20E-03	4.00E-04	0.00E+00	3.20E-03
INEL	2.60E-03	5.40E-03	6.00E-04	6.00E-03	0.00E+00	0.00E+00	3.60E-03
KCP	1.60E-03	0.00E+00	0.00E+00	2.00E-04	0.00E+00	0.00E+00	0.00E+00
LLNL	6.40E-03	3.08E-02	4.40E-03	5.84E-02	7.60E-03	4.00E-04	2.26E-02
LANL	3.60E-03	6.20E-03	3.60E-03	4.22E-02	3.60E-03	0.00E+00	7.60E-03
ORR	0	0	0	0	0	0	1.00E-03
Pantex	0	2.20E-03	4.00E-04	1.22E-02	2.00E-04	0	0
SNL-NM	4.20E-03	0.00E+00	8.20E-03	2.96E-02	8.00E-04	0.00E+00	6.40E-03
SRS	2.00E-04	0.00E+00	0.00E+00	1.50E-02	1.56E-02	0.00E+00	4.00E-04
Spill Plus Fire	(2a)	(2b)	(2c)	(2d)	(2e)	(2f)	
ANL-E	8.00E-05	7.29E-04	3.19E-04	1.00E-03	1.82E-04	1.37E-04	
Fermi	0.00E+00	6.67E-05	6.67E-05	1.78E-04	0	0	
Hanford	4.00E-05	7.58E-04	9.48E-05	2.13E-04	1.90E-04	7.11E-05	
INEL	6.00E-05	1.34E-03	7.17E-05	2.15E-04	7.89E-04	2.63E-04	
KCP	0.00E+00	1.80E-03	2.95E-05	5.60E-04	1.18E-04	0.00E+00	
LLNL	4.40E-04	8.09E-03	5.04E-04	1.20E-03	8.16E-04	3.12E-04	
LANL	3.60E-04	3.20E-03	3.45E-04	0.00E+00	5.98E-04	4.37E-04	
ORR	0.00E+00	2.51E-03	0.00E+00	3.81E-05	3.81E-05	0.00E+00	
Pantex	4.00E-05	2.48E-03	5.52E-05	5.52E-04	3.31E-04	0.00E+00	
SNL-NM	8.20E-04	2.74E-03	3.62E-04	3.28E-03	2.31E-03	3.85E-04	
SRS	0	7.24E-03	2.78E-05	2.31E-03	2.37E-03	0	
Other Event	(3a)	(3b)	(3c)	(3d)	(3e)		
ANL-E	1.39E-05	3.00E-03	9.30E-02	2.80E-04	1.20E-02		
Fermi	0	0	3.00E-03	1.40E-04	0		
Hanford	3.33E-05	3.00E-03	6.60E-02	1.40E-04	1.20E-02		
INEL	5.09E-05	3.00E-03	1.47E-01	1.60E-04	2.70E-02		
KCP	7.57E-05	3.00E-03	9.00E-03	4.40E-04	3.00E-03		
LLNL	1.28E-04	1.20E-02	5.04E-01	6.40E-03	1.02E-01		
LANL	5.39E-05	1.80E-02	8.16E-01	1.48E-03	2.40E-02		
ORR	0	0	0	0	0		
Pantex	0	3.00E-03	1.02E-01	0.00E+00	3.00E-03		
SNL-NM	5.57E-05	8.40E-02	2.67E-01	1.26E-03	6.90E-02		
SRS	7.84E-06	0.00E+00	2.10E-01	0.00E+00	2.10E-02		

Table F.7-4. Site-Dependent Annual Frequencies of Representative HW Handling Accidents—Continued

Site/Event[a]	Regionalized Alternative						
Spill	(1a)	(1b)	(1c)	(1d)	(1e)	(1f)	(1g)
Hanford	8.20E-03	3.22E-02	4.80E-03	6.56E-02	8.00E-03	4.00E-04	2.58E-02
INEL	2.60E-03	5.40E-03	6.00E-04	6.00E-03	0.00E+00	0.00E+00	3.60E-03
LANL	7.80E-03	8.40E-03	1.22E-02	8.40E-02	4.60E-03	0.00E+00	1.40E-02
ORR	2.60E-03	3.00E-03	8.00E-04	7.80E-03	4.00E-04	2.00E-04	2.40E-03
SRS	2.00E-04	0.00E+00	0.00E+00	1.50E-02	1.56E-02	0.00E+00	4.00E-04
Spill Plus Fire	(2a)	(2b)	(2c)	(2d)	(2e)	(2f)	
Hanford	4.80E-04	7.38E-03	5.00E-04	1.18E-03	8.40E-04	3.20E-04	
INEL	6.00E-05	1.12E-03	6.00E-05	1.80E-04	6.60E-04	2.20E-04	
LANL	1.22E-03	7.00E-03	6.60E-04	3.30E-03	2.80E-03	7.20E-04	
ORR	8.00E-05	3.24E-03	3.60E-04	1.44E-03	2.60E-04	1.20E-04	
SRS	0.00E+00	5.20E-03	2.00E-05	1.66E-03	1.70E-03	0.00E+00	
Other Event	(3a)	(3b)	(3c)	(3d)	(3e)		
Hanford	7.85E-09	1.50E-02	5.70E-01	6.54E-03	1.14E-01		
INEL	0.00E+00	3.00E-03	1.47E-01	1.60E-04	2.70E-02		
LANL	0.00E+00	1.05E-01	1.19E+00	2.74E-03	9.60E-02		
ORR	7.28E-09	6.00E-03	1.05E-01	8.60E-04	1.50E-02		
SRS	0.00E+00	0.00E+00	2.10E-01	0.00E+00	2.10E-02		
Site/Event[a]	Centralized Alternative						
Spill	(1a)	(1b)	(1c)	(1d)	(1e)	(1f)	(1g)
East	2.80E-03	3.00E-03	8.00E-04	2.28E-02	1.60E-02	2.00E-04	2.80E-03
West	1.86E-02	4.60E-02	1.76E-02	1.56E-01	1.26E-02	4.00E-04	4.34E-02
Spill Plus Fire	(2a)	(2b)	(2c)	(2d)	(2e)	(2f)	
East	8.00E-05	8.44E-03	3.80E-04	3.10E-03	1.96E-03	1.20E-04	
West	1.76E-03	1.55E-02	1.22E-03	4.66E-03	4.31E-03	1.26E-03	
Other Event	(3a)	(3b)	(3c)	(3d)	(3e)		
East	7.41E-09	6.00E-03	3.15E-01	8.60E-04	3.60E-02		
West	3.76E-09	1.23E-01	1.90E+00	9.44E-03	2.37E-01		

[a] Refer to Table F.7-3 for definitions of accidents and released chemicals.

Tables F.7-5 and F.7-6 summarize the results for the storage and treatment facility accidents by site and alternative. The column labeled "Total Number of Containers" represents the MAR (that is, the total number of containers with the relevant chemicals for each accident that are estimated to be involved in accidents at the facility). The "Number of Containers Breached" is the product of the containers at risk and the DF. The remaining columns in the tables provide the breakdown of the total number of containers involved in the accident for each of the various relevant surrogate chemicals.

Table F.7-5. Frequencies and Source Term Parameters for WM HW Storage Facility Accidents

WM PEIS Alternative[a]	Site	Accident Frequency (per year)	Total Number of Containers	DF	Total Number of Containers Breached	Representative Subcategory Chemical Containers Involved[b]						
Representative Fire						(2a)	(2b)	(2c)	(2d)	(2e)	(2f)	
1	INEL	1.0E-04	29	1.0E+00	29	14	1	1	2	8	3	
	KCP	1.0E-04	21	1.0E+00	21	15	0	0	5	1	0	
	LLNL	1.0E-04	119	1.0E+00	119	84	6	5	13	8	3	
	LANL	1.0E-04	56	1.0E+00	56	35	5	4	0	7	5	
	ORR	1.0E-04	17	1.0E+00	17	17	0	0	0	0	0	
	Pantex	1.0E-04	33	1.0E+00	33	23	1	1	5	3	0	
	Hanford	1.0E-04	15	1.0E+00	15	8	1	1	2	2	1	
	SNL-NM	1.0E-04	109	1.0E+00	109	30	10	4	36	25	4	
	SRS	1.0E-04	107	1.0E+00	107	65	0	0	21	21	0	
	ANL-E	1.0E-04	28	1.0E+00	28	8	1	4	11	2	2	
	Fermi	1.0E-04	4	1.0E+00	4	1	0	1	2	0	0	
2	INEL	1.0E-04	29	1.0E+00	29	14	1	1	2	8	3	
	Hanford	1.0E-04	94	1.0E+00	94	64	5	4	11	7	3	
	LANL	1.0E-04	151	1.0E+00	151	69	12	7	27	26	8	
	ORR	1.0E-04	52	1.0E+00	52	33	1	3	12	2	1	
	SRS	1.0E-04	107	1.0E+00	107	65	0	0	21	21	0	
3	INEL	1.0E-04	361	1.0E+00	361	194	24	16	58	53	16	
	ORR	1.0E-04	177	1.0E+00	177	106	1	5	39	24	2	
Seismic Events						(1a)	(1b)	(1c)	(1d)	(1e)	(1f)	(1g)
1	INEL	1.8E-04	24	1.0E-02	0	0	0	0	0	0	0	0
	KCP	6.0E-05	2	1.0E-02	0	0	0	0	0	0	0	0
	LLNL	1.0E-03	165	1.0E-02	2	0	1	0	1	0	0	0
	LANL	6.0E-04	86	1.0E-02	1	0	0	0	1	0	0	0
	ORR	4.0E-04	1	1.0E-02	0	0	0	0	0	0	0	0
	Pantex	6.0E-05	19	1.0E-02	0	0	0	0	0	0	0	0
	Hanford	6.0E-05	19	1.0E-02	0	0	0	0	0	0	0	0
	SNL-NM	6.0E-04	61	1.0E-02	1	0	0	0	1	0	0	0

Table F.7-5. Frequencies and Source Term Parameters for WM HW Storage Facility Accidents—Continued

WM PEIS Alternative[a]	Site	Accident Frequency (per year)	Total Number of Containers	DF	Total Number of Containers Breached	Representative Subcategory Chemical Containers Involved[b]							
Seismic Events (Cont.)						(1a)	(1b)	(1c)	(1d)	(1e)	(1f)	(1g)	
	SRS	8.0E-05	40	1.0E-02	0	0	0	0	0	0	0	0	
	ANL-E	1.0E-04	17	1.0E-02	0	0	0	0	0	0	0	0	
	Fermi	1.0E-04	1	1.0E-02	0	0	0	0	0	0	0	0	
2	INEL	1.8E-04	24	1.0E-02	0	0	0	0	0	0	0	0	
	Hanford	6.0E-05	129	1.0E-02	1	0	0	0	1	0	0	0	
	LANL	6.0E-04	139	1.0E-02	1	0	0	0	1	0	0	0	
	ORR	4.0E-04	14	1.0E-02	0	0	0	0	0	0	0	0	
	SRS	8.0E-05	40	1.0E-02	0	0	0	0	0	0	0	0	
3	INEL	1.8E-04	374	1.0E-02	4	0	1	0	2	0	0	1	
	ORR	4.0E-04	61	1.0E-02	1	0	0	0	1	0	0	0	
Large-Aircraft Impacts						(2a)	(2b)	(2c)	(2d)	(2e)	(2f)	(3a)	(3d)
1	INEL	2.0E-09	34	1.0E+00	34	14	1	1	2	8	3	3	2
	KCP	--	29	--	--	--	--	--	--	--	--	-	-
	LLNL	--	207	--	--	--	--	--	--	--	--	-	-
	LANL	--	80	--	--	--	--	--	--	--	--	-	-
	ORR	--	17	--	--	--	--	--	--	--	--	-	-
	Pantex	2.3E-07	33	1.0E+00	33	23	1	1	5	3	0	0	0
	Hanford	8.5E-09	19	1.0E+00	19	8	1	1	2	2	1	2	2
	SNL-NM	2.1E-05	130	1.0E+00	130	30	10	4	36	25	4	5	16
	SRS	8.2E-09	107	1.0E+00	107	65	0	0	21	21	0	0	0
	ANL-E	--	33	--	--	--	--	--	--	--	--	-	-
	Fermi	--	6	--	--	--	--	--	--	--	--	-	-
2	INEL	2.0E-09	34	1.0E+00	34	14	1	1	2	8	3	3	2
	Hanford	8.5E-09	157	1.0E+00	157	64	5	4	11	7	3	7	3
	LANL	--	189	--	--	--	--	--	--	--	--	-	-
	ORR	--	62	--	--	--	--	--	--	--	--	-	-

Table F.7-5. Frequencies and Source Term Parameters for WM HW Storage Facility Accidents—Continued

WM PEIS Alternative[a]	Site	Accident Frequency (per year)	Total Number of Containers	DF	Total Number of Containers Breached	Representative Subcategory Chemical Containers Involved[b]							
Large-Aircraft Impacts (Cont.)						(2a)	(2b)	(2c)	(2d)	(2e)	(2f)	(3a)	(3d)
	SRS	8.2E-09	107	1.0E+00	107	65	0	0	21	21	0	0	0
3	INEL	2.0E-09	503	1.0E+00	503	194	24	16	58	53	16	23	119
	ORR	--	192	--	--	--	--	--	--	--	--	--	--
Small-Aircraft Impacts													
1	INEL	--	34	--	--	--	--	--	--	--	--	--	--
	KCP	2.70E-07	29	1.0E+00	29	15	0	0	5	1	0	2	6
	LLNL	2.70E-07	207	1.0E+00	207	84	6	5	13	8	3	8	80
	LANL	2.70E-07	80	1.0E+00	80	35	5	4	0	7	5	5	19
	ORR	2.70E-07	17	1.0E+00	17	17	0	0	0	0	0	0	0
	Pantex	--	33	--	--	--	--	--	--	--	--	--	--
	Hanford	--	19	--	--	--	--	--	--	--	--	--	--
	SNL-NM	--	130	--	--	--	--	--	--	--	--	--	--
	SRS	--	107	--	--	--	--	--	--	--	--	--	--
	ANL-E	2.70E-07	33	1.0E+00	33	8	1	4	11	2	2	1	4
	Fermi	2.70E-07	6	1.0E+00	6	1	0	1	2	0	0	0	2
2	INEL	--	34	--	--	--	--	--	--	--	--	--	--
	Hanford	--	157	--	--	--	--	--	--	--	--	--	--
	LANL	2.70E-07	189	1.0E+00	189	71	12	7	27	26	8	8	30
	ORR	2.70E-07	62	1.0E+00	62	33	1	3	12	2	1	2	8
	SRS	--	107	--	--	--	--	--	--	--	--	--	--
3	INEL	--	503	--	--	--	--	--	--	--	--	-	--
	ORR	2.70E-07	192	1.0E+00	192	106	1	5	39	24	2	3	12

Note: -- = not applicable.
[a] Case 1 is the No Action/Decentralized alternative with two treatment sites. Case 2 is the Regionalized 1 alternative with five treatment sites. Case 3 is the Regionalized 2 alternative with two treatment sites.
[b] Refer to Table F.7-3 for definitions of released chemicals.

Table F.7-6. Frequencies and Source Term Parameters for WM HW Incineration Facility Accidents

WM PEIS Alternative[a]	Site	Accident Frequency (per year)	Total Number of Containers	DF	Number of Containers Breached	Representative Subcategory Chemical Containers Involved[b]					
						2a	2b	2c	2d	2e	2f
Representative Fire											
2	INEL	1.5E-02	20	1E-01	2	1	0	0	0	1	0
	LANL	1.5E-02	50	1E-01	5	3	0	0	1	1	0
	ORR	1.5E-02	50	1E-01	5	2	1	0	1	1	0
	Hanford	1.5E-02	30	1E-01	3	2	0	0	1	0	0
	SRS	1.5E-02	20	1E-01	2	1	0	0	1	0	0
3	INEL	1.5E-02	80	1E-01	8	5	1	0	1	1	0
	ORR	1.5E-02	80	1E-01	8	5	0	0	2	1	0
Seismic Events											
2	INEL	5.0E-05	20	2E-01	4	2	0	0	0	1	1
	LANL	5.0E-05	50	2E-01	10	7	1	0	1	1	0
	ORR	5.0E-05	50	2E-01	10	5	1	0	2	2	0
	Hanford	5.0E-05	30	2E-01	6	4	0	1	1	0	0
	SRS	5.0E-05	20	2E-01	4	2	0	0	1	1	0
3	INEL	5.0E-05	80	2E-01	16	9	1	1	3	2	0
	ORR	5.0E-05	80	2E-01	16	10	0	1	3	2	0
Large-Aircraft Impacts											
2	INEL	1.2E-09	20	3E-01	6	3	0	0	0	2	1
	LANL	--	--	--	--	--	--	--	--	--	--
	ORR	--	--	--	--	--	--	--	--	--	--
	Hanford	5.4E-09	30	3E-01	9	6	0	1	2	0	0
	SRS	5.0E-09	20	3E-01	6	4	0	0	1	1	0
3	INEL	2.7E-09	80	3E-01	24	12	2	1	4	4	1
	ORR	--	--	--	--	--	--	--	--	--	--
Small-Aircraft Impacts											
2	INEL	--	--	--	--	--	--	--	--	--	--
	LANL	7.0E-09	50	2E-01	10	6	1	1	1	1	0
	ORR	7.0E-09	50	2E-01	10	5	1	0	2	2	0
	Hanford	--	--	--	--	--	--	--	--	--	--
	SRS	--	--	--	--	--	--	--	--	--	--
3	INEL	--	--	--	--	--	--	--	--	--	--
	ORR	7.0E-09	80	2E-01	16	10	0	1	3	2	0

Note: -- = not applicable.
[a] Case 1 is the No Action/Decentralized Alternative with two treatment sites. Case 2 is the Regionalized 1 Alternative with five treatment sites. Case 3 is the Regionalized 2 Alternative with two treatment sites.
[b] Refer to Table F.7-3 for definitions of released chemicals.

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WHC. *See* Westinghouse Hanford Co.

WSRC. *See* Westinghouse Savannah River Co.

Appendix G

Pollution Prevention

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Acronyms and Abbreviations

The following is a list of acronyms and abbreviations (including units of measure) used in this appendix.

Ames	Ames Laboratory
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
BCL	Batelle Columbus Laboratories
Bettis	Bettis Atomic Power Laboratory
BNL	Brookhaven National Laboratory
CISS	Colonie Interim Storage Site
CH	contact-handled
Charleston	Charleston Naval Shipyard
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EO	Executive Order
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	environmental restoration
ETEC	Energy Technology Engineering Center
FEMP	Fernald Environmental Management Project
Fermi	Fermi National Accelerator Laboratory
g	gram(s)
GA	General Atomics
GJPO	General Junction Projects Office
h	hour(s)
Hanford	Hanford Site
HLW	high-level waste
HW	hazardous waste
INEL	Idaho National Engineering Laboratory
ITRI	Inhalation Toxicology Research Institute
KAPL-K	Knolls Atomic Power Laboratory (Kesselring)
KAPL-S	Knolls Atomic Power Laboratory (Schenectady)
KAPL-W	Knolls Atomic Power Laboratory (Windsor)
KCP	Kansas City Plant
kg	kilogram(s)
km^2	square kilometer(s)
K-25	Oak Ridge K-25 Site

LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LDR	land disposal restrictions
LEHR	Laboratory for Energy-Related Health Research
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level radioactive waste
m^3	cubic meter(s)
Mare Is	Mare Island Naval Shipyard
MAWS	Minimum Additive Waste Stabilization
mi^2	square mile(s)
Mound	Mound Plant
mrem	millirem(s)
nCi	nanocurie(s)
Norfolk	Norfolk Naval Shipyard
NTS	Nevada Test Site
ORR	Oak Ridge Reservation
Pantex	Pantex Plant
Pearl H	Pearl Harbor Naval Shipyard
PGDP	Paducah Gaseous Diffusion Plant
PORTS	Portsmouth Naval Shipyard
PP	pollution prevention
PPOA	pollution prevention opportunity assessment
PPPL	Princeton Plasma Physics Laboratory
Puget So	Puget Sound Naval Shipyard
PWA	process waste assessment
RCRA	Resource Conservation and Recovery Act
RDDT&E	Research, Development, Demonstration, Testing, and Evaluation
R&D	research and development
RFETS	Rocky Flats Environmental Technology Site
RH	remote-handled
RMI	Reactive Metals, Inc.
SNL-CA	Sandia National Laboratories (California)
SNL-NM	Sandia National Laboratories (New Mexico)
SRS	Savannah River Site
TRUW	transuranic waste
TSD	treatment, storage, and disposal
UofMO	University of Missouri (Columbia)
VOCs	volatile organic compounds

WAC	waste acceptance criteria
WIPP	Waste Isolation Plant Project
WM	waste management
WMin/PP	waste minimization and pollution prevention
WM PEIS	Waste Management Programmatic Environmental Impact Statement
WVDP	West Valley Demonstration Project
Y-12	Oak Ridge Y-12 Plant
yr	year(s)

APPENDIX G
Pollution Prevention

G.1 DOE's Pollution Prevention Program

A quantitative evaluation of the potential effect of pollution prevention is included in the WM PEIS in response to public comments during the scoping process (DOE, 1994a). Within the U.S. Department of Energy (DOE), pollution prevention encompasses those activities that involve source reduction and recycling of all waste and pollutants and includes those practices that reduce or eliminate pollutants through increased efficiency in the use of raw materials, energy, water, or other resources, or the protection of natural resources by conservation. The term "source reduction" can be applied to any practice that reduces the amount of any hazardous substance, pollutant, or contaminant that enters any waste stream or that otherwise is released into the environment prior to recycling, treatment, or disposal. Source reduction also describes any practice that reduces the hazards to public health and the environment associated with the release of any such substances, pollutants, or contaminants (DOE, 1994b).

Waste Minimization/Pollution Prevention (WMin/PP) programs derive from the Pollution Prevention Act of 1990 (Public Law 101-508, November 5, 1990), which established a national strategy for waste management and pollution control. This strategy places primary reliance on source reduction, followed by environmentally safe recycling, treatment, and disposal. DOE Order 5400.1, "General Environmental Protection Program" (DOE, 1988), requires that DOE facilities develop a WMin/PP plan as part of an environmental protection plan. The purpose of this appendix is to discuss how DOE's pollution prevention programs and practices may affect the waste loads that waste management (WM) facilities receive, and, consequently, the need for such facilities. This appendix contains estimates of reductions in waste loads, estimated risks associated with WM activities, and estimated WM costs resulting from pollution prevention practices.

On August 3, 1993, President Clinton issued Executive Order (EO) 12856, "Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements" (EO, 1993). To help ensure that Federal agencies manage their facilities so that the objectives of the Pollution Prevention Act are met to the maximum extent practicable, EO 12856 requires agencies to develop voluntary goals to reduce their total releases of toxic chemicals or toxic pollutants to the environment and offsite transfers of such toxic chemicals or toxic pollutants by 50% by December 31, 1999.

Subsequent to the issuance of EO 12856, the Secretary of Energy on December 28, 1993, directed that DOE's policy shall be to embrace pollution prevention as the DOE's strategy to reduce the generation of all waste streams and thus minimize the impact of DOE operations on the environment, as well as improving the safety of operations and energy efficiencies. The Secretary further directed cognizant Secretarial Offices in DOE to identify, plan, and allocate funds for field implementation of WMin/PP activities during the Departmental budget and review process so that there is an identified budget dedicated to pollution prevention activities each year.

On December 27, 1994, the Secretary of Energy approved a Departmental pollution prevention strategy for compliance with EO 12856. DOE has a pollution prevention strategy that requires DOE sites to engage in pollution prevention and to have an established program for implementing this policy. In approving the Departmental strategy, the Secretary directed that information on progress made toward meeting the milestones and achieving the goals set forth in the strategy are to be included in site pollution prevention awareness plans and in Annual Reports to the Secretary on Waste Generation and Waste Minimization Progress. Specific milestones and goals contained in the approved strategy include the following:

- Achieve a Departmentwide 50% reduction of total releases of toxic chemicals to the environment and offsite transfers of such toxic chemicals from the baseline year by December 31, 1999.
- Establish a Departmentwide plan, with goals, to eliminate or reduce unnecessary acquisitions of hazardous substances or toxic chemicals.
- Establish a Departmentwide plan, with goals, to reduce DOE manufacture, process, and use of extremely hazardous substances and toxic chemicals.
- Review DOE standards and specifications to identify opportunities to eliminate or reduce unnecessary acquisitions of hazardous or toxic substances by August 31, 1995, and complete all necessary revisions by December 31, 1998.

In accordance with DOE's policy on pollution prevention, DOE issued the 1994 Waste Minimization/ Pollution Prevention Crosscut Plan (DOE 1994b), which established Departmentwide goals to meet the targets of EO 12856. The 1994 crosscut plan, as well as the approved DOE strategy for compliance with EO 12856, calls for each DOE site to establish site-specific goals to reduce the generation and use of radioactive materials and other hazardous materials to the extent practicable. The 1994 crosscut plan focuses on wastes and pollutants generated within DOE and includes an activity plan. The outline of the activity plan, as presented in Table G-1, attempts to fully integrate WMin/PP practices into DOE operations.

Table G-1. Outline of the WMin/PP Activity Plan

1. WMin/PP Policy Direction Activities	
1.1 Establish goals to minimize waste generation	Each DOE site will set quantitative WMin/PP goals and implement plans for achieving these goals.
1.2 Establish senior management commitment and follow-through for DOE WMin/PP activities	All DOE and contractor organizations will translate the Secretarial WMin/PP policy into policies specific to their sites or programs and be accountable for incorporating WMin/PP into routine operations.
1.3 Distinguish WMin/PP budget allocations through activity data sheets	Specific WMin/PP budgets will be established through preparation of separate Activity Data Sheets.
1.4 Promote regulatory review and reform	The Department will work with regulators and stakeholders to ensure that the best waste management practices are evaluated and incorporated into Federal and State regulations and laws.
1.5 Update DOE policies, orders, and procedures to integrate WMin/PP	DOE policies, orders, and procedures will be updated to reflect the Department's focus on integrating WMin/PP objectives into all activities.
2. WMin/PP Infrastructure Development	
2.1 Standardize material and tracking systems	The Department will develop standards and criteria to measure materials and wastes and provide performance requirements for materials and waste tracking systems.
2.2 Estimate waste management costs for use in decision making	The Department will develop standards for estimating the costs and benefits of introducing WMin/PP changes into its operations.
2.3 Facilitate WMin/PP technology transfer and information exchange	The Department will enhance existing systems to optimize WMin/PP technology transfer and information exchange within the DOE complex.
2.4 Develop a DOE WMin/PP incentives program	The Department will acknowledge and reward reductions in waste generation and environmental releases.
2.5 Develop and conduct WMin/PP employee training and awareness programs	The Department will operate a comprehensive WMin/PP training program that considers all applicable job-specific situations.
2.6 Develop and implement a WMin/PP outreach and public relations program	The Department will inform government agencies and local communities of WMin/PP accomplishments and invite them to participate in environmental activities and initiatives.
3.1 Develop and maintain consistent sitewide WMin/PP programs at all sites	The Department will provide core sitewide WMin/PP activities and services at every site. It will clarify its organizational roles and responsibilities to ensure stable funding and consistent management of its sitewide WMin/PP programs.

Table G-1. Outline of the WMin/PP Activity Plan—Continued

3. WMin/PP Program Implementation	
3.2 Develop and maintain consistent generator-specific programs	The Department will require that waste-generating organizations include appropriate WMin/PP concepts and techniques into their program operations and other activities such as weapons disassembly, decontamination and decommissioning, and environmental restoration.
3.3 Perform opportunity assessments and identify WMin/PP projects	The Department, acting to minimize total costs, will perform opportunity assessments and identify and implement WMin/PP projects that show a rapid (within 36 months) return on investment.
3.4 Design WMin/PP into new products, processes, and facilities	The Department will integrate WMin/PP into all new design criteria.
3.5 Integrate WMin/PP into research, development, and demonstration programs	The Department will couple waste generation and R&D communities to ensure that WMin/PP R&D projects offering the greatest technical benefit are available to generator organizations.
3.6 Modify procurement practices to promote WMin/PP	The Department will promote the purchase of less toxic, more durable, more energy-efficient materials.
3.7 Develop multimedia WMin/PP strategies	The Department will require that all operations develop and implement engineering design-based pollution and waste prevention strategies, process chemistry and technology strategies, operations-based WMin/PP strategies, and maintenance-based proactive strategies.

Source: Appendix C of DOE (1994b).

DOE's WMin/PP practices in 1991 and 1992 are described in the WMin/PP annual report (DOE, 1993b). The following are some examples of WMin/PP practices:

- Substitution of nonhazardous (or less hazardous) for more hazardous solvents. For example, substitution reduced the use of naphtha-based solvents by 90% at the Pantex Plant. Several sites substituted a less harmful material for 1,1,1-trichloroethane.
- Resale to outside manufacturers of virgin chemicals that have exceeded the stringent shelf life requirements of the weapons programs.
- Offsite reclamation of lead batteries (lead acid, gel-cells, and nickel-cadmium), waste oil, and photo fixer for silver reclamation.
- Onsite reclamation and recycling of antifreeze, Freon, and waste oil.
- Implementation of a chemical exchange program whereby chemicals no longer needed were made available for use by other scientists who would otherwise buy additional chemicals.

- Offsite recycle of Freon and methylene chloride resulting in recovery for reuse of approximately 80% of the solvent.
- Replacement of flammable scintillation cocktails with a nonhazardous, biodegradable material that eliminated a mixed waste stream at Brookhaven National Laboratory.

A procedure that may identify opportunities and be a component of a facility's pollution prevention program is the process waste assessment (PWA), also known as a pollution prevention opportunity assessment (PPOA). A PPOA is an analysis of a process or activity to identify opportunities to eliminate or reduce the generation of waste or the consumption of raw materials, water, or energy. Once identified, opportunities are evaluated and compared to determine the most efficient and cost-effective option.

The approach used reflects one method of estimating waste minimization impacts in the absence of installation-specific goals for the reduction of wastes and pollution. A 50% reduction in the future generation of waste to be handled in WM treatment, storage, and disposal (TSD) facilities has been assumed. Cost and risk reductions for the operation of waste management TSD facilities have been calculated based on this assumption. The other factor in cost calculations not yet available is the probable cost of achieving this 50% level of waste generation in the operating facilities that generate the waste. In some instances, such as capital equipment investments to meet the goal, the cost could be substantial and the net dollar gain through pollution prevention would be lower than projected. Since these latter costs cannot yet be calculated, they are considered beyond the scope of this Waste Management Programmatic Environmental Impact Statement (WM PEIS).

G.2 Effect of Pollution Prevention on Waste Management Activities

Executive Order 12856 requires the Secretary of Energy and the heads of other Federal agencies to ensure that the agency develop voluntary goals to either reduce the agency's total release of toxic chemicals to the environment and offsite transfers of such toxic chemicals for treatment and disposal by 50%, or to plan for a 50% reduction in the release or offsite transfer of toxic pollutants. The Executive Order defines toxic chemicals to be those chemicals for which toxic chemical release forms shall be completed pursuant to section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA). Toxic pollutants include toxic chemicals. Federal agencies may choose to include other substances such as extremely hazardous chemicals as defined by EPCRA or hazardous wastes as defined under the Resource Conservation and Recovery Act as toxic pollutants.

The 1994 WMin/PP crosscut plan states that site-specific goals for reduction of wastes and pollution will be set. The Executive Order does not expressly refer to the various waste types; rather, it refers to and defines toxic chemicals and toxic pollutants. The DOE's interpretation of the Executive Order, whether ultimately strict or broad, will influence site-specific goals. It can be expected that these goals will call for source reductions of at least 50% in the aggregate. Source reduction and recycling would be greater than 50% for some waste streams and less than 50% for other waste streams. However, as site-specific pollution prevention plans may not be waste-stream-specific, a simple assumption is made that source reduction and recycling will result in a 50% reduction in the annual transfer to WM of each waste stream for each year of the time spans considered in the WM PEIS. This assumption does not represent the flexibility allowed by DOE policy; more precise estimates require the definition of site-specific goals. However, recent DOE experience indicates that more than a 50% source reduction is achievable for some waste streams.

G.2.1 Waste Types Addressed

DOE's pollution prevention program applies to all DOE activities and all types of waste that these activities generate. This appendix emphasizes pollution prevention as it relates to four waste types: (1) low-level radioactive waste (LLW), (2) low-level mixed waste (LLMW), (3) hazardous waste (HW), and (4) transuranic waste (TRUW). Because high-level waste (HLW) is no longer being generated, pollution prevention activities cannot be applied to HLW.

Much of DOE's pollution prevention policy is directed toward source reduction, which affects WM by reducing the quantity of waste that is transferred to its facilities. Source reduction by generators in Defense Programs, Energy Research, and other DOE offices will affect WM operations significantly by reducing the amount and radioactivity level of waste that WM handles. Source reduction could result in fewer shipments of waste and in either TSD facilities with smaller capacities or fewer TSD facilities.

The following sections contain estimates of reductions in the waste loads to TSD facilities, the cost of constructing and operating these facilities, and the human health risks to the public and workers from a 50% reduction in the annual generation of the four waste types described in WM PEIS Chapters 6–10. The impact of a given percentage reduction in general depends on the existing inventory of waste. If the inventory is large compared with annual generation, then a reduction in annual generation will have little effect because most of the waste processed will be from the inventory. On the other hand, if the inventory is small compared with annual generation, a reduction in annual generation will have a greater effect. For

the four waste types considered, existing inventories are most significant for TRUW and least significant for HW.

G.2.2 LOW-LEVEL WASTE

Estimates of the effect of source reduction on LLW facilities are based on information in the LLW technical report (ANL, 1996a), the WM facility human health risk appendix (Appendix D), and the waste management costs technical report (INEL, 1995a). LLW is divided into 10 waste categories (for example, combustible, surface-contaminated bulk metals and equipment) that define how the waste is treated. Two alternatives with volume reduction treatment (incineration, supercompaction, size reduction, and grout stabilization) are considered here. Regionalized Alternative 2 has volume reduction treatment at 11 sites and disposal at 12 sites; Regionalized Alternative 5 has such treatment at 4 sites and disposal at 6 sites. The waste inventory and annual generation information does not include waste transferred to waste management from environmental restoration (ER) operations. Some of these categories of waste are amenable to recycling. For example, surface-contaminated metals and equipment could be decontaminated and recycled.

G.2.2.1 Waste Load Reductions

Estimates of the effect of pollution prevention are given in Table G-2 for treatment waste loads and in Table G-3 for disposal waste loads. These tables contain waste loads based on current annual generation and waste loads when a 50% decrease in annual generation is assumed. The waste loads are based on the waste inventory and 20 years of annual generation being treated and disposed of in 10 years. It is assumed, in effect, that the inventory and waste generated for 10 years are stored until the treatment facilities become available during a second 10-year period. This assumption does not apply to aqueous waste and saltstone waste at SRS, which will be treated and disposed of over 20 years. Thus, the treatment and disposal waste loads in Tables G-2 and G-3 are for the second 10-year period. The effect of the first 10 years of operation (for aqueous waste and saltstone at SRS) is mainly on the need for disposal capacity. Existing capacity by technology is also given in these tables so that the effect of pollution prevention practices on the need for new capacity can be assessed.

Table G-2. Effect of Pollution Prevention on Waste Management LLW Treatment Waste Loads (Second 10 Years of Treatment)

Treatment Site	Treatment Technology	Existing Capacity (m^3/yr)	Regionalized 2 (m^3/yr)		Regionalized 5 (m^3/yr)	
			Current	WMin/PP[a]	Current	WMin/PP[a]
FEMP	Thermally treat	--	7.7E+02	4.4E+02	*	*
	Solidify	--	3.5E+01	2.0E+01	*	*
	Supercompact	--	NA	NA	*	*
	Size reduce	--	1.0E+02	6.4E+01	*	*
Hanford	Thermally treat	--	5.3	3.0	3.5E+01	2.0E+01
	Solidify	--	5.3E+01	3.0E+01	5.5E+01	3.1E+01
	Supercompact	4.0E+03	4.8E+03	2.4E+03	5.0E+03	2.5E+03
	Size reduce	--	3.1E+03	2.0E+03	3.2E+03	2.0E+03
INEL	Thermally treat[b]	2.3E+03	1.7E+03	1.0E+02	1.0E+04	5.8E+03
	Solidify	2.8E+04	1.0E+03	5.8E+02	1.3E+03	7.4E+02
	Supercompact	5.7E+03	6.8E+02	3.3E+02	5.7E+03	2.9E+03
	Size reduce	5.0E+03	2.1E+03	1.3E+03	7.1E+03	4.5E+03
LANL	Thermally treat	--	5.6E+03	3.2E+03	*	*
	Solidify	--	2.6E+02	1.3E+02	*	*
	Supercompact	--	4.8E+03	2.7E+03	*	*
	Size reduce	--	1.1E+03	6.9E+02	*	*
LLNL	Thermally treat	--	2.9E+01	1.7E+01	*	*
	Solidify	--	2.1E+02	1.2E+02	*	*
	Supercompact	1.5E+03	1.2E+02	5.9E+01	*	*
	Size reduce	1.2E+02	7.5E+01	4.8E+01	*	*
ORR	Thermally treat[b]	--	2.4E+02	1.4E+02	3.1E+03	1.8E+03
	Solidify[c]	--	7.9E+02	4.4E+02	9.3E+02	5.3E+02
	Supercompact	1.4E+03	4.4E+03	2.2E+02	5.0E+03	2.5E+03
	Size reduce	--	1.6E+04	1.0E+04	2.7E+04	1.7E+04
Pantex	Thermally treat	-	NA	NA	*	*
	Solidify	--	6.6E-02	3.8E-02	*	*
	Supercompact	1.1E + 03	1.8E+01	1.0E+01	*	*
	Size reduce	--	2.4E+02	1.5E+02	*	*
PGDP	Thermally treat	--	5.4E+02	3.1E+02	*	*
	Solidify[c]	--	5.4E+01	3.1E+01	*	*
	Supercompact	--	5.8E+02	2.9E+02	*	*
	Size reduce	--	9.4E+01	5.9E+01	*	*
PORTS	Thermally treat	--	1.5E+03	8.8E+02	*	*
	Solidify	--	1.3E+02	7.2E+01	*	*
	Supercompact	--	6.9E+01	3.5E+01	*	*
	Size reduce	--	1.1E+04	6.9E+03	*	*

Table G-2. Effect of Pollution Prevention on Waste Management LLW Treatment Waste Loads (Second 10 Years of Treatment)—Continued

Treatment Site	Treatment Technology	Existing Capacity (m^3/yr)	Regionalized 2 (m^3/yr)		Regionalized 5 (m^3/yr)	
			Current	WMin/PP[a]	Current	WMin/PP[a]
RFETS	Thermally treat	--	2.8E+03	1.6E+03	*	*
	Solidify	--	2.6E+02	1.5E+02	*	*
	Supercompact	5.6E+03	5.9	3.0	*	*
	Size reduce	--	4.2E+02	2.7E+02	*	*
SRS	Thermally treat[b]	8.2E+03	1.5E+03	8.3E+02	1.5E+03	8.3E+02
	Solidify	2.1E+02	2.0E+03	1.1E+03	2.0E+03	1.1E+03
	Supercompact	4.0E+03	9.4E+03	4.7E+03	9.4E+03	4.7E+03
	Size reduce	--	9.2E+02	5.8E+02	9.2E+02	5.8E+02

Notes: -- = no existing capacity; * = not a treatment site for this alternative.
[a] The pollution prevention case assumes a 50% reduction in annual generation. When the waste inventory to be worked off over 10 years is taken into account, the waste loads are 57.5%, 56.6%, 50.4%, and 62.5% of the no reduction waste loads for thermal treatment, solidification, supercompaction, and size reduction, respectively.
[b] There are thermal treatment facilities at INEL, ORR, and SRS; these are assumed to be dedicated to treating LLMW and unavailable for LLW.
[c] For ORR and PGDP, the existing solidification capacities are assumed to be adequate to meet the no action waste loads.

Table G-3. Effect of Source Reductions on Waste Management LLW Disposal Waste Loads (Second 10 Years of Disposal)

Disposal Site	Existing Disposal Capacity (m^3/yr)	Regionalized 2 (m^3/yr)		Regionalized 5 (m^3/yr)	
		Current	WMin/PP[a]	Current	WMin/PP
Hanford	8.5E+03	2.1E+03	1.1E+03	2.1E+03	1.1E+03
INEL	3.9E+03	3.9E+03	2.0E+03	4.7E+03	2.6E+03
NTS	4.5E+04	1.8E+02	9.1E+01	2.7E+02	1.4E+02
LANL	1.3E+03	5.1E+03	2.7E+03	6.4E+03	3.5E+03
ORR	6.0E+02	1.3E+04	8.2E+03	4.1E+04	2.3E+04
SRS	5.4E+03	4.5E+04	2.3E+04	4.6E+04	2.3E+04
PORTS	+	1.2E+04	6.3E+03	*	*
PGDP	+	4.2E+03	2.1E+03	*	*
LLNL	+	6.2E+02	3.1E+02	*	*
Pantex	+	2.9E+02	1.8E+02	*	*
RFETS	+	1.0E+03	6.3E+02	*	*

Notes: + = no existing capacity; * = not a disposal site for this case.
[a] The pollution prevention results are based on a 50% reduction in annual generation. However, the volumes disposed of decrease by less than 50% because the category-dependent inventory is also being disposed of.

The waste loads for the pollution prevention cases with a 50% reduction in annual generation are more than 50% of the base cases, that is, a 50% reduction in annual generation rate results in less than a 50% reduction in waste load. This is because the waste loads include existing inventories of waste that are treated along with the new waste. The ratio of inventory to annual generation is dependent on waste category and site. For simplicity, complex-averaged ratios are used for each waste category. These complexwide waste load reductions are 42.5% for thermal treatment, 43.4% for solidification, 49.6% for supercompaction, and 37.5% for size reduction. For the four technologies considered, source reduction is estimated to be most effective in reducing waste loads for supercompaction and least effective in reducing waste loads for size reduction. Overall, the total waste load reduction for the four volume reduction technologies is estimated to be approximately 43%. The waste categories contributing to each volume reduction treatment are taken from ANL (1996a).

As Table G-2 shows, a majority of the 11 sites have no existing capacity for most volume reduction treatments listed in the table. Except for the Idaho National Engineering Laboratory (INEL), the other DOE sites do not have existing capacities for the complete set of the volume reduction technologies considered. Source reduction would reduce the capacities required of new facilities. For the alternatives considered, an annual generation reduction of 50% is estimated to eliminate the need for additional supercompaction capacity at the Hanford Site; for the cases with four regional treatment centers, this annual generation reduction also would eliminate the need for new supercompaction and size reduction capacity at the INEL.

As indicated in Table G-3, the assumed annual waste generation reduction from pollution prevention practices affects the adequacy of the existing disposal capacity at INEL. Without the reduction in annual generation, the capacity is inadequate; with an assumed 50% reduction in annual generation, it is adequate. For new disposal sites and some existing disposal sites (LANL, ORR, and SRS), generation reduction would reduce the amount of new capacity needed. For Hanford and the Nevada Test Site (NTS), the existing disposal capacities are adequate regardless of generation reduction. Overall, a 50% generation reduction is estimated to result in approximately a 48% reduction in disposal waste loads.

G.2.2.2 Cost Savings

Cost savings from pollution prevention reductions are estimated for treatment, disposal, and transportation. Because installation-specific goals are as yet unavailable, it is assumed that pollution prevention practices reduce new source generation by the same percentage (50%) throughout the DOE complex. There may be

additional costs to waste generators to effect such waste generation reductions; however, the costs of making reductions are beyond the scope of this WM PEIS. The savings from waste generation reduction considered here are the waste management cost savings, which may be higher than the net savings.

Waste management cost savings associated with treatment, disposal, and transportation are considered. These are based on planning-level life-cycle costs for 10 years of operations (see INEL, 1995a) and the Site Data Tables in Volume II. Facility costs for treatment and disposal can be considered to consist of costs related to operations and costs related to construction. Operations costs are assumed to be proportional to throughput (waste load). Cost savings for construction depends on whether there are existing facilities for the type of treatment at a site. If there are no existing facilities, then costs for construction are assumed to be proportional to waste load. If there are existing facilities, then costs for construction are assumed to be proportional to the difference between the existing capacity and the capacity needed to process (or dispose of) the waste load. A given percentage reduction in waste load results in a greater percentage decrease in capacity needed when there is existing capacity. For example, if existing capacity is half the capacity needed to treat a given waste load, a reduction of 40% in waste load will result in an 80% reduction in the new capacity needed. In general, if the existing waste load is equivalent to E; the fractional decrease in waste loads with pollution prevention is equivalent to F; the additional capacity needed without pollution prevention is equivalent to Δ; and Δ_{WMin} is the additional capacity needed with pollution prevention, then the fractional new capacity needed is:

$$\Delta_{WMin}/\Delta = (1 - F) - F \times E/\Delta \qquad (G.1)$$

Cost savings have been estimated for the two volume reduction cases considered above. Estimates of cost savings for treatment at the sites with volume reduction facilities are presented in Table G–4. The treatment costs considered are for thermal treatment, grout stabilization, supercompaction, size reduction (i.e., shredding and compacting), packaging, and certification and shipping. The same percentage decreases in costs (F) for thermal treatment, grout stabilization, size reduction, and supercompaction are used as percentage decreases in waste load (see Table G–2). The percentage decreases in costs for packaging and certification and shipping are taken to be the cost-weighted average for thermal treatment, grout stabilization, supercompaction, and size reduction. When there is an existing facility, the complement of Δ_{WMin}/Δ from equation (G.1) is used for the fractional decrease in construction costs. If equation (G.1) is negative, then the existing capacity is adequate for the assumed decrease in annual generation rate.

For three situations, the existing capacity is estimated to become inadequate for reductions in annual generation of between 0 and 50%. For a generation reduction of less than 26%, existing supercompaction capacity at the Hanford Site becomes inadequate; for a generation reduction of less than 10%, the existing supercompaction capacity at INEL becomes inadequate; and for a generation reduction of less than 37%, the existing size reduction capacity at INEL becomes inadequate. From Table G-4, overall, a 50% generation reduction is estimated to result in approximately a 40% reduction in costs for treatment.

Estimates of cost savings for disposal for an assumed 50% reduction in annual generation of LLW are given in Table G-5 for the alternatives being considered. Percentage cost reductions for disposal are assumed to be equal to percentage waste load reductions for disposal for operations and for construction when there is no existing disposal facility. When there is an existing facility, then the complement of equation (G.1) is used. Overall, a 50% reduction in annual generation is estimated to result in approximately a 48% reduction in disposal costs.

The waste management costs technical report (INEL, 1995a) also contains estimates of transportation costs of LLW for the two volume reduction cases being considered. From the volume information in (ANL, 1996a), percentage waste load reductions by generating site for a 50% reduction in annual LLW generation were calculated by volume-averaging over waste categories. These generating-site percentage load reductions were multiplied by the transportation costs from each site to yield an estimate of the reduction in transportation costs from a 50% reduction in annual generation. Thus, this estimate is based on the assumption that the cost of transporting waste is proportional to the volume of waste moved and that all transport is from the generation site. Table G-6 contains the estimate of the total savings in transportation and the total savings for treatment and disposal from the information in Tables G-4 and G-5, respectively. Overall cost reductions for treatment, disposal, and transportation are estimated to be approximately 45% for a 50% reduction in annual generation.

The total savings are in the range of $8 to $9 billion for 10 years of operations. These values are for a 20-year interval (inventory and 20 years of waste generation are treated and disposed of in 10 years) and are approximately $400 million per year. This estimate of savings is consistent with a recent estimate of avoidable DOE waste management costs (Teclaw et al., 1993), which estimated avoidable annual costs for LLW of between $10 million and $10 billion.

Table G-4. Effect of Pollution Prevention on Costs of Waste Management LLW Treatment[a] for Two Volume Reduction Alternatives (in dollars)

Installation	Regionalized 2		Regionalized 5	
	Current	WMin/PP[b]	Current	WMin/PP
FEMP	3.12E+08	1.83E+08	--	--
Hanford	9.62E+08	5.88E+08	1.00E+09	6.12E+08
INEL	1.11E+09	6.34E+08	2.86E+09	1.63E+09
LANL	8.12E+08	4.81E+08	--	--
LLNL	2.82E+08	1.60E+08	--	--
ORR	3.77E+09	2.38E+09	4.52E+09	2.82E+09
Pantex	1.42E+08	8.92E+07	--	--
PGDP	4.85E+08	2.88E+08	--	--
PORTS	9.14E+08	5.70E+08	--	--
RFETS	6.90E+08	4.08E+08	--	--
SRS	1.27E+09	7.17E+08	1.27E+09	7.48E+08
Total	1.07E+10	6.57E+09	9.65E+09	5.81E+09

Note: -- = not a regional treatment site for this alternative.
[a] Treatments considered are thermal treatment, grout stabilization, supercompaction, size reduction (i.e., shredding and compaction), packaging, and certification and shipment. The cost of other treatment steps is not considered for LLW in this Appendix.
[b] A 50% reduction annual generation rate is assumed. Costs for operations are assumed to be proportional to throughput. Cost reductions for construction depends on whether there are existing facilities or not. If there are no existing facilities, costs for construction are assumed to be proportional to throughput. If there are existing facilities, cost for construction are proportional to the capacity of new construction needed.

G.2.2.3 Human Health Risk Reduction

For the volume reduction cases considered above, reductions in human health risk from reduction in annual generation are estimated for routine operations at the volume-reduction treatment centers and disposal sites. Incidence of cancer is taken as the measure of human risk because it applies to the four waste types considered in this appendix (person-rem would apply to LLW, LLMW, and TRUW, but not to HW). Cancer incidence based on the risk from the second 10 years of treatment and storage, not risks per year of operations, were obtained from tables in the human health risk appendix (Appendix D).

Table G-5. Effect of Pollution Prevention 50% Reduction in Annual Generation on Costs for Waste Management LLW Disposal in Two Volume Reduction Alternatives (in dollars)

Installation	Regionalized 2		Regionalized 5	
	Current	WMin/PP	Current	WMin/PP
Hanford	3.8E+08	2.0E+08	3.8E+08	2.1E+08
INEL	4.2E+08	2.2E+08	6.2E+08	3.1E+08
LANL	6.0E+08	3.1E+08	1.8E+09	9.8E+08
LLNL	3.1E+08	1.6E+08	NA	NA
NTS	2.0E+07	1.1E+07	5.9E+07	3.1E+07
ORR	3.7E+08	2.1E+08	8.0E+08	4.3E+08
Pantex	8.0E+07	5.1E+07	NA	NA
PGDP	3.1E+08	1.6E+08	NA	NA
PORTS	5.2E+08	2.7E+08	NA	NA
RFETS	3.5E+08	1.8E+08	NA	NA
SRS	3.4E+09	1.7E+09	3.4E+09	1.7E+09
Total	6.8E+09	3.4E+09	6.6E+09	3.7E+09

Note: NA = not applicable; not a disposal site for this alternative.

Table G-6. Summary of Effect of Pollution Prevention 50% Reduction in Annual Generation on Costs[a] for Waste Management LLW in Two Volume Reduction Alternatives (in dollars)

Activity	Regionalized 2		Regionalized 5	
	Current	WMin/PP	Current	WMin/PP
Treatment[b]	1.0E+10	6.6E+09	9.6E+09	5.8E+09
Disposal	6.8E+10	3.4E+09	6.6E+09	3.7E+09
Transportation[c]	6.4E+07	3.3E+07	3.3E+08	2.1E+08

[a] Costs are life-cycle costs for treatment at regional treatment facilities, disposal, and all transportation.
[b] Treatments considered are thermal treatment, supercompaction, size reduction, packaging, and certification and shipment.
[c] Based on transport by truck.

Table G–7 contains estimates of the effect of a 50% across-the-board reduction in annual generation on cancer incidence among the offsite population and WM workers at sites with volume-reduction facilities. The alternatives considered have either 11 or 4 sites with volume reduction facilities. The radiological risk to the offsite population at the sites with volume reduction facilities arises mainly from releases from thermal treatment facilities. Thus, the effect of generation reduction is estimated on the basis of inventory and annual generation (with and without reduction) of waste in the two LLW categories (combustible, compactible solids; organic liquids) that feed a specific thermal treatment facility. There is an exception for the Pantex Plant volume reduction center, which does not treat the waste categories undergoing thermal treatment. At the Pantex Plant, the health risk to the offsite population is assumed to arise from size-reduction treatment. The human health risk to workers is more evenly distributed among treatment facilities, with the risk being greatest at handling facilities where all waste categories are handled. Therefore, the effect of source reduction is estimated on the basis of the ratio of inventory to annual generation for all waste categories for the LLW treated at a volume-reduction site. From Table G–7, a 50% source reduction is estimated to result in approximately a 46% reduction in cancer incidence to both the general public and workers at treatment facilities.

Table G–8 contains estimates of the effects of a 50% across-the-board reduction in annual generation on human health risk at disposal facilities. Here, the assumed population consists of farm families that are at risk through the groundwater pathway. The percentage reduction in risk at a site from source reduction to these farm families is taken to be the same as the reduction in disposal waste load in Table G–3. Overall, a 50% source reduction is estimated to result in a 49% human health risk reduction to farm families.

G.2.3 Low-Level Mixed Waste

LLMW is waste that contains both radioactive material and hazardous material. Thus LLMW should be processed so that the hazardous constituents can be treated in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA) and the radioactive components are treated for safe disposal. LLMW may be classified as either contact-handled (CH: dose at waste surface <200 mrem/h) or remote-handled (RH: dose at waste surface >200 mrem/h); and also as either alpha LLMW (combined activity of transuranic radionuclides between 10 and 100 nCi/g), or non-alpha LLMW (combined activity of transuranic radionuclides <10 nCi/g). The technologies appropriate for treatment of LLW depend on

Table G-7. Effect of Pollution Prevention 50% Reduction in Annual Generation on Health Risks from Waste Management LLW Treatment (Cancer Incidence Among the Offsite Population and WM Workers for Second 10 Years of Treatment)

Site	Receptor	Regionalized 2		Regionalized 5	
		Current	WMin/PP	Current	WMin/PP
FEMP	Population[a]	7.9E-01	4.3E-01	--	--
	Worker[b]	2.3E-02	1.2E-02		
Hanford	Population	1.2E-05	6.0E-06	1.6E-01	8.6E-02
	Worker	6.9E-01	3.5E-01	7.2E-01	3.6E-01
INEL	Population	4.6E-06	2.5E-06	1.4E-03	7.6E-04
	Worker	5.8E-01	3.0E-01	1.9	1.2
LANL	Population	2.7E-02	1.4E-02	--	--
	Worker	6.5E-01	3.4E-01		
LLNL	Population	1.3	7.0E-01	--	--
	Worker	1.7E-01	1.2E-01		
ORR	Population	2.8E-04	2.5E-04	1.0	5.0E-01
	Worker	1.1	6.7E-01	1.5	9.1E-01
Pantex	Population	1.5E-06	1.3E-06	--	--
	Worker	2.7E-03	2.5E-03		
PGDP	Population	6.4E-06	4.2E-06	--	--
	Worker	5.8E-03	3.2E-03		
PORTS	Population	1.8E-04	9.8E-05	--	--
	Worker	9.6E-02	4.9E-02		
RFETS	Population	6.3E-04	3.3E-04	--	--
	Worker	4.0E-03	2.1E-03		
SRS	Population	2.1E-03	1.8E-03	2.1E-03	1.8E-03
	Worker	9.6E-01	4.8E-01	9.6E-01	4.8E-01

Note: -- = not a volume-reduction treatment center for this case.

[a] Risk to the offsite population is assumed to arise predominantly from releases from thermal treatment. The reduction in risk from a 50% source reduction is estimated on the basis of site-specific inventories and annual generation rates for the waste categories that are thermally treated (Categories 1 and 9). At the Pantex Plant, which does not have thermal treatment, reduction in risk is based on size reduction treatment of waste categories 3 and 4.

[b] Risk to workers is relatively evenly distributed among treatments; site-specific inventories and annual generation averaged over all waste categories for the sites of origin are used to estimate the reduction in risk to workers from a 50% source reduction.

Table G–8. Effect of Pollution Prevention Reduction on Health Risk From Waste Management LLW Disposal (Cancer Incidence Among All Farm Family Lifetimes for Second 10 Years of Disposal)

Disposal Site	Regionalized 2		Regionalized 5	
	Current	WMin/PP[a]	Current	WMin/PP
Hanford	2.1E-01	1.2E-01	6.1E-01	3.4E-01
INEL	0	0	0	0
NTS	0	0	0	0
LANL	0	0	0	0
ORR	7.7E-05	4.8E-05	3.6E-05	2.2E-05
SRS	7.2E-03	3.6E-03	7.2E-03	3.6E-03
PORTS	4.5E-04	3.8E-04	*	*
PGDP	2.8E-02	1.4E-02	*	*
LLNL	2.3E-04	1.2E-04	*	*
Pantex	0	0	*	*
RFETS	2.1E-05	1.1E-05	*	*

Note: * = not a disposal site.
[a] The WMin/PP results are based on a 50% reduction in annual generation. However, the volumes disposed of decrease by less than 50% because the category-dependent inventory is also being disposed of.

the physical and chemical properties of the waste. In contrast, technologies appropriate for treatment of LLMW depend on both the physical and chemical properties of the waste, and on the RCRA contaminant category of the hazardous constituents. Only general categories of RCRA contaminants frequent in DOE waste have been considered. These are toxic organics, toxic metals, mercury, ignitables, corrosives, reactives, and combinations thereof. LLMW may require treatment by several technologies in series.

Estimates of the effect of a 50% reduction in annual generation have been made for three diverse alternatives for LLMW generated from waste management operations (WM LLMW). These are the Decentralized Alternative with disposal of CH LLMW at 16 sites, Regionalized Alternative 2 with treatment of CH non-alpha LLMW at 7 sites and disposal at 6 sites, and the Centralized Alternative with all CH treatment and disposal at one site, the Hanford Site. Estimates of the effect of this source reduction are based on information in the LLMW technical report (ANL, 1996b); Appendix D, "Waste Management Facility Human Health Risk Estimates;" and the waste management costs technical report (INEL, 1995b).

G.2.3.1 Waste Load Reductions

Estimates on annual treatment waste load of the effect of a 50% step decrease in generation of WM LLMW are given in Tables G-9 and G-10 for CH non-alpha LLMW and CH alpha LLMW, respectively. The waste loads without the WMin/PP source reduction (the columns labeled "Current") are from ANL (1996b). The effect of pollution prevention was obtained from the site-totaled inventories and annual generation rates and the assumption that inventory and 20 years of generation will be treated and disposed of in a 10-year period. With the assumed 50% reduction in annual generation, in effect, 20 years of generation is reduced to 10 years of generation. The ratio of inventory plus 10 years of generation to inventory plus 20 years of generation gives the impact of pollution prevention. This ratio is applied to the contribution to the waste load at a treatment site from a generation site. From these tables, it is seen that waste minimization is more effective in reducing the CH non-alpha waste load than the CH alpha waste loads. For CH non-alpha LLMW, the assumed 50% reduction is estimated to reduce the overall waste load by approximately 36%, while the same percentage decrease in annual generation of CH alpha LLMW is estimated to decrease CH alpha waste load by only approximately 9%. Table G-11 gives the estimated percentage decreases from a 50% source reduction for RH non-alpha LLMW.

The percentage reductions in the waste loads from a 50% source reduction for disposal of waste management CH non-alpha LLMW and waste management CH alpha LLMW are given in Tables G-12 and G-13, respectively. As can be shown from these tables, the impact of the assumed decrease in annual generation disposal waste loads is similar to the impact on treatment waste loads, namely, approximately a 35% reduction for non-alpha waste and a 9% reduction for alpha waste.

Some existing facilities in the DOE complex were assumed to be used for treatment of LLMW. Conversely, because disposal facilities for LLMW would have to be permitted pursuant to RCRA and existing DOE disposal facilities do not have such permits, it was assumed that there are no existing disposal facilities for LLMW. Table G-14 gives the capacities of existing treatment facilities (ANL, 1996b), except for aqueous treatment, the capacities required without source reduction, and the capacities required with the assumed source reduction. From the table it is seen that the existing capacities are adequate for those sites and technologies.

Table G-9. Percentage Reduction in Annual Treatment Throughput of Waste Management CH Non-Alpha LLMW

Site	Decentralized		Regionalized 2		Centralized	
	Current[a]	% Reduct[b]	Current	% Reduct	Current	% Reduct
Ames	4.0E-02	12	--	--	--	--
ANL-E	1.6E+01	40	--	--	--	--
ANL-W	2.0	21	--	--	--	--
BCL	1.0E-02	50	--	--	--	--
BNL	1.9E+01	28	--	--	--	--
Bettis	4.8	23	--	--	--	--
Charleston	3.0E-01	46	--	--	--	--
CISS	1.1	0	--	--	--	--
ETEC	1.7	24	--	--	--	--
FEMP	2.6E+02	1	--	--	--	--
GA	4.3	1	--	--	--	--
GJPO	1.5E-01	29	--	--	--	--
Hanford	3.6E+03	45	3.7E+03	46	1.4E+04	36
INEL	1.8E+02	30	6.1E+02	36	--	--
ITRI	3.5	46	--	--	--	--
K-25	2.7E+03	30	--	--	--	--
KAPL-S	8.3	49	--	--	--	--
KAPL-K	1.0E+01	49	--	--	--	--
KAPL-W	4.0	50	--	--	--	--
KCP	8.0E-02	0	--	--	--	--
LANL	3.8E+01	25	1.2E+02	32	--	--
LBL	2.8E+01	46	--	--	--	--
LEHR	7.0E-01	17	--	--	--	--
LLNL	2.2E+02	47	--	--	--	--
Mound	2.2E-03	25	--	--	--	--
Mare Is	5.2	41	--	--	--	--
Norfolk	6.0E-01	50	--	--	--	--
NTS	3.0E+02	45	--	--	--	--
ORR[d]	5.9E+03	36	6.3E+03	25	--	--

Table G-9. Percentage Reduction in Annual Treatment Throughput of Waste Management CH Non-Alpha LLMW—Continued

Site	Decentralized		Regionalized 2		Centralized	
	Current[a]	% Reduct[b]	Current	% Reduct	Current	% Reduct
Pantex	6.9E+01	40	--	--	--	--
PGDP	6.0E+01	0	--	--	--	--
Pearl H	6.0E-01	32	--	--	--	--
Ports Nav	1.0E-01	33	--	--	--	--
PORTS	3.3E+03	42	3.5E+03	38	--	--
PPPL	2.0E-03	25	--	--	--	--
Puget So	2.3E+01	33	--	--	--	--
RFETS	0	NA[c]	1.9E-01	20	--	--
RMI	2.9	12	--	--	--	--
SNL-CA	1.1E+01	45	--	--	--	--
SNL-NM	1.0E+01	0	--	--	--	--
SRS	9.4E+02	38	9.4E+02	38	--	--
Y-12	1.8E+03	19	--	--	--	--

Note: -- = not a treatment site under the Regionalized or Centralized Alternatives.
[a] Annual throughput in m^3.
[b] Percentage reduction annual throughout from a 50% reduction in annual generation.
[c] NA = not applicable because no CH non-alpha LLMW is generated at RFETS.
[d] ORR includes K-25, Y-12, and ORNL.

Table G-10. Reduction in Annual Treatment Throughput of Waste Management CH Alpha LLMW From a 50% Decrease in Annual Generation

Site	Decentralized		Regionalized 2		Centralized	
	Current	% Reduct	Current	% Reduct	Current	% Reduct
Hanford	--	--	--	--	1.0E+00	9
INEL	2.5E+03	0	2.5E+03	4	--	--
LANL	2.1E+02	42	2.1E+02	42	--	--
LLNL	2.0E+02	48	--	--	--	--
Mound	8.0	4	--	--	--	--
RFETS	2.1E+03	10	6.9E+03	10	--	--
SRS	4.1E+02	14	4.2E+02	14	--	--
WVDP	5.5	29	--	--	--	--

Note: -- = not a regional treatment site.

Table G-11. Percentage Reduction in Annual Treatment and Disposal Throughput of Waste Management RH Non-Alpha LLMW From a 50% Decrease in Annual Generation

Site	Treatment (m^3/yr)	Disposal (m^3/yr)	Reduction (%)
Hanford	7.4E-02	1.2E-02	0
INEL	8.6E+02	1.5E+02	49
ORR	3.5E+02	7.0E+02	17
SRS	2.8	8.8E-01	47

Table G-12. Percentage Reduction in Annual Disposal Throughput (m^3/yr) for Waste Management CH Non-Alpha LLMW

	Decentralized		Regionalized 2		Centralized	
Disposal Site	Current	% Reduct[a]	Current	% Reduct	Current	% Reduct
ANL-E	1.4E+02	40	--	--	--	--
BNL	8.4E+01	28	--	--	--	--
FEMP	1.1E+02	1	--	--	--	--
Hanford	1.3E+03	46	1.3E+03	46	5.3E+03	35
INEL	4.3E+01	30	1.4E+02	26	--	--
LANL	1.1E+01	25	3.3E+02	33	--	--
LLNL	1.9E+02	34	--	--	--	--
NTS	1.0E+01	50	--	--	--	--
ORR	1.5E+03	25	1.1E+04	32	--	--
Pantex	2.0E+01	40	--	--	--	--
PGDP	2.2E+01	0	--	--	--	--
PORTS	5.8E+02	42	--	--	--	--
RFETS	5.7E-01	29	--	--	--	--
SNL-NM	1.4	1	--	--	--	--
SRS	4.4E+02	38	4.5E+02	38	--	--

Note: -- = not a disposal site for this alternative.
[a] Percentage reduction annual throughput from a 50% reduction in annual generation.

Table G-13. Percentage Reduction in Annual Disposal Throughput for Waste Management CH Alpha LLMW

Disposal Site	Decentralized		Regionalized 2		Centralized	
	Current[a]	% Reduct[b]	Current	% Reduct	Current	% Reduct
Hanford	--	--	--	--	3.2E+03	9
INEL	6.1E+02	0	7.0E+02	6	--	--
LANL	5.6E+01	21	2.4E+03	10	--	--
LLNL	8.1E+01	48	--	--	--	--
RFETS	2.3E+03	10	--	--	--	--
SRS	1.1E+02	14	1.1E+02	14	--	--
WVDP	1.1	29	--	--	--	--

Note: -- = not a disposal site for this alternative.
[a] Annual throughput in m^3.
[b] Percentage reduction annual throughout from a 50% reduction in annual generation.

G.2.3.2 Cost Savings

Cost savings associated with the treatment, disposal, and transportation of CH waste management LLMW are considered. These are based on planning-level life-cycle costs for 10 years of operations (see INEL, 1995b). As with LLW, treatment and disposal costs are divided into operations costs and construction (or capital) costs. Operations costs are assumed to be proportional to throughput and (waste load). Capital costs are assumed to be proportional to throughput also, except when there is existing capacity for a specific treatment step that is inadequate for the waste load. However, as shown in Table G-14, the existing capacity is adequate for the waste load. Therefore, capital costs are also assumed to be proportional to waste load, because no new capacity is needed when there is existing capacity.

Estimates of the impact of a 50% reduction in annual generation for the three alternatives being considered are given in Table G-15 for CH waste management LLMW, both non-alpha and alpha. The transportation, operations, and capital costs without pollution prevention reductions are from INEL (1995b). The table indicates that for the assumed source reduction and linearity between waste load and cost, substantial savings may result from pollution prevention reductions. These savings range from over $3 billion for the Decentralized Alternative to nearly $2 billion for the Centralized Alternative.

Table G-14. Effect of Pollution Prevention 50% Reduction in Annual Generation on the Need for New Facilities to Meet Waste Management CH Non-Alpha LLMW Treatment Needs

Site/Facility	Existing Capacity (kg/h)[a]	Current WMin/PP	Capacity Required (kg/h)		
			Decentralized	Regionalized 2	Centralized
Hanford					
GROUT	2.1E+03	Current	3.1E+02	3.3E+02	1.1E+03
		WMin/PP	1.6E+02	1.8E+02	6.8E+02
INEL					
INCIN	3.2E+02	Current	7.3	1.5E+01	--
		WMin/PP	5.0	1.1E+01	--
GROUT	3.8E+02	Current	8.6	4.1E+01	1.0E-02
		WMin/PP	5.9	3.0E+01	7.E-03
ORR					
INCIN	1.9E+03	Current	5.9E+02	6.4E+02	--
		WMin/PP	3.8E+02	5.0E+02	--
Pantex					
GROUT	1.0E+01	Current	3.8	7.3E-02	7.3E-02
		WMin/PP	2.3	4.4E-02	4.4E-02
RFETS					
GROUT	3.8E+03	Current	--	1.5E-02	--
		WMin/PP	--	1.2E-02	--
SRS					
INCIN	1.1E+03	Current	1.7E+02	1.7E+02	--
		WMin/PP	1.0E+02	1.1E+02	--
GROUT	5.9E+03	Current	5.0E+1	5.0E+01	1.0E-02
		WMin/PP	3.1E+01	3.1E+01	6.8E-03

Notes: -- = no throughput for this process for this alternative; INCIN = thermal treatment; GROUT = grout stabilization.
[a] 1 kg/h≡7.1 m^3/yr.

G.2.3.3 Human Health Risk Reduction

Reductions in human health risk for a 50% reduction in annual generation are estimated for routine operations of treatment facilities and from long-term releases from disposal facilities. As before, cancer incidence is taken as the measure of human health risk. For treatment facilities, cancer incidence among two populations are considered, the offsite population and WM workers. For disposal facilities, the risk to all nearby farm family generations is considered. For LLMW, cancer incidence arises from exposure to chemical carcinogens as well as from radiological doses. The estimated reductions in cancer incidence among the offsite population near treatment site, among WM workers at treatment sites, and among farm family generations near disposal sites are given in Tables G-16 through G-18, respectively. As before, it is assumed that health risk decreases linearly with waste load.

Table G–15. Effect of Pollution Prevention on Cost of Treatment, Disposal, and Transportation of CH Waste Management LLMW (in dollars)

Case/Operation	Non-Alpha		Alpha[a]	
	Current	WMin/PP	Current	WMin/PP
Decentralized				
Treatment				
Operations & maintenance	4.0E+09	2.6E+09	2.2E+09	1.8E+09
Capital	2.0E+09	1.4E+09	1.5E+09	1.3E+09
Disposal				
Operations & maintenance	1.1E+09	6.6E+08	7.6E+08	7.0E+08
Capital	2.7E+08	1.7E+08	3.0E+08	3.0E+08
Transportation	4.8E+05	3.5E+05	1.7E+05	1.4E+05
Total	7.4E+09	4.8E+09	4.8E+09	4.1E+09
Regionalized 2				
Treatment				
Operations & maintenance	2.7E+09	1.8E+09	2.5E+09	2.2E+09
Capital	9.1E+08	6.0E+08	1.6E+09	1.4E+09
Disposal				
Operations & maintenance	8.2E+08	5.0E+08	6.5E+08	5.8E+08
Capital	1.8E+08	1.0E+08	9.1E+07	8.2E+07
Transportation	1.5E+07	9.5E+06	8.4E+06	7.4E+06
Total	4.3E+09	2.8E+09	4.5E+09	4.0E+09
Centralized				
Treatment				
Operations & maintenance	2.8E+09	1.9E+09	2.0E+09	1.9E+09
Capital	7.6E+08	5.2E+08	1.2E+09	1.0E+09
Disposal				
Operations & maintenance	5.3E+08	2.9E+08	3.1E+08	2.9E+08
Capital	5.4E+07	2.9E+07	4.3E+07	3.9E+07
Transportation	1.9E+07	1.3E+07	7.8E+06	6.8E+06
Total	3.8E+09	2.5E+09	3.3E+09	2.9E+09

[a] CH non-alpha waste generated at INEL and LANL are treated at INEL and LANL CH alpha facilities.

Table G-16. Percentage Reduction in Risk to the Offsite Population[a] for Treatment of Waste Management LLMW

Site	Decentralized		Regionalized 2		Centralized	
	Current	% Reduct[b]	Current	% Reduct	Current	% Reduct
ANL-E	5.6E-05	40	2.0E-06	40	2.0E-06	40
BNL	4.1E-05	28	1.9E-07	28	1.9E-07	28
FEMP	9.1E-05	1	5.8E-07	1	5.8E-07	1
Hanford	5.0E-03	45	4.5E-02	45	8.5E-02	36
INEL	1.8E-04	30	2.1E-03	36	1.7E-05	36
KAPL-K	1.0E-03	49	8.9E-07	49	8.9E-07	49
KCP	1.3E-05	0	8.4E-09	0	8.4E-09	0
LANL	2.0E-03	25	2.9E-03	32	1.3E-04	25
LBL	3.5E-02	46	4.9E-08	46	4.9E-08	46
LLNL	5.2E-01	47	1.9E-06	47	1.9E-06	47
Mound	4.3E-04	25	7.3E-08	25	7.4E-08	25
NTS	2.7E-06	45	2.2E-08	45	2.2E-08	45
ORR	3.7E-03	25	4.1E-03	25	2.4E-05	25
Pantex	1.2E-04	40	8.0E-06	40	8.0E-06	40
PGDP	4.1E-04	0	2.8E-06	0	2.8E-06	0
PORTS	1.2E-05	42	3.6E-04	38	1.1E-07	38
RFETS	2.3E-04	20	2.4E-04	20	4.9E-06	20
SNL-NM	4.7E-04	0	6.1E-08	0	6.1E-08	0
SRS	5.9E-03	38	6.0E-03	38	4.6E-06	38
WVDP	8.6E-07	50	5.8E-07	50	5.9E-07	50
Total	5.8E-01	47	6.1E-02	42	8.6E-02	36

[a] Cancer incidence among the offsite population from radiation and chemical carcinogens.
[b] Percentage reduction in risk based on a 50% reduction in annual generation of LLMW.

Table G-17. Percentage Reduction in Risk to WM Workers[a] for Treatment of Waste Management LLMW

Site	Decentralized		Regionalized 2		Centralized	
	Current	% Reduct[b]	Current	% Reduct	Current	% Reduct
ANL-E	2.3E-04	40	1.1E-04	40	1.1E-04	40
BNL	4.3E-04	28	2.0E-04	28	2.0E-04	28
FEMP	1.1E-03	1	8.8E-04	1	8.8E-04	1
Hanford	3.6E-01	45	5.0E-01	45	1.8E+00	36
INEL	3.6E-01	30	3.9E-01	36	2.5E-01	36
KAPL-K	6.2E-03	49	2.2E-02	49	2.2E-03	49
KCP	1.2E-04	0	2.8E-06	0	2.8E-06	0
LANL	5.5E-03	25	8.2E-03	32	2.4E-03	25
LBL	1.3E-04	46	7.4E-05	46	7.4E-05	46
LLNL	2.8E-02	47	2.2E-03	47	2.2E-03	47
Mound	4.7E-05	25	4.3E-05	25	4.6E-05	25
NTS	4.8E-02	12	1.0E-02	12	1.0E-02	12
ORR	6.2E-01	25	4.2E-01	25	8.4E-02	25
Pantex	1.2E-03	40	5.8E-04	40	5.8E-04	40
PGDP	8.5E-04	0	5.2E-04	0	5.2E-04	0
PORTS	5.6E-03	42	2.7E-01	42	2.9E-03	42
RFETS	4.1E-03	20	4.6E-03	20	3.5E-03	20
SNL-NM	1.2E-03	0	6.1E-05	0	6.1E-05	0
SRS	3.7E-01	38	3.8E-01	38	1.1E-01	38
WVDP	8.6E-03	50	9.7E-05	50	1.0E-04	50
Total	1.8E+00	34	2.0E+00	36	2.3E+00	37

[a] Cancer incidence among the WM workers from radiation and chemical carcinogens.
[b] Percentage reduction in risk based on a 50% reduction in annual generation of LLMW.

Table G-18. Percentage Reduction in Risk[a] From Disposal of CH Waste Management LLMW

Disposal Site	Decentralized		Regionalized 2		Centralized	
	Current	% Reduct[b]	Current	% Reduct	Current	% Reduct
ANL-E	6.4E-04	40	--	--	--	--
BNL	9.0E-03	28	--	--	--	--
FEMP	2.6E-04	1	--	--	--	--
Hanford	6.5E-02	46	8.0E-02	46	8.7E-01	35
INEL	4.1E-05	30	4.2E-05	26	--	
LANL	5.5E-03	25	3.2E-03	33	--	--
LLNL	2.6E-04	34	--	--	--	--
NTS	4.3E-04	46	--	--	--	--
ORR	4.5E-01	25	8.1E-01	32	--	--
Pantex	3.6E-04	40	--	--	--	--
PGDP	2.4E-04	0	--	--	--	--
PORTS	8.8E-03	42	--	--	--	--
RFETS	2.5E-02	29	--	--	--	--
SNL-NM	3.2E-02	1	--	--	--	--
SRS	7.2E-03	38	7.2E-03	38	--	--
Total	6.1E-01	29	9.1E-01	33	8.7E-01	35

Note: -- = not a disposal site for this alternative.
[a] Cancer incidence among all farm family lifetimes from radiation and chemical carcinogens.
[b] Percentage reduction in risk based on a 50% reduction in annual generation of CH non-alpha LLMW.

From Table G-16, it is seen that the effectiveness of pollution prevention in reducing health risk to the offsite population near treatment sites varies significantly with alternative. For the Decentralized Alternative, this risk is dominated by the risk at LLNL and the health risk reduction is 47%. In contrast, the health risk for treatment at Hanford dominates the Centralized Alternative 17 and is reduced by only 36%. From Table G-17, the aggregate reduction in WM worker health risk at treatment sites is not as strongly dependent on alternative and is approximately 35% for all three alternatives. From Table G-18, the aggregate reduction in health risk from the assumed source reduction from pollution prevention varies from 29% for the Decentralized Alternative to 35% for the Centralized Alternative.

G.2.4 HAZARDOUS WASTE

Hazardous waste contains materials that are hazardous under RCRA and other Federal environmental statutes (such as the Toxic Substances Control Act) but does not contain radioactive materials. As with LLMW, HW is treated primarily to meet statutory requirements. Estimates of the effect of reduction in annual generation on HW facilities are based on information in the hazardous waste technical report (ANL, 1996c); Appendix D, "Waste Management Facility Human Health Risk Estimates;" and the waste management costs technical report (INEL, 1995c).

The vast majority of HW is contaminated wastewater and is always treated onsite in wastewater treatment facilities. This appendix addresses HW other than contaminated wastewater, that is, HW that is transferred for treatment at specialized facilities, either onsite or offsite. Most, approximately three-quarters, of the HW generated in the DOE complex is generated at 11 sites. This appendix considers only HW generated at these 11 sites.

G.2.4.1 Waste Load Reductions

Table G-19 contains quantities of HW transferred for treatment by type of treatment for 1992 for the 11 top HW-generating sites. Storage of HW is limited by RCRA to 90 days at unpermitted facilities. Therefore, unlike the other waste types, there is no year-to-year storage of HW and no inventories to be worked off with the HW generated annually. Also, because there is no long-term storage, waste loads for HW generated by waste management operations are based on 20 years of generation being treated and disposed of in 20 years. Thus, a given percentage reduction in annual production is estimated to result in the same percentage reduction in treatment waste loads. For a 50% across-the board reduction in annual generation, the values in Table G-19 would be cut in half.

G.2.4.2 Cost Savings

Two of the alternatives considered in the WM PEIS are elaborated here. The first is Regionalized Alternative 2 in which there are two DOE treatment hubs: one in the east at ORR and the second in the west at INEL. In this alternative, all HW is shipped to the DOE hubs where approximately 90% of treatment is performed. Three treatments (stabilization, battery recycling, and mercury removal) take place at

Table G-19. Technologies Used to Treat Hazardous Waste Transfers (1992)

Treatment Technology	Quantity[a] (kg)	Comments
Incineration	1.6E+06	This is the principal form of treatment for a wide range of organic wastes.
Organic removal/recovery	9.8E+05	This treatment technology is primarily fuel burning or blending, and solvent recycling or distillation.
Stabilization	2.6E+05	This treatment technology is most commonly used for inorganic waste. The waste is mixed with solidification agents, such as Portland cement, to meet disposal facility waste acceptance criteria.
Deactivation	2.7E+05	Treatment technologies that are so classified include neutralization of corrosive waste, and controlled detonation, reaction, or deactivation of explosives.
Metal removal/recovery	9.4E+04	This technology involves precipitation of heavy metals from aqueous solutions. The resulting precipitate may be further treated to recover metals or be stabilized prior to land disposal.
Mercury recovery/treatment	1.1E+05	This is a specialized treatment (e.g., mercury roasting or retorting, amalgamation, or incineration of organic wastes containing mercury) that is offered only by a few commercial facilities in the country.
Aqueous treatment	6.3E+04	This type of treatment includes a range of technologies, including biological treatment, wet air oxidation, and chemical oxidation/reduction.
Recycling	6.8E+03	Most DOE "recycled" wastes are lead acid storage batteries and scrap metals.

[a] Quantities are based on offsite transfers from the eleven top HW generators.

commercial facilities after shipment from DOE hubs. The second case is Regional Alternative 1 in which HW is shipped to five DOE hubs. The DOE hubs perform roughly half of the organic removal and recovery treatment and ship treated HW to commercial facilities for other treatment.

Table G-20 shows the cost savings for a 50% across-the-board reduction in annual generation based on cost information in the waste management costs technical report (INEL, 1995c). The table breaks out costs for treatment and disposal at DOE and commercial facilities, and for transportation. In ANL (1996c), existing facilities for treatment of HW are identified. However, the cost estimates in INEL (1995c) are based on the assumption that these existing facilities are dedicated to treatment of LLMW and that all HW

Table G-20. Cost Savings at HW Treatment Hubs and From Pollution Prevention 50% Reduction in Annual Generation ($1,000)

Site	Regionalized 2[a]	Regionalized 1[b]
ANL-E		
Transportation	1.5E+03	3.3E+03
Commercial Treatment and Disposal	NA[c]	NA
Fermi		
Transportation	5.8E+02	1.5E+04
Commercial Treatment and Disposal	NA	NA
Hanford		
Government Treatment and Disposal	NA	3.0E+04
Transportation	6.8E+01	2.4E+03
Commercial Treatment and Disposal	NA	4.2E+03
INEL		
Government Treatment and Disposal	6.6E+04	1.1E+04
Transportation	1.8E+03	6.8E+02
Commercial Treatment and Disposal	2.7E+03	1.0E+03
KCP		
Transportation	3.9E+03	8.0E+03
Commercial Treatment and Disposal	NA	NA
LANL		
Government Treatment and Disposal	NA	2.8E+04
Transportation	1.3E+01	1.2E+03
Commercial Treatment and Disposal	NA	4.0+03
LLNL		
Transportation	7.1E+03	5.2E+03
Commercial Treatment and Disposal	NA	NA
ORR		
Government Treatment and Disposal	5.6E+04	3.3E+04
Transportation	6.8E+01	1.4E+03
Commercial Treatment and Disposal	1.1E+04	1.5E+04
Pantex		
Transportation	1.9E+03	1.9E+03
Commercial Treatment and Disposal	NA	NA
SNL-NM		
Transportation	4.4E+03	5.0E+03
Commercial Treatment and Disposal	NA	NA

Table G-20. Cost Savings at HW Treatment Hubs and From Pollution Prevention 50% Reduction in Annual Generation ($1,000)—Continued

Site	Regionalized 2[a]	Regionalized 1[b]
SRS		
Government Treatment and Disposal	NA	1.4E+04
Transportation	1.3E+03	2.2E+03
Commercial Treatment and Disposal	NA	1.5E+03
Total		
Government Treatment and Disposal	1.2E+05	1.2E+05
Transportation	2.4E+04	4.4E+04
Commercial Treatment and Disposal	1.4E+04	2.5E+04
Total	1.6E+05	1.9E+05

[a] This case has two DOE treatment hubs, one in the east and one in the west; only hubs ship to commercial facilities.
[b] This case has five DOE treatment hubs; only hubs ship to commercial facilities.
[c] NA = not available.

treatment facilities at DOE sites are new facilities. Therefore, the values in Table G-20 are based on the assumption that both operations and construction cost savings are proportional to source reduction.

G.2.4.3 Human Health Risk Reductions

Reduction in human health risk for a 50% across-the-board reduction in annual generation of HW from routine operations of hazardous waste facilities were estimated for the same two alternatives (Regionalized 2 and Regionalized 1) considered above. The human health risk considered cancer incidence for three types of receptors: the onsite population of noninvolved workers, the offsite population, and workers at WM facilities. Risks to the onsite and offsite population are proportional to throughput. Aggregate risks to WM workers are proportional to the number of such workers, which will be assumed to be proportional to throughput. The estimated reduction for 20 years of operations is tabulated by DOE site and case in Table G-21. With these assumptions, the reductions in human health risks are 50% of the human health risks given in Appendix D.

Table G–21. Reduction in Cancer Incidence[a] at DOE HW Treatment Hubs From Pollution Prevention 50% Reduction in Annual Generation

Hub/Receptor	Regionalized 2	Regionalized 1
Hanford		
Noninvolved worker population	--	1.3E-03
Offsite population	--	2.1E-03
WM workers	--	1.4E-01
INEL		
Noninvolved worker population	6.5E-04	7.0E-05
Offsite population	4.8E-04	5.0E-05
WM workers	3.7E-01	3.8E-02
LANL		
Noninvolved worker population	--	4.7E-03
Offsite population	--	1.0E-02
WM workers	--	1.5E-01
ORR		
Noninvolved worker population	1.6E-02	5.5E-03
Offsite population	4.7E-02	1.8E-02
WM workers	5.5E-01	2.1E-01
SRS		
Noninvolved worker population	--	3.0E-04
Offsite population	--	6.0E-04
WM workers	--	4.6E-02
Total		
Noninvolved worker population	1.7E-02	1.2E-02
Offsite population	4.8E-02	3.0E-02
WM workers	9.2E-01	5.8E-01

Note: -- = not a treatment hub for this alternative.
[a] Cancer incidence arising from 20 years of treatment.

G.2.5 TRANSURANIC WASTE

TRUW is defined as radioactive waste contaminated with alpha-particle-emitting transuranic radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g at the time of assay. The DOE distinguishes between CH TRUW (packaged waste with an external surface dose rate not exceeding 200 mrem/h) and RH TRUW (packaged waste with an external surface dose rate exceeding 200 mrem/h). TRUW generated prior to 1970 is buried in shallow landfill-type disposal grounds and is considered as an ER waste. TRUW waste generated since 1970 is considered a waste management waste. Some TRUW wastes are contaminated with hazardous materials. Such material can be treated using the same processes

as for LLMW, with additional precautions appropriate for the radioactive component being TRUW rather than LLW.

Estimates of the effect of source reduction on TRUW facilities are based on information in the transuranic waste technical report (ANL, 1996d); Appendix D, "Waste Management Facility Human Health Risk Estimates;" and the waste management costs technical report (INEL, 1995d).

G.2.5.1 Waste Load Reduction

Tables G–22 and G–23 contain estimates of the effect on generating site waste loads of an across-the-board 50% source reduction of CH TRUW and RH TRUW, respectfully. Inventory and generation rates for a site are obtained from volume-weighted averages over treatment classes. The waste loads are based on inventory and 20 years of generation being treated in 10 years. The inventories and waste loads include the following waste stream categories from the DOE (1994e) *Mixed Waste Inventory Report*: 1000 (aqueous liquids); 2000 (organic liquids); 3000 (solid process wastes); 4000 (soils); and 5000 (debris). Waste categories 6000 (special: lab packs with and without reactive metals) and 7000 (inherently hazardous; for example, reactive metals, mercury, and cadmium batteries) are not included because impacts of their treatment, storage, and transportation were not considered elsewhere in the WM PEIS. The percentage differences in waste load attributed to source reduction are smaller than for the other waste types considered because the inventories are larger relative to annual generation. Thus, changes in annual generation rates have relatively smaller effects on waste loads. Averaged over the DOE complex, a 50% reduction in annual generation of CH TRUW is estimated to reduce CH TRUW waste loads by 19%, and a 50% reduction in annual generation of RH TRUW is estimated to reduce RH TRUW waste loads by 48%.

The effect of a 50% across-the-board reduction in annual generation is considered for four representative CH TRUW alternatives and one RH TRUW alternative. The four CH TRUW alternatives are: Regionalized Alternative 3, 3 regional sites with treatment to RCRA compliance; Regionalized Alternative 2, 5 regional sites with treatment to RCRA compliance; Regionalized Alternative 1, 5 regional sites with stabilization treatment; and the Decentralized Alternative, 16 sites treating to the Waste Isolation Plant Project (WIPP) waste acceptance criteria (WAC). These four alternatives provide diversity in the number of treatment sites and the level of treatment. The RH alternative has two sites with RCRA treatment. The effect of this source reduction on the waste loads at the regional treatment facilities for the three regional site and five regional

Table G-22. Effect of Pollution Prevention 50% Reduction in Annual Generation on CH-TRUW Generating Site Waste Loads

TRUW Site	Inventory (m^3)	Generation Rate (m^3/yr)	Waste Loads[a] (m^3/yr)		Percentage Difference
			Current	WMin/PP	
ANL-E	1.5E+01	4.7E+01	9.6E+01	4.9E+01	49%
Hanford	1.2E+04	1.2E+03	3.6E+03	2.3E+03	35%
INEL	3.8E+04	1.4E+01	3.8E+03	3.8E+03	1%
LANL	8.2E+03	1.3E+02	1.1E+03	9.3E+02	12%
LBL	8.0E-01	1.0E-02	1.0E-01	9.0E-03	10%
LLNL	2.0E+02	7.4E+01	1.7E+02	1.1E+02	33%
Mound	2.7E+02	1.2E+03	1.5E+02	9.0E+01	40%
NTS	6.1E+02	0	6.1E+01	6.1E+01	0%
PGDP	1.4E+01	0	1.4	1.4	0%
RFETS	1.5E+03	2.4E+02	6.2E+02	3.7E+02	38%
SNL-NM	1.0	0	1.0E-01	1.0E-01	0%
SRS	5.1E+03	5.8E+02	1.7E+03	1.1E+03	35%
UofMO	0	1.0E-01	2.0E-01	1.0E-01	50%
Total	6.7E+04	2.4E+03	1.1E+04	8.8E+03	19%

[a] Assumes inventory and 20 years of generation are treated in 10 years; for the WMin/PP case, the annual generation rate is half the current generation rate. Includes waste stream categories: aqueous liquids (1000); organic liquids (2000); solid process residues (3000); soils (4000); and debris (5000).

site CH TRUW cases and for the two regional site RH TRUW cases is given in Table G-24. For the Decentralized Alternative, with 16 sites treating to the WIPP WAC, the treatment takes place where the waste originates so that the percentage waste load reductions in Table G-22 apply.

G.2.5.2 Cost Savings

Cost savings from WMin/PP are considered for the four CH TRUW alternatives and for one RH TRUW alternative. Since disposal at WIPP is common to all alternatives, costs of disposal are considered to be beyond the scope of this appendix. The estimates of the effects of a 50% reduction in annual generation on costs used the effects of that reduction on waste loads in Tables G-22 through G-24. Table G-24 was used for the effects on treatment at and transportation from regional treatment facilities. Tables G-22 (for CH

Table G-23. Effect of Pollution Prevention 50% Reduction in Annual Generation on RH TRUW Generating Site Waste Loads

TRUW Site	Inventory (m^3)	Generation Rate (m^3/yr)	Waste Loads[a] (m^3/yr)		Percentage Differences
			Current	WMin/PP	
ANL-E	0.00	1.7E+01	3.4E+01	1.7E+01	50%
Hanford	2.0E+02	7.7E+02	1.6E+03	7.9E+02	49%
INEL	1.1E+02	2.5E+01	6.1E+01	3.6E+01	41%
LANL	7.9E+01	5.0E-01	8.9	8.4	6%
ORR	1.3E+03	1.8E+01	1.7E+02	1.5E+02	12%
SRS	1.0	1.0	2.1	1.1	48%
Total	1.7E+03	8.5E+02	1.8E+03	9.4E+02	48%

[a] Assumes inventory and 20 years of generation are treated in 10 years; for the WMin/PP case, the annual generation rate is half the current generation rate. Includes waste stream categories: aqueous liquids (1000); organic liquids (2000); solid process residues (3000); soils (4000); and debris (5000).

Table G-24. Effect of Pollution Prevention 50% Reduction in Annual Generation on Regional Treatment Site TRUW Waste Loads

Regional Treatment Site	Percentage Decrease in Waste Load[a]		
	CH 3 Regional Sites	CH 5 Regional Sites	RH 2 Regional Sites
Hanford	41	41	49
INEL	7	1	--
LANL	NA	35	--
ORR	NA	NA	19
RFETS	NA	39	--
SRS	35	12	--

Notes: -- = not a regional treatment site under the specified alternative; NA = not applicable.
[a] Assumes inventory and 20 years of generation are treated in 10 years; for the WMin/PP case, the annual generation rate is half the current generation rate.

waste) and Table G–23 (for RH waste) were used for the effects on treatment at and transportation from other sites.

Reductions in costs of treatment storage, and transportation were assumed to be proportional to reduction in waste load. In estimating the effect of reduction in annual generation on the facilities cost, the same distinction was made between situations where there are existing facilities and when there are no existing facilities, as in Section G.2.2.2. Using information on existing facilities from INEL (1995d), Table G–25 summarizes the effect of a 50% reduction in annual generation on the need for new capacity. For the cases considered, the existing facilities at the Rocky Flats Environmental Technology Site (RFETS) and the aqueous treatment facility at LANL are estimated to have adequate capacity regardless of source reduction in annual generation. On the other hand, the grout stabilization facility would not have sufficient capacity even with a 50% reduction.

The effects of the assumed source reduction on the planning level life-cycle costs of operations and maintenance, construction, and transportation are given in Tables G–26 and G–27 for the TRUW alternatives and an RH TRUW alternative, respectively. For the TRUW alternatives, the assumed reduction in annual generation is estimated to result in a 22% reduction in costs, while the cost reduction for RH TRUW is estimated to be 26%. In Table G–26, the costs are for both CH and RH TRUW.

G.2.5.3 Human Health Risk Reduction

Reductions in human health risk from a 50% across-the-board reduction in the annual generation of TRUW were estimated for the same four CH TRUW alternatives and RH TRUW alternative considered above. The human health risk considered was cancer incidence among the offsite population and among workers at WM facilities. Risk reduction is assumed to be proportional to throughput reduction. With this assumption, the estimated reductions in risk for 10 years of operation of treatment facilities are given in Table G–28. The table shows that reduction in annual generation of CH TRUW is estimated to have a larger impact on human health risk to the public (approximately 30% reduction) than to WM workers (approximately 18% reduction). This is because human health risks are estimated to be greater at SRS than at other sites. Because SRS has a relatively small ratio of inventory to annual generation, reductions in annual generation are relatively effective in reducing human health risk.

Table G-25. Effect of Pollution Prevention Reduction[a] on the Need for New CH TRUW Facilities

Site/Facility	Existing Capacity (m^3/yr)	Current/ WMin/PP	Total Capacity Required by Case (m^3/yr)			
			Decentralized	Regionalized 1	Regionalized 2	Regionalized 3
LANL						
AQWTR	2.0E+02	Current	NA	NA	6.7E+01[c]	NA
		WMin/PP	NA	NA	6.0E+01[c]	NA
INCIN[b]	6.8E+02	Current	NA	NA	3.9E+02[c]	NA
		WMin/PP	NA	NA	3.4E+02[c]	NA
GROUT	7.7	Current	1.6E+02	1.4E+02	1.5E+02	NA
		WMin/PP	1.4E+02	1.2E+02	1.3E+02	NA
RFETS						
AQWTR	1.5E+05	Current	NA	NA	4.3E+01[c]	6.1[c]
		WMin/PP	NA	NA	2.6E+01[c]	3.8[c]
CMPCT	3.6E+03	Current	NA	3.7E+02[c]	3.9E+02[c]	NA
		WMin/PP	NA	2.3E+02[c]	2.4E+02[c]	NA
GROUT	5.0E+02	Current	1.1E+02[c]	7.2E+01[c]	8.5E+01[c]	6.1E-01[c]
		WMin/PP	6.4E+01[c]	5.4E+01[c]	5.0E+01[c]	6.1E-01[c]

Notes: NA = not applicable; AQWTR = aqueous water treatment; INCIN = thermal treatment; CMPCT = shredding and compaction; and GROUT = grout stabilization.
[a] The required capacities for pollution prevention are based on an assumed 50% across-the-board reduction in annual generation.
[b] Thermal treatment unit at LANL is currently unfunded and in shutdown mode.
[c] The existing capacity is sufficient regardless of reduction in annual generation.

Table G-26. Effect of Pollution Prevention on Costs for Four TRUW Alternatives[a] (in dollars)

Alternative	O&M[b]		Construction[c]		Transportation	
	Current	WMin/PP	Current	WMin/PP	Current	WMin/PP
Decentralized	4.7E+09	3.6E+09	2.1E+09	1.6E+09	5.6E+08	4.8E+08
Regionalized 1	4.9E+09	3.7E+09	2.3E+09	1.8E+09	5.1E+08	4.4E+08
Regionalized 2	5.5E+09	4.2E+09	3.0E+09	2.2E+09	4.5E+08	4.1E+08
Regionalized 3	5.1E+09	3.9E+09	2.9E+09	2.1E+09	4.9E+08	4.0E+08

[a] Based on a 50% across-the-board reduction in annual generation.
[b] Includes decontamination and decommissioning costs for both CH and RH TRUW.
[c] Includes preoperations costs for both CH and RH TRUW.

Table G-27. Effect of Pollution Prevention on Costs for an RH TRUW Alternative[a]

Site	O&M[b]		Construction[c]		Transportation	
	Current	WMin/PP	Current	WMin/PP	Current	WMin/PP
ANL-E	3.4E+06	1.7E+06	NA[d]	NA	2.1E+05	1.0E+05
Hanford	7.7E+08	5.6E+08	4.2E+08	3.0E+08	1.3E+07	9.4E+06
INEL	3.9E+07	2.3E+07	1.0E+07	6.0E+06	3.5E+05	2.1E+05
LANL	1.2E+07	1.1E+07	3.3E+06	3.1E+06	1.0E+05	9.5E+04
ORR	3.6E+08	3.0E+08	2.6E+08	2.1E+08	5.5E+05	4.5E+05
Total	1.2E+09	9.0E+08	6.9E+08	5.2E+08	1.4E+07	1.0E+07

[a] This is for treatment to RCRA standards at two installations (Hanford and Oak Ridge); ANL-E ships to ORR; INEL and LANL ship to Hanford. It is assumed that there is a 50% across-the-board reduction in annual generation.
[b] Includes preoperations costs.
[c] Includes decontamination and decommissioning costs.
[d] NA = not applicable.

Table G-28. Effect of Pollution Prevention Source Reduction on Cancer Incidence for TRUW Alternatives

Alternative	Offsite Population		WM Workers	
	Current	WMin/PP[a]	Current	WMin/PP
CH Decentralized	5.5E-04	4.0E-04	2.1	1.8
CH Regionalized 1	8.6E-04	6.3E-03	2.2	1.8
CH Regionalized 2	2.8	2.0	2.0	1.7
CH Regionalized 3	6.5E-01	4.3E-01	2.2	1.8
RH[b]	1.6E-01	1.3E-01	3.4E-01	2.8E-01

[a] 50% across-the-board reduction in annual generation.
[b] Treat RH TRUW at 2 sites to RCRA LDR.

In contrast, health risks to WM workers are more evenly spread among sites, with WM workers at INEL having the greatest cancer incidence. At INEL, the inventory of CH TRUW far exceeds annual generation. Thus, pollution prevention has a smaller impact on estimated cancer incidence among WM workers.

G.3 Pollution Prevention Applied to Environmental Restoration and Decontamination and Decommissioning Activities

Environmental restoration activities are directed toward removal and treatment of contaminated media and facilities. Waste and pollution may be generated during restoration activities just as they may be generated by decontamination and decommissioning (D&D) of plants and equipment and by dismantlement of weapons systems. Appendix B of the 1994 crosscut plan (DOE, 1994b) states that pollution prevention is applicable to the processes and techniques used to perform ER and D&D activities. In this section, application of pollution prevention practices to ER and D&D activities is discussed in view of the Office of Science and Technology's research, development, demonstration, testing, and evaluation program.

G.3.1 Groundwater and Soils Cleanup

Some of DOE's most pressing ER needs are for cleanup or containment of radioactive and hazardous contaminants in soils and groundwater. DOE is responsible for waste management and cleanup of more than 100 contaminated installations (containing approximately 3,700 contaminated sites) in 36 states (DOE, 1993b). These sites have over 26,000 acres with hazardous and radiologically contaminated surface water, groundwater, and soil that are in need of some measure of remediation. The following are a few examples of the extent of the contamination. At SRS and the Hanford Site, for example, soils and groundwater are contaminated with volatile organic compounds (VOCs). At the Nevada Test Site, more than 13 km^2 of soil are contaminated with plutonium, and a large quantity of soil is contaminated with uranium at the Fernald Environmental Management Project (FEMP) Site.

The DOE Office of Science and Technology Research, Development, Demonstration, Testing and Evaluation (RDDT&E) efforts include several programs directed for groundwater and soils cleanup. One concept being explored that is in conformity with pollution prevention principles is the Minimum Additive Waste Stabilization (MAWS) concept for stabilization of LLW and LLMW (DOE, 1994c). This new approach to vitrification uses multiple waste streams as substitutes for additives otherwise needed to be purchased. The MAWS concept integrates vitrification with other treatment technologies as appropriate, increasing waste loadings and reducing costs. The minimum additive waste stabilization technology is being demonstrated at FEMP. Applicable waste streams appear to be soils, sludges, groundwater, and ash and debris from burn pits.

Most of the RDDT&E programs in the ER area are integrated programs or demonstrations. In an integrated program, multiple technologies are assembled and evaluated as a cradle-to-grave solution to a representative generic environmental problem (DOE, 1993a). Some current RDDT&E integrated demonstrations are for VOCs in non-arid soils, VOCs in arid soils, cleanup of mixed waste landfills, uranium in soils, and in-situ remediation. Some of the technologies in the integrated demonstrations can be considered source reduction technologies. One such technology is methane-enhanced bioremediation, in which methane is injected via horizontal wells to become a food source for indigenous microorganisms known to be capable of degrading trichloroethylene (DOE, 1994d). By destroying contamination rather than transferring it from one medium to another, methane-enhanced bioremediation can be considered a pollution prevention technique (DOE, 1994d).

G.3.2 DECONTAMINATION, DECOMMISSIONING, AND RECYCLE

Because many facilities in the DOE complex are aging or changing their missions, there is a need to deactivate and decommission a large number of surplus buildings that currently contain radiological, hazardous, mixed, and special (such as asbestos) contaminants. Facilities in the DOE complex are assumed to contain substantial quantities of scrap steel, nickel, aluminum, and copper, which if decontaminated could be recycled and reused. The Office of Science and Technology's RDDT&E program has a component concerned with reuse and recycle of both metal and concrete from decommissioned facilities (DOE, 1993a). Technologies being considered for the removal of both surface and volume contamination because they appear to have no technological barriers, worker safety problem, or public health limitations are:

- Surface decontamination of concrete using a microwave process
- Surface decontamination of metals using a laser process
- Volumetric decontamination of concrete using an electrostatic process
- Volumetric decontamination of stainless steel and of mild steel using a refining process
- Surface decontamination (internal) of equipment using a gas-phase process
- Volumetric decontamination of transite/asbestos using a melting process

This component includes developing industrial capacity to reuse and recycle the contaminated material.

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Appendix H

Technology Development

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Acronyms and Abbreviations

The following is a list of acronyms and abbreviations (including units of measure) used in this appendix.

Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
BDAT	best demonstrated available technology
BUSS	Beneficial Uses Shipping System
CAA	Clean Air Act
CEM	continuous emission monitoring
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH	contact-handled
CWCO	catalytic wet chemical oxidation
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DNAPL	dense nonaqueous phase liquid
EM	Office of Environmental Management
EPA	U.S. Environmental Protection Agency
ESC	expedited site characterization
FTIR	Fourier transform infrared
FY	fiscal year
INEL	Idaho National Engineering Laboratory
ISV	in-situ vitrification
LDR	land disposal restriction
LIBS	laser-induced breakdown spectroscopy
LLMW	low-level mixed waste
LNAPL	light nonaqueous phase liquid
MAWS	minimum additive waste stabilization
NEPA	National Environmental Policy Act
NO_x	nitrogen oxides
PCB	polychlorinated biphenyl
PHP	plasma hearth process
PNA	polynuclear aromatic
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
SCDE	supercritical carbon dioxide extraction

SCWO	supercritical water oxidation
TCLP	toxicity characteristics leach procedure
TD	Technology Development
TSCA	Toxic Substances Control Act
VOC	volatile organic compound
WM PEIS	Waste Management Programmatic Environmental Impact Statement

Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
psi	pounds per square inch

APPENDIX H
Technology Development

H.1 Introduction

This appendix addresses the potential impact of technology development on the Waste Management Alternatives described in Chapter 3 of the Waste Management Programmatic Environmental Impact Statement (WM PEIS). This discussion outlines the approach taken by the U.S. Department of Energy's (DOE's) Office of Environmental Management (EM) through its Office of Technology Development and discusses selected examples of emerging technologies that may influence the WM PEIS Alternatives or mitigate the impact of EM activities.

The Office of Technology Development is responsible for managing an aggressive national program of applied research, development, demonstration, testing, and evaluation for environmental cleanup, waste management, and related technologies. This Technology Development (TD) Program undertakes a focused problem-oriented approach to have technologies available for use to support the DOE's environmental management needs in a manner that also supports the DOE's industrial competitiveness goals. The TD Program is designed to resolve major technical issues, to rapidly advance beyond current technologies for waste management operations, and to expedite compliance with applicable environmental laws and regulations. The underlying strategy is to identify and develop high-payoff waste management technologies that can: (1) cleanup the inventory of DOE nuclear component manufacturing sites and (2) better manage DOE-generated waste than is possible with existing environmental cleanup technologies. In many cases, the development of new technologies presents the best hope for ensuring a substantial reduction in risk to the environment and improved safety for workers and the public within realistic financial constraints.

The availability, and the projected availability, of appropriate technologies govern what can be cleaned up, how, and how soon. DOE's objective is to manage its waste with the greatest effectiveness, efficiency, and lowest tolerable risks to people (health, safety, jobs) and the environment. Although emerging technologies are discussed in the context of the WM PEIS, they will likely play their most prominent role in the National Environmental Policy Act (NEPA) process during remediation at individual sites or during the decision-making process of facility design and selection. This is the point at which candidate technologies would receive specific consideration. To date, thirty-nine technologies developed and demonstrated by the Office

of Technology Development have been either implemented or selected for implementation by DOE sites. Many of these technologies have been transferred to industry and are commercially available. Many more are in various stages of demonstration needed to become viable candidates for implementation. Past accomplishments in technology development are detailed in a series of Annual Reports to Congress required under Public Law 101-189.

The technologies postulated by DOE for use in waste management applications for the purpose of estimating attributes associated with the various WM PEIS Alternatives are ones which have already been widely approved by regulators. On the other hand, the technologies discussed in this Appendix, while believed to be sound in theory, require significant development before they would be considered proven, demonstrated, and generally acceptable to regulators. Emerging technologies must meet at least one, and preferably all, criteria for being "better, faster, safer, cheaper" than the current baseline technologies that they may supplant. Representative emerging technologies, if available for wide application, are considered in this appendix to help determine whether they might alter the selection of WM PEIS Alternatives. Consideration is also given to the potential ability of technology development to mitigate the environmental and economic costs of the EM program.

H.2 Focus Areas and Crosscutting Programs

The EM Office of Technology Development is organized on the basis of focus areas and cross-cutting programs. Five major remediation and waste management focus areas identified and targeted for action on the basis of risk, prevalence, or need for technology development to meet environmental requirements and regulations include: contaminant plume containment and remediation; mixed waste characterization, treatment, and disposal; high-level waste tank remediation; landfill stabilization; and facility transitioning, decommissioning, and final disposition.

Subsurface Contaminants. This focus area deals with uncontained hazardous and radioactive contaminants in soil and groundwater. At most sites, information about contaminant distribution and concentration is insufficient. Moreover, many containment and treatment technologies are ineffective or too costly to use. Improvements are being sought in containment systems and systems to remediate contaminated soils and groundwater.

Mixed Waste Characterization, Treatment, and Disposal. This focus area addresses major technical challenges to managing low-level mixed waste. Disposal capacity for mixed waste is expensive and severely limited; DOE now spends millions of dollars each year to store mixed waste because of the unavailability of accepted treatment technology and disposal capacity. Currently available waste management practices require extensive, and therefore expensive, waste characterization before disposal. Improvements are being sought in thermal and nonthermal treatments emissions, nonintrusive drum characterization, material handling, and final waste forms.

High-Level Waste Tank Remediation. This focus area is primarily concerned with deteriorating tank structures and consequent leakage of their contents. Research and technology development activities must concentrate on safe, reliable, cost-effective methods for characterization, retrieval, treatment, and final disposal of high-level tank wastes. Special emphasis is placed on in-situ or remotely handled processes and waste volume minimization.

Landfill Stabilization. This focus area addresses the significant remediation challenges posed by numerous DOE landfills. Some existing landfills have contaminants that are migrating, thus requiring interim containment before final remediation. Materials buried in "retrievable" storage pose another problem—retrieval systems that reduce worker exposure and reduce the quantity of secondary waste must be developed. Development of in-situ methods for containment and treatment is also a high-priority need.

Facility Transitioning, Decommissioning, and Final Disposition. This focus area addresses the technological problems associated with the numerous weapons complex facilities no longer needed because of age or changing national security requirements. While the building and scrap materials at the facilities are a potential resource with significant economic value, current regulations lack clear release standards. The recovery, recycling, or reuse of these resources can be encouraged by enhanced technological developments for their decontamination. In addition, material removal, handling, and processing technologies must be improved to enhance worker safety and to reduce cost.

In addition to these focus areas, the Office of Technology Development manages three cross-cutting programs: *characterization*, *efficient separations*, and *robotics*. The objective of these cross-cutting programs is to provide needed research or technologies, in a timely, cost-effective manner, to support waste management, environmental restoration, and facility transition and management missions.

The remainder of this appendix contains a discussion of several emerging technologies. Section H.3 discusses emerging treatment and airborne monitoring technologies for waste management, with example technologies for managing low-level mixed waste, particularly the organic components of such waste. Section H.4 is an analogous discussion of emerging technologies particularly relevant to characterization and environmental remediation issues, with emphasis on their impacts on groundwater and soil contamination. The technology discussed in Section H.4 is relevant to this PEIS to the extent to which it increases (that is, by making remediation technically and economically feasible at additional DOE sites) or decreases (that is, by enabling in-situ cleanup of soil and groundwater sites) the volume of waste to be transferred to the EM Office of Waste Management for treatment and disposal. Section H.5 discusses technologies that relate to transportation risks associated with most WM PEIS Alternatives. While technologies are discussed under particular categories for convenience, the reader should note that many technologies overlap both site remediation and waste management categories.

H.3 Waste Management Technologies in Development

DOE has identified nearly 2,000 different stored mixed, high-level, transuranic, or low-level waste streams at more than 50 of its sites. The Office of Technology Development has undertaken a systematic approach to solving key problems in waste management (and environmental restoration) by conducting technology development in the categories of characterization and monitoring, retrieval, treatment, and stabilization in a form suitable for final disposal. During fiscal year (FY) 1996, the Office supported the work packages shown in the Attachment to this appendix. Waste management (as opposed to environmental restoration) efforts are being conducted most extensively in the Mixed Waste Characterization, Treatment, and Disposal Focus Area and in the crosscutting areas of characterization, robotics, and efficient separations; some other efforts (for example, pollution prevention) are also being conducted.

In this section, the technical capabilities and limitations of emerging technologies are compared with the baseline technology (usually incineration) for organic destruction in low-level mixed waste. This discussion will concentrate on the treatment of low-level mixed waste (LLMW) for several reasons: this type of waste is most broadly distributed throughout the DOE complex, at large and small sites; past practices for the storage and treatment of these wastes have led to public concerns about possible safety and health impacts; few treatment technologies have been proven for LLMW; and these are not acceptable for most of the LLMW streams. Thus, new technological advances for mixed waste treatment are widely sought.

The organic destruction step is particularly suited for illustration because it clearly offers the potential for advances in an overall system integrating treatment, monitoring, and improved final waste forms. Technology for each of these areas is included in this discussion. The choice of organic destruction technology is also important within the framework of the WM PEIS because of the potential impacts at sites of all sizes within the DOE complex. Thus, this issue relates directly to the degree of centralization and the choice among the Alternatives analyzed in this PEIS.

H.3.1 DEFINITION OF THE ISSUE

Most of the approximately 50 DOE sites where LLMW now exists, has existed, or is expected to exist, generate and store small volumes of LLMW. More than 99% of DOE LLMW exists at just 13 of them. Of the 50 sites, about half would require treatment of 10 cubic meters or less of LLMW per year, and several would require treatment of less than 1 cubic meter. Although much LLMW would not be suitable for incineration (for example, bulk wastes contaminated with heavy metals) the baseline technology for dealing with the organic components of these wastes is assumed for discussion purposes to be treatment using a thermal technology, such as incineration. Specific treatment categories and volumes for DOE sites are provided elsewhere in the WM PEIS.

Land disposal restrictions specifically prohibit the disposal of a wide range of waste categories into the earth (40 CFR Part 268). Prominent on the list of prohibited waste categories are organic compounds regulated under the Resource Conservation and Recovery Act (RCRA). The inventory of DOE-generated LLMW contains the regulated organics as well as substances, such as inorganics, metals, and low-level radioactive constituents.

Use of emerging technologies in treating organic mixed wastes could change the number of treatment facilities, as well as respond to concerns about the social equity of treating waste at one site shipped from elsewhere—particularly from other States or regions. Alternate thermal or nonthermal approaches to organic destruction that would make onsite treatment of small volumes more feasible could minimize these concerns and reduce the importance of organic LLMW components in decisions between centralized and decentralized treatment configurations. The degree of centralization may also be affected if similar emerging technologies, applicable at larger scales, alter the balance of costs, risks, or public acceptance of currently available technologies for treating wastes at the larger volume sites.

H.3.2 BASELINE TECHNOLOGY

According to 40 CFR 268.42, the U.S. Environmental Protection Agency (EPA)-approved technology-based standard treatment for organic destruction is incineration; a technology that has attained this status is commonly referred to as best demonstrated available technology, or BDAT.

The schedule for availability for incineration is not a problem; the technology has been applied to the treatment of both hazardous and mixed waste. Although improvements in technique are still being made, no further development is required for using the technology at conventional fixed facilities.

The cost of incinerators is a concern. Incinerators have a relatively high initial capital cost, especially when used to treat small volumes of mixed waste. An incinerator must be designed and sized to maintain a sufficient residence time at an elevated temperature to ensure the high level of destruction necessary to meet regulatory requirements. In addition, current units are larger than the size required to treat the low volumes of waste at smaller sites. The size of the treatment unit cannot simply be reduced proportionally for smaller waste volumes; therefore, the cost per unit volume would increase as less material is treated. Because of the high capital costs for constructing fixed facilities, industry has developed mobile incinerators for hazardous waste treatment. However, no mobile systems are yet commercially available to treat DOE's mixed wastes.

Technical limitations are also a concern when applied to the DOE complex. Treatment units must be designed to accommodate a wide range of wastes with different compositions and physical characteristics. Some degree of overdesign will be necessary, resulting in a larger, more costly, and more complex system. Difficulties with segregating secondary wastes (for example, ash) may also require additional treatment and incur additional costs. Incinerators require a complex off-gas treatment system to ensure that the release of hazardous compounds will be below specified or permitted levels. This problem is compounded for many DOE wastes by the presence of radionuclides. These may contaminate the off-gas stream as entrained particulates, or through volatilization resulting from the elevated temperatures required for complete combustion. The off-gas treatment system needs redundancy in design to insure appropriate levels of safety under all conditions.

Public acceptability issues are complicated by the interplay between onsite treatment and transportation. (Public acceptance is explicitly or implicitly considered by regulators under RCRA and the Comprehensive

Environmental Response, Compensation, and Liability Act (CERCLA); therefore, public acceptance strongly affects the timing for new technologies to become widely accepted and the willingness of the private sector to invest in these technologies. Consequently, judgments about acceptability are necessarily a part of an emerging technologies evaluation.) Public and stakeholder concerns about the potential for release of hazardous materials during treatment have affected the application of incineration at existing public sites and may similarly affect DOE sites. On the other hand, construction of treatment units at a site would eliminate the costs and risks associated with transportation of the wastes to other locations for treatment. These decentralized, onsite options should be favored by those stakeholders along the transportation routes, and those near the sites that would otherwise have been receivers of shipped wastes.

H.3.3 EMERGING TREATMENT TECHNOLOGIES (MIXED WASTE CHARACTERIZATION, TREATMENT, AND DISPOSAL FOCUS AREA)

H.3.3.1 Introduction

This section contains a general discussion of some alternative technologies and addresses several in greater detail. Many alternative treatment technologies are being developed or demonstrated within DOE or the private sector. These include thermal treatments that destroy organic components at high temperatures and nonthermal treatments that destroy organic components at lower temperatures. Table H-1 lists specific technologies applicable to the destruction of small volumes of LLMW that were examined during preparation of this document. The list of technologies applicable to larger sites would be similar.

H.3.3.2 General

The potential advantages of the emerging technologies are compared to the baseline (incineration) using similar criteria.

The schedule for availability for these emerging technologies *is* an issue. The alternative technologies are not developed to the point where application is guaranteed, especially within the time frame important to

Table H-1. Emerging Technologies Evaluated for Organic Destruction of LLMW at Small-Volume Sites[a]

Thermal Treatments
Plasma hearth (fixed hearth and centrifugal hearth units are commercially available)
Steam reforming
Mobile incinerators
Molten salt oxidation (MSO)
Catalytic extraction (e.g., molten metal technologies)
Reverse burn gasification (e.g., ChemChar)
Thermal reductive (e.g., ECO-Logic)
Pyrolysis
Vitrification
Nonthermal Treatments
Chemical oxidation Acid digestion Wet oxidation Wet air oxidation Wet chemical oxidation Supercritical water oxidation Catalyzed wet chemical oxidation Catalyzed acid oxidation Chemical and biological treatment
Biological treatment (both oxidative and anaerobic)
Photolytic oxidation Ultraviolet (UV) oxidation, including UV-hydrogen peroxide and UV-ozone Catalyzed UV oxidation Laser-induced oxidation Photothermal detoxification unit
Electrochemical oxidation Direct (electron beam) Indirect (catalyzed electrochemical oxidation [CEO], mediated electrochemical oxidation [MEO])
Dehalogenation (e.g., potassium ethylene glycolate KPEG process)

[a] Technologies tabulated are being evaluated by either private industry or the Federal Government.

selecting a programmatic Alternative. Thus, the capability of a new technology, or combination of technologies, to treat all incinerable wastes is not certain.

While some pilot-scale testing has been completed for many emerging technologies, some technologies are still being evaluated at the bench scale. Because of the limited amount of data available from the testing that has been completed, considerable technical testing is necessary before full-scale demonstrations are justified. For example, because of the difficulties and costs of handling radioactive materials, only a few tests have been carried out so far with actual mixed wastes. Most developmental efforts have used surrogates (nonradioactive materials with similar chemical or physical properties to the radioactive contaminants).

The capital cost of many of these technologies, both thermal and nonthermal, may be lower than an incinerator with similar capacity. However, because of the early stage of development, only rough cost estimates have been completed for most emerging technologies. Emerging technologies may also offer advantages in simplicity and may be more readily transported from site to site. A portable system would reduce the capital costs by avoiding the construction of multiple facilities. Another potential cost saving occurs with the reduction in characterization required for those technologies that are more "robust" than incinerators. For these cases, a wide variety of wastes can be processed without the need for extensive characterization before treatment. This would also reduce the cost for constructing complex characterization facilities at the small-volume sites and thus cut total system costs.

Technical limitations may be fewer than for incineration in the case of some of these emerging technologies; however, others may have additional limitations. Nonthermal technologies do not involve high temperature, reducing the potential for volatilization of metals and radionuclides. In addition, many of these approaches generate much lower volumes of off-gas compared to incineration. Similarly, some thermal treatment technologies under development would generate lower volumes of off-gas. Thus, a less complex off-gas treatment system may be possible. However, for some nonthermal systems, other components (such as nitrogen oxides [NO_x]) and secondary waste streams (such as spent reaction solutions) may also require treatment. The complexity of the total system, including secondary treatment, must be considered when comparing to the baseline. As with the baseline treatment, many emerging technologies may be designed for application in mobile units.

Public acceptability may be higher for nonthermal treatment technologies than for incineration, inasmuch as they do not bear the incineration label and may be viewed as alternatives.

The situation is further complicated by private sector market considerations. Because incineration is controversial, but is nonetheless BDAT for organic destruction of hazardous wastes, private industry is developing many alternatives to incineration to capture non-Federal markets. Much of the technology development effort has been directed toward specific waste streams found in large volume within the private sector. Only a limited amount of testing has been done to learn the range of waste types that can be treated efficiently with any particular technology. A significant amount of additional work will have to be done to show applicability, and to find acceptable processing conditions for a broader variety of waste streams, before wide market acceptance of an emerging technology is likely. Further, the emergence of a technology capable of capturing a significant share of the private sector market could lead to a sharp decline in the willingness of industry to act in partnership with DOE to continue to address DOE waste streams for which the new technology is not applicable—with adverse implications for the development of technology useful to DOE.

H.3.3.3 Specific Example: Plasma Hearth Process

The plasma hearth process (PHP) is a robust process that can treat a wide variety of wastes through exposure to plasma at temperatures greater than 3,000°C. The fixed-hearth plasma process has the potential to treat nearly all mixed waste streams present in the DOE complex, including solid combustibles, heterogeneous debris, and chemical containers. The process burns off organic components of the waste stream. The inorganic components are melted to form a glassy slag and a metal phase that can be separated and potentially recycled. Radionuclides and heavy metal contaminants are bound in the slag, which has been shown to have sufficiently low leachability to pass the EPA toxicity characteristics leach procedure (TCLP). The process includes a secondary destruction unit to ensure high organic destruction efficiency regardless of the properties of the incoming waste. Additional treatment of this secondary waste may be necessary to render the final form compliant with land disposal restriction (LDR) regulations.

The PHP can treat multiple mixed waste types contained in drums without opening them. This would greatly reduce the need for characterization of the waste before treatment and may result in a large saving in the total system cost compared with that for a less robust technology.

Schedule for availability. The plasma hearth process may be usable at one or more small-volume sites within a few years. Scale-up to larger volume applications would follow. Development of the plasma hearth

process is still at the pilot scale. Tests have been carried out with several surrogate low-level mixed and transuranic waste streams. An integrated nonradioactive pilot-scale demonstration system was constructed at Retech, Inc. (California) in FY 1995, with bench-scale radioactive testing scheduled for FY 1997. Argonne National Laboratory–West conducted an integrated bench-scale radioactive demonstration in FY 1995. The results of the demonstration on actual mixed wastes allowed a more reliable estimate of the availability of the PHP for treatment of LLMW. An integrated pilot-scale plasma hearth test system will be ready for operation in FY 1997 at Retech, Inc. This system is expected to be similar in capacity to that required to provide treatment at the smaller DOE sites. Thus, a significant amount of information on the capabilities and any limitations of this technology will be available at the time NEPA and other regulatory decisions are made about application of technologies for treating DOE's wastes at specific sites.

Cost. Savings could occur with use of the plasma hearth process. (Estimated cost savings will be a product of the Office of Technology Development Cost/Benefit Project, an ongoing activity to establish economic parameters for technologies as a guide to setting priorities in the program and a support for technology transfer.) Baseline incineration and cementation technology requires detailed characterization and segregation of containerized heterogeneous mixed waste, followed by high-temperature incineration and cementation of the ash byproduct. PHP technology has an economic advantage over the baseline technology, with the major differences being driven by the costs of process equipment and operation, annual maintenance, and disposal. The reduced cost of process equipment is the principal factor accounting for a large cost difference over the 20-year life cycle. In PHP, pretreatment characterization requirements are reduced and the final waste form usually passes leachability requirements for final disposal.

Technical limitations. Two problem areas exist for the plasma hearth process: off-gas and materials (drum) handling. Only 1% of the air for fossil fuel burners is required for operation of the plasma torch; therefore, the volume of off-gas is much lower. The lower volume of gas is easier to monitor and control, and increases the potential for operation with a closed off-gas system, in which the release of contaminants to the atmosphere is eliminated by recycle of the off-gas. However, test results to date have shown the possibility of high levels of NO_x formation.

The plasma hearth process can be designed with a primary destruction chamber that is relatively small (e.g., contains a single 55-gallon drum of waste at a time) or scalable to accommodate multiple drums. Thus, it is applicable to small-volume DOE sites, either as fixed or mobile units. However, design issues do arise in handling drums of waste with the plasma torch before and after treatment. For example, the

inorganic slag produced will initially be at a high temperature. The temperature complicates the process of moving the slag into waste drums for disposal without compromising the integrity of the drums.

Public acceptability. The public acceptability of this process is unknown. Although the PHP involves high temperatures, the low volume of off-gas may minimize fears about the release of hazardous substances. In addition, the low thermal mass of the system would allow rapid shutdown in case of a process upset. This attribute should also be viewed favorably.

H.3.3.4 Specific Example: Catalytic Wet Chemical Oxidation

Wet chemical oxidation systems use the reaction of oxygen, or an alternative oxidizing agent, to destroy the organic constituents of a waste in an aqueous solution. In catalytic wet chemical oxidation, one or more chemical species are added to increase the rate at which the oxidation reactions progress. The example catalytic wet chemical oxidation system being developed by Delphi Research, Inc. (DETOX), uses an iron catalyst and a co-catalyst to degrade the organic contaminants in a strong acid solution. The system operates at temperatures much below those used in incineration and at moderate pressures. The expected operating conditions are approximately 150°F and 70 psi.

Schedule for availability. The DETOX system will undergo a pilot-scale cold test at the Savannah River Technology Center in FY 1997. Because design of a portable system is under way, application to wastes at small sites may be possible within 3 to 5 years. However, because of the early stage of development, a high degree of uncertainty remains about issues associated with the technology.

Cost. Catalytic wet chemical oxidation uses equipment typical of that used in chemical processing operations. A system could be constructed at a scale appropriate for treatment of the wastes at the small-volume sites or scaled up. Because the equipment is readily available, development costs should not be an impediment to commercialization. However, because development is still in the early stages, equipment and treatment costs have not yet been determined. The processing required for spent reaction acid solutions and for stabilization and disposal would add to the cost.

Technical limitations. The DETOX technology has been demonstrated at bench scale, with destruction efficiencies of 99.9999% achieved for liquid hydrocarbons, including some chlorinated organics. Successful

treatment has also been demonstrated for solid combustibles and for contaminated soils. However, only a limited amount of data is available. Treatment of materials that volatilize from the reactor will require further study even though off-gas volume will be small. Because of the strongly acidic nature of the reaction mixture, engineering development is focused on construction materials, along with scale-up problems. Other technical problems include treatment of the spent reaction solutions and system integration.

Public acceptability. As stated above, catalytic wet chemical oxidation is a nonthermal technology that operates at moderate temperature and slightly elevated pressure. Although the technology should not suffer from the incineration stigma, achieving public acceptability will likely require educating the public.

H.3.3.5 Specific Example: Vitrification

Vitrification of wastes into glass is an alternative to incineration, as well as a stabilization technology for incinerator secondary waste. Wastes and glass additives are combined and melted in a refractory furnace at approximately 1,100°C. Organic components and liquids are destroyed while radionuclides and metals are entrapped in a glass final waste form.

A broad range of waste, such as organic liquids, wet solids, dry solids, and heterogeneous solids, can be processed in a glass melter. Contaminants are chemically bound into the glass rather than simply encapsulated in the material. This will lead to improved leachability resistance over grout. Long-term stability is being evaluated as part of the technology development efforts. The stability of glass waste forms is higher than that for cement-based waste forms. Initial studies show the leachability results of low-level waste vitrification to be comparable to high-level waste glass standards. The glass reduces waste volume by at least 30% and meets land disposal restrictions. Minimal volatilization of most metals occurs because of the oxidizing atmosphere that allows wastes to form oxides and stay in the glass phase. Employing appropriate melter technology, such as a cold top unit, will minimize volatilization of other metals, such as mercury, by causing condensation on the cap.

Schedule for availability. Waste vitrification is the selected waste form process for high-level waste at DOE's Savannah River Site near Aiken, South Carolina. The Defense Waste Processing Facility (DWFP) became operational on March 12, 1996. Vitrification of mixed waste inorganic sludge has been demonstrated at the bench scale at the Rocky Flats Environmental Technology Site (RFETS) using

microwave energy. Further technology development of low-level waste vitrification for higher waste loading and for organic destruction will incorporate experience gained from high-level waste solidification.

Cost. Oxide raw materials for glass are inexpensive. However, melting equipment, energy required for melting, and off-gas requirements may be more expensive than incineration. The volume reduction of at least 30% for waste vitrification translates into a large cost savings in disposal. The Minimum Additive Waste Stabilization (MAWS) concept of combining waste streams and using waste materials as the glass additive is also being developed by DOE. This would decrease costs in two ways—by further reducing volume and by decreasing the cost of additives.

Technical limitations. One important concern remaining to be addressed for organic destruction application is a potential problem with glass integrity because of concentration sensitivity for carbon, some radionuclides (e.g., uranium), and some hazardous metals. This integrity concern may prove to be a stumbling block for this application. Vitrification is expected to have other important applications in DOE remediation and waste management where these materials are not present in the streams. Applications may include environmental restoration wastes, decontamination and decommissioning wastes, and incinerator ash.

Public acceptability. Public confidence should be high considering that high-level waste vitrification began at the DWPF and also at the West Valley Demonstration Project (WVDP) in 1996.

H.3.4 Emerging Air Monitoring Technologies

Progressive monitoring technologies are not treatment technologies like those listed in Table H-1, but may be a key factor in enhancing public acceptance of currently available and advanced waste treatment and organic destruction technologies. The baseline monitoring methodology involves periodic sample collection of process emissions, transferring samples to a laboratory instrument, and analysis. Advanced air monitoring technologies would allow improved and real-time evaluation of the effectiveness of toxic compound destruction during treatment of mixed waste, thereby contributing to the safety and acceptability of current and advanced treatment technologies.

The primary technical limitation of current methods is the inability to conduct real-time monitoring of certain species. Online analysis of the incinerator effluent would satisfy the requirements of the Clean Air Act (CAA) while simultaneously addressing public concern over waste incineration. Public acceptance of any waste treatment depends heavily on the ability of sensors to monitor the effectiveness of the treatment and to demonstrate that effluent streams do not contribute to worker and public risk exposure. The sensors need to be integrated with control systems and safety procedures to ensure that, if effluent levels exceed their limits, contaminants are controlled in a manner that prevents their entry into the environment.

Several technologies are emerging with the potential to effectively monitor important waste treatment parameters, such as those that measure incinerator performance. These new, real-time, continuous emission monitoring (CEM) technologies would be significantly cheaper than currently required monitoring techniques. Real-time monitoring makes it possible to perform diagnostic control of feed materials to help maintain necessary incinerator operating parameters and to allow process control of gaseous effluents containing unacceptably high levels of contaminants before release. Continuous monitoring will directly address issues of environmental safety, and the technology can be used to identify and quantify organic chemicals in the air. Thus, a continuous monitor directly addresses some public concerns about thermal treatment systems.

Typical examples of these new technologies should be available for demonstration in 1 to 5 years. The schedule is controlled by technical and regulatory acceptance concerns that can only be satisfied by testing.

Fourier transform infrared (FTIR) monitoring is one emerging technology that has already undergone testing on the Toxic Substances Control Act (TSCA) incinerator at Oak Ridge. FTIR is a mathematical method that allows for spectroscopic signal averaging to significantly improve signal-to-noise ratios and improve levels of detection of organic and selected inorganic molecular stack emissions. FTIR is not a new technique, but advances in instrument design allow its use in association with in-situ devices. FTIR is thus beneficial for generating rapid results while dramatically reducing the problem of spectral interference, or failure to differentiate between different chemical species.

In an indication of potential regulatory acceptance, EPA has facilitated these tests by issuing a protocol for an FTIR continuous emission monitor to ensure that the data that the technology can obtain will be compliant. The method can readily be extended to cover thermal treatment, stack, and ambient air monitoring.

Techniques for continuous emission monitoring of elements (for example, heavy metals and radionuclides) has not yet gone through a similar protocol/data verification process. Laser-induced breakdown spectroscopy (LIBS) is one such technology. In LIBS, laser light is focused on a specific region to vaporize a small amount of material. The vaporized material forms a short-lived plasma, which emits light that is collected, dispersed, and analyzed. Elements targeted specifically are among those of primary concern at many DOE and industrial waste sites—chromium, lead, arsenic, selenium, antimony, cadmium, zirconium, uranium, beryllium, and thorium. Technical issues that must still be addressed include: (1) determining possible spectral interferences; and (2) understanding detection limits, sensitivities, and precisions of the best spectral line or lines to be analyzed. Both issues must be resolved before LIBS can achieve regulatory acceptance.

FTIR development was completed in FY 1995 and the technology will be demonstrated in FY 1997 as part of the Plasma Hearth Process project. The LIBS system has been demonstrated in FY 1995 and FY 1996. Other important CEM technology demonstrations include the real-time airborne alpha emissions monitor (will be demonstrated in FY 1997), and the total, elemental and speciated mercury monitor (successfully demonstrated in FY 1996).

These monitoring technology advances are not expected, by themselves, to alter the ranking of the WM PEIS waste management configuration Alternatives, but they may mitigate public concerns about air quality for whichever configuration is adopted.

H.3.5 Conclusions About Emerging Technologies for Waste Management

Emerging technologies exist that should enhance waste treatment at many small sites. Some of these emerging technologies offer the potential to be:

- Less costly than those using fixed incineration
- Technically suited for the treatment of small volumes of waste
- Transportable, if permitting and decontamination requirements are resolved
- Ready for application in a time frame compatible with the requirements for key policy decisions at individual sites
- More readily acceptable to the public and other stakeholders

The plasma hearth process, catalytic chemical oxidation, and vitrification appear to have the potential to treat mixed waste streams at many of the smaller sites; however, neither the successful development of the necessary technologies nor their application to all waste streams at DOE's smaller sites are certain within the time-frame for formulating policy decisions. The difficulty of organic destruction argues against treatment of all DOE mixed wastes at all small-volume sites.

The emerging technologies discussed in this section may also be suitable for large-scale applications and may affect decisions on the overall waste treatment configuration. Private sector development directed toward larger scale organic destruction applications is also active because of non-DOE markets. Although not directed toward small DOE sites, the pilot-scale versions of private sector technologies might be adaptable at such sites on a case-by-case basis, if the developers see such adaptation as closely tied to eventual commercialization at larger scales.

Emerging air monitoring technologies will also enhance the acceptance of current and advanced treatment technologies; this may have the greatest impact at large-volume treatment sites, but should be viewed primarily as a mitigation measure rather than one that affects configuration selection.

H.4 Restoration Technologies in Development

The environmental restoration of DOE sites and facilities will likely affect groundwater and soil. The restoration waste loads identified as part of the sensitivity analysis in this PEIS assume reliance on land use restrictions rather than remediation to handle certain exposure pathways. A rationale for such restrictions is that applying currently available (baseline) technology to the treatment of large volumes of soil or groundwater imposes excessive time, cost, and risk (to workers and transportation) penalties. This section describes several emerging characterization and treatment technologies, and addresses their potential impacts. Their potential to mitigate the cost of implementing baseline Environmental Restoration Program technologies is also discussed. Emerging technologies could also have a significant impact on other restoration problems not specifically addressed here.

Groundwater remediation is particularly important because due to relative volumes involved, it is more costly than soil remediation and would allow greater potential for cost savings from the application of new and emerging technology. However, as discussed below, new approaches to groundwater remediation

increasingly recognize that the behavior of the solid matrix above and surrounding the groundwater is critical to a technology's success or failure.

The Office of Technology Development's efforts affecting soil and groundwater are conducted principally in two focus areas (Landfill Stabilization Focus Area and Contaminant Plume Containment and Remediation Focus Area), as well as in two cross cutting areas—characterization and robotics.

H.4.1 Definition of Key Analysis Issues

H.4.1.1 Contaminated Groundwater

Conventional technology cannot successfully treat the groundwater contamination occurring at some DOE sites to levels that would allow unrestricted access after remediation—particularly where the contaminant plume is large. Any emerging technology that radically increases the feasibility of treating groundwater to acceptable levels would lessen the need to restrict land use. Furthermore, even if cleanup levels consistent with such restrictions were adopted, but not envisioned as necessarily permanent (in effect, adopting a policy of taking interim actions and delaying cleanup while awaiting a new technology), the timing of technology emergence would determine when the restrictions would ultimately be lifted.

Groundwater contaminant plumes at DOE sites include volatile organic compounds (VOCs), such as carbon tetrachloride, trichloroethylene, and tetrachloroethylene; semivolatile organics, such as petroleum oil and polynuclear aromatics (PNAs), pesticides, and polychlorinated biphenyls (PCBs); heavy metals, such as chromium, lead, and mercury; toxic inorganic salts, such as nitrates; and radionuclides, such as uranium, transuranics, and tritium. Although most radioactive substances are inorganics and often can be treated similarly to other heavy metal extraction processes (with regard for the special problems of radioactivity), unique treatments are sometimes required for the lower-molecular-weight species of cesium, strontium, and tritium.

Tritium isolation, containment, and/or removal poses unique problems for waste management. Tritium, as an isotope of hydrogen, is primarily contained in waste bound in water molecules; thus, tritium is released to the environment as water vapor is released. Standard production-scale chemical separation methods are ineffectual in removing tritium from the water molecule. The only method that can segregate tritium-

containing water molecules from normal water uses extremely expensive isotopic separation techniques, and at present, these are not developed to process bulk quantities of water. The only possible method to lower the release of tritium in water vapor would be to condense all water vapor released during the incineration process and collect the liquid water for disposal. This method would not be practical for two reasons. First, containment and storage of large quantities of liquid water are simply not cost effective and may be prohibited by current land-ban disposal restrictions. Second, since the tritium is effectively one with the water molecule, any alternative treatment of the contained water that would result in water evaporation and/or surface/groundwater discharge would introduce tritium to the environment through other pathways. Tritium-containing wastes could be segregated and stored until the tritium decays to harmless levels. The waste could then be treated and disposed of. This last method is feasible, given the approximately 12-year half-life of tritium.

In addition to the contaminants in the plume, contaminants are adsorbed onto the aquifer matrix material and referred to as "secondary contamination." Low-water-solubility organics adsorb to natural organic matter in the aquifer matrix, and positively charged ions (cations) of inorganic contaminants (for example, heavy metal and radionuclide cations) adsorb by ion exchange to the surface of clays or natural organic matter. When the plume is remediated and replaced by clean groundwater, the secondary contamination recontaminates the plume; this source may continue to release contaminants long after the primary source and the original plume have been remediated, thereby extending the life of the contamination plume. A means is needed to destroy secondary contamination in place, or to accelerate the desorption/exchange of the contaminants back into the groundwater. Thus, full cleanup of contaminated groundwater requires removal of the primary source (if it has not been completely depleted in generating the plume), removal of the plume itself, and removal of the secondary contamination.

Dense nonaqueous phase liquids (DNAPLs) are contamination sources that are difficult to locate or remove. DNAPLs flow downward through the surface soil and vadose zone to the water table; because they are denser than water, they can continue to sink into the aquifer until they reach an impermeable zone. Many DOE groundwater contaminants are potential DNAPLs, including PCBs, mercury, trichloroethylene, and tetrachloroethylene.

Small volumes of DNAPLs can give rise to large groundwater plumes having concentrations far above acceptable health-based levels. DNAPL pools, which may be hidden in weathered bedrock layers or dead-end fractures in bedrock, can continue to diffuse back into the aquifer gradually over prolonged

periods. They may take 50 to 100 years or more to disappear through natural dissolution in groundwater. Because locating DNAPLs is so difficult, attempting to use conventional excavation methods for DNAPL removal may result in disturbance rather than recovery and can cause DNAPL migration to deeper positions in the subsurface.

Water-insoluble liquids that are less dense than water are called "light nonaqueous phase liquids" or LNAPLs. Refined petroleum fuels and oils can be LNAPLs, which are another source of contaminant plumes. LNAPLs tend to be more easily detected than DNAPLs and are thus more easily remediated. They tend to float on the water table and spread within the vadose zone. If present, LNAPLs tend to be readily collected with groundwater samples and during pumping of groundwater, and are seen as a separate phase floating on top of the water samples. Thus, LNAPLs are not nearly the special detection and removal problem that DNAPLs are, and will not be considered in detail in this discussion.

H.4.1.2 Contaminated Soils

A wide variety of soil types are present at DOE sites, including desert and humid climate soils, shallow and deep soils, permeable (sandy) and impermeable (clayey) soils, homogeneous and heterogeneous size mixes, and true soils and weathered bedrock (pre-soils). In general, common usage of the term "soil" (the correct geologic term is "overburden") includes all of the non-coherent subsurface matrix above the water table. The large volumes of soil requiring remediation at DOE sites imply that the risk to the public and to workers from handling so much soil, treating it, and transporting it to treatment facilities would be substantial. Emerging soil remediation technologies that would radically alter the need for handling and transport would also radically alter these estimated risks and capacity of required WM facilities.

The soil contaminants at DOE sites include the same VOCs, semivolatile organics, inorganics, and radionuclides found in groundwater (which is usually contaminated by soil-borne contamination). Because of the inherent affinity of many inorganic contaminants to adsorb on soil and subsurface minerals, and the low solubility and resultant accumulation of organics in the subsurface (which is enhanced immensely if the soil contains any natural organic matter), the solid matrix of the saturated and unsaturated zones can contain far more contamination than the water. Remediation attempts that approach the water alone are either destined for failure or extremely long-term programs.

The type of soil remediation technology that can greatly reduce the risks of excavation and treatment on the surface (or disposal in an engineered and approved facility) is remediation in the actual zone of contamination, that is, in-situ remediation. In-situ biological treatment is an available technology in need of significant refinement. In-situ chemical, thermal, and electrokinetic treatment technologies are being developed. Depending on the extent to which these technologies can be developed and implemented, future soil remediation should become considerably safer and more effective than existing approaches.

H.4.1.3 The Role of Characterization

The ability to remediate all DOE facilities to current Applicable or Relevant and Appropriate Requirements (ARARs), and to remediate many contamination sites to ARARs in a timely and cost-effective manner, is partly limited by the inability to characterize wastes effectively; that is, to identify locations and boundaries of the contaminated region and to identify the level and kind of contaminants present at the start and the conclusion of cleanup.

Inefficient characterization also increases worker risk, because of exposures during the characterization process and during actual remediation. Within the Office of Technology Development, characterization programs are given specialized, cross-cutting, technology development emphasis. Consideration involves not only environmental restoration needs, but also those associated with waste management and facility transition; the former will be emphasized in this section. Analogous "monitoring" technologies directly relevant to waste management are discussed in Section H.3.4 of this appendix.

The scope of characterization, monitoring, and sensor technology consideration includes:

- Initial location and characterization of wastes and waste environments (for example, transport and fate) before treatment
- Monitoring of waste retrieval, remediation, and treatment processes
- Characterization of the composition of final waste treatment forms to evaluate the performance of waste treatment processes
- Site closure and compliance monitoring

H.4.2 BASELINE REMEDIATION TECHNOLOGIES

H.4.2.1 Baseline Groundwater Remediation

The most commonly used baseline technology for plume remediation is pumping the groundwater to the surface through an extraction well, followed by treatment above ground. For organics, treatment might involve air stripping, biological treatment, or oxidation; for inorganics, treatments might involve ion exchange, oxidation, or precipitation. If the groundwater were accompanied by a LNAPL phase, an oil/water separation would be performed before further conventional treatment.

In general, ex-situ groundwater treatment technologies exist for almost any conceivable situation. Remediating contaminated groundwater with these technologies, however, often provides inadequate removal of secondary adsorbed organic or inorganic contaminants (both hazardous and radioactive) from the aquifer matrix during extraction pumping. Furthermore, if the source was a DNAPL, then remediation of groundwater by conventional pump-and-treat methods is usually effective only for remediating the existing plume, not for removing the contamination source or the secondary contamination.

The common technology now used to remove secondary heavy metals or inorganic radionuclides contamination is pumping and treating. The rate of desorption of secondary metal contaminants depends on the aquifer matrix material's ion exchange capacity (which depends on organic matter and mineral—especially clay—content), the pH and redox potential of the groundwater, and the specific metal species. Desorption may be extremely slow if conditions are not optimal, but no technology to create optimal conditions for metal desorption is now widely accepted by regulators as effective.

Although pumping and treating groundwater is often proposed for cleaning up plumes, in relatively few cases can this be expected to achieve acceptable levels of cleanup in a reasonable period (for example, 5 to 10 years) because of inadequate solubilization of secondary contamination. Pumping and treating for 50 to 100 years may often be required to desorb secondary contaminants adequately. In-situ bioremediation of organics and certain inorganics in groundwater is another currently available technology and, under appropriate conditions, it has the advantage of simultaneously treating the secondary adsorbed contamination in the aquifer. It can be effective for volatile, semivolatile, and relatively nonvolatile organic

compounds. It is not considered effective for DNAPLs still in "pool" form. Also, inadequate in-situ treatment of secondary contaminants is likely to occur if:

- The organic material is only slightly water soluble (groundwater concentration would be too low to support biological activity); this tends to include many DNAPLs and most high molecular weight organics.
- The hydraulic conductivity of the aquifer is too low; in this case, the flow rate of nutrients or gases would be too low to support increased biological activity.
- The aquifer temperature is too low; here biological activity would be too weak to accomplish cleanup with microbes.
- The total amount of dissolved organics or toxic metals in the groundwater is high enough to poison the microbes.
- The destruction efficiency of the microbes for the contaminants is too low (refractory chemicals); then the contamination would remain untreated.

When in-situ bioremediation is adequate for cleaning up a plume and any secondary contamination of the aquifer, it should be possible to complete the cleanup in 1 to 5 years.

A currently available groundwater remediation technology for VOCs is in-situ air sparging, which will strip VOCs from the groundwater and will accelerate the removal of VOCs from the aquifer matrix as well. In-situ air sparging will also strip volatile LNAPLs and DNAPLs from the subsurface. This technique is discussed further in the following section because it also applies to soils.

H.4.2.2 Baseline Soil Remediation

The most commonly used baseline technology for soil remediation is excavation followed by transport to an acceptable disposal facility. Other available technologies involve excavation and surface processing. Ex-situ soil treatment methods (specifically, waste volume reduction methods) such as separation of the contaminated soil fraction and soil washing are being used more often to reduce the volume of waste requiring land disposal. A primary baseline technology for contaminant removal applicable to oxidizable substances is incineration. Other thermal processes induce volatilization and then capture the contaminants for further treatment or disposal.

In-situ treatment technologies are focusing on either immobilizing the contamination in an artificially generated rock matrix, or extracting the contamination by soil-washing. The primary immobilization technology involves solidification by chemical cementation. Depths are limited by the availability of the deep-soil mixing equipment needed. Soil washing is applicable to greater depths, but does require that the contaminant be readily mobilized by the wash fluid. Injection of solubilizing agents such as oxidants, reductants, acids, bases, or complexing substances is still an emerging technology.

In-situ bioremediation can be effective for many organic compounds. However, inadequate in-situ treatment of soil contaminants will occur under the same conditions described above for groundwater (insoluble contaminants, low temperatures, excessively high levels of contaminants, low hydraulic conductivity, inadequate destruction efficiency of the microbes). When in-situ bioremediation is appropriate for a site, it is possible to complete the remediation in 1 to 5 years.

In-situ air sparging is another currently available soil remediation technology, applicable to VOCs. This technique involves pumping air into the subsurface and sweeping out the more volatile substances. To some extent, this flushing can also enhance the volatilization of these compounds from an underlying aquifer matrix. In-situ air sparging will strip volatile separated phases—LNAPLs and DNAPLs—from the subsurface. Air sparging is inefficient for semivolatile organics such as most pesticides, PCBs, and PNAs.

H.4.2.3 Baseline Site Characterization

Today, the general method for characterizing a site entails drilling wells or clusters of wells, based on a grid outline of the site. Samples are taken from these wells to determine the geology, hydrology, and aquifer contaminant levels. When drilling a well, a split spoon auger may be used to sequentially collect soil samples until the aquifer is reached. Then, the well is cased and a section (approximately 10 feet) is screened to monitor the aquifer over a period of time. This procedure, when done for a specific grid pattern across the site, provides a horizontal mapping of aquifer contaminants. If a vertical profile is desired, a cluster of wells is installed at a specified point to monitor discreet levels of contaminants in the aquifer. For example, if the depth of an aquifer at a certain grid point is 50 feet, and 10-foot screens are called for by the regulators for well monitoring, then five wells must be drilled to analytically profile the aquifer at one grid point. Certain volatile contaminants and radioactive particles, such as gamma rays, are detectable at the surface, and certain information about the nature of the subsurface contaminants and potential exposures

may be inferred. However, it is not generally possible to use that information to provide much more than guidance in planning the more detailed subsurface sampling.

The primary objective of site characterization is to map the contours of a contaminated area or contaminant plume; this mapping may be difficult if grid sample points are not well positioned along the plume contours, or if many data points indicate nondetectable contaminant levels. Further, the geological, hydrological, and chemical data are generally analyzed separately, not integrated. Thus, migration pathways and contaminant plume contours may not easily be determined.

Regulators establish protocols for the characterization program at each site, based upon data quality requirements, pre-existing knowledge of the site contaminants, hazards of known contaminants, and the particular statutes and regulations applicable to the program (for example, sites regulated under CERCLA and under RCRA within the same State may be responding to different regulators). Thus, instrumentation to be used, sampling frequency, and sample handling will not necessarily be identical across the entire DOE complex.

Samples are normally sent to an analytical laboratory where standard chemical and radiological instrumentation is used to measure contaminant identities and levels. Except under special circumstances, these laboratories typically are not on the site itself. The laboratories may be government operated, depending on the source site of the sample and suspected contaminants, but are often commercial enterprises, approved by the EPA through the Certified Laboratory Program.

Current characterization methods are expensive, time-consuming, intrusive, may give rise to new contaminant migration pathways, and can produce large quantities of secondary wastes. People collecting samples and those performing the analysis often do not communicate directly. Therefore, not all aspects of the data may be fully understood during analysis. Furthermore, appropriate modifications in the protocol based on past analyses may be slow to reach the field.

H.4.3 Emerging Remediation Technologies (Subsurface Contaminants Focus Area)

A number of strategies and technologies for contaminated groundwater and soil characterization and remediation are emerging. These technologies promise improvements in the scope of applicability, cost

effectiveness, and completion times for future cleanups that would significantly reduce environmental hazards and risk. They include technologies for better field detection and pinpointing of groundwater and soil contamination, as well as chemical and thermal technologies for improved mobilization of contaminants for extraction and treating.

H.4.3.1 Improved Techniques to Detect, Remove, and Contain Primary Groundwater Contamination Sources

The detection of concentrated primary sources of contamination, especially DNAPLs, is difficult with conventional technologies. The existence and location of DNAPLs at DOE sites may often be undetermined. The cone penetrometer, a vehicle-mounted punch-like device used for many years to characterize the engineering properties of the shallow subsurface, has recently been adapted for sensing subsurface contamination using optic fiber sensors, and for continuous sampling of liquids or vapors without requiring removal of the penetrometer. Many punches of a cone penetrometer can be accomplished in the time and for the cost of installing a single groundwater monitoring well. The penetrometer should eventually permit detection of small pockets (0.5 cubic meters or less) of DNAPLs in-situations where installing a well would likely disturb, or spread them, but not accurately determine their location.

Recent improvements in the design and use of the cone penetrometer include the ability to penetrate rocky soils—through the use of higher drive weights and stronger, larger diameter penetrometer rods—and the ability to emplace well points and tubing, which can be used for soil gas measurements. The emplacement of well points may ultimately be modified to allow vapor or groundwater recovery without the necessity of installing a well.

Improved nonintrusive detection methods are being developed that may be expected to detect shallow pockets of DNAPLs. These detection technologies include seismic, passive and active magnetic, ground-penetrating radar, and induced resistivity/polarization methods. Current development is focused on improving their sensitivities at greater depths. Ground-penetrating radar shows the most promise. At present, none of these technologies is sensitive enough to be used alone or on all sites for DNAPL characterization, but when used in combination with other techniques such as the cone penetrometer, they can result in excellent delineation of DNAPLs.

Methods for adsorbing or siphoning pockets of DNAPLs are also needed to exploit these detection advances. A continuous sampling cone penetrometer may be adapted to pump DNAPLs to the surface, but such development has not yet begun. Conventional excavation methods may be adaptable for DNAPL removal without causing deeper migration, if conducted in conjunction with precise locating of DNAPLs with a cone penetrometer or other sensing device.

Emplacing conventional slurry walls or sheet piling, or hydraulic control using down-gradient extraction wells, are methods for containing a DNAPL source that can be used once DNAPL detection technologies emerge. These temporary containment technologies would allow time for source study while DNAPL removal methods are being considered or tested, without delaying initiation of other plume remediation activities.

Development of equipment capable of locating DNAPLs accurately enough for containment will likely occur in the next 3 to 5 years, but pinpointing individual DNAPL pools precisely enough for removal may be 5 to 10 years in the future. Because DNAPLs are one of the most common sources of groundwater contamination, these advances can be expected to save decades in remediation times, and hundreds of millions of dollars as compared with the alternative of simply attempting to pump and treat as long as necessary to exhaust the DNAPL source.

H.4.3.2 Improved Techniques to Detect Soil Contaminants

Detection and characterization of contamination using conventional technology involves the use of either fixed monitoring wells or shallow soil-gas surveys. Although improvements have occurred in location, sampling, and analysis speed, significant limitations of these methods make them expensive and somewhat unreliable. Improved techniques are under development to reduce cost and improve accuracy. These include the SEAMIST™ system and the previously discussed cone penetrometer. SEAMIST™ is an add-on to well technology that improves measurements of soil or water-borne contamination in both vertical and horizontal boreholes. The system facilitates chemical characterization and is a platform for geophysical sensors and video devices. Installation can be either temporary or permanent.

The technology uses an airtight membrane to line a conventional well or borehole. The membrane is forced into a drilled or punched well pneumatically. After emplacement, the entire hole wall is sealed, preventing

ventilation of the pore space or circulation of pore water in the well. Once monitoring instruments are placed on the outer surface of the membrane, in contact with the hole wall, the membrane isolates each measurement location. High spatial resolution of the contaminant distribution is thereby possible.

Nonintrusive detection methods for contamination in groundwater are also applicable to characterization of soils. A suite of improved techniques for locating soil contamination probably will be in place in the next 3 to 5 years.

The same set of containment technologies already described for groundwater can usually be applied to soils once contaminants have been accurately located.

H.4.3.3 Improved General Site Characterization

In addition to purely "hardware" solutions, innovations that involve methodology may also be a key to characterization advances. The expedited site characterization (ESC) is one method for rapid, less expensive, and technically superior characterization of a site's groundwater and soil. ESC, as initially conceived, deploys a highly technical, multidisciplinary team to the field. The team collects data daily, discusses and integrates the results, and then formulates a strategy for sampling and analysis for the following day's activities. While field chemical instrumentation analysis costs vary, they are generally more than five times lower than offsite laboratory costs. For example, costs associated with sample transportation are eliminated. One typically exploits this cost savings potential, and the associated time savings from field analysis, to take more field samples. In addition, field testing is facilitated by being able to relocate sampling locations rapidly, if analytical results suggest that this is desirable. The resulting improvement in resolution of the plume allows for sampling many fewer monitoring wells and more than compensates for any differences in the quality of analyses that might occur between field and centralized laboratory settings. This dynamic approach to characterization saves time by reducing data integration and analysis turnaround times and saves money by minimizing well drilling and laboratory sample analyses. The net result is a faster and cheaper process that is arguably more accurate than conventional site characterization techniques.

The ESC has been successfully demonstrated at several U.S. Department of Agriculture sites in Nebraska and Kansas and at Bureau of Land Management landfill sites in New Mexico. Near-term tests will demonstrate the functionality and benefits of the process compared to conventional characterization

methodologies and will characterize smaller sites focusing on organics, heavy metals, and radiological contaminants.

H.4.3.4 Improved Techniques to Mobilize and Remove Secondary Sources From Groundwater

In-situ air sparging can remediate a plume and its secondary contamination simultaneously if the contaminants are water insoluble VOCs, such as trichloroethylene and carbon tetrachloride. If semivolatile or nonvolatile organics are present that are also water insoluble, heat can be added to enhance volatility or water solubility. The aquifer matrix can be heated with steam, as has been shown in the Office of Technology Development's Dynamic Underground Stripping Project. There, steam was used to remove spilled gasoline by a combination of heating and gas stripping in the vadose zone and in the aquifer itself. If this technique were applied to nonvolatile, slightly soluble, secondary contamination, including inorganics or organics, solubilization in the groundwater could be enhanced.

Methods for heating the vadose zone also are being tested, including radio frequency or microwave heating and multiphase joule (conductive) heating of the subsurface. The solubility of contaminants in water, and the volatility of organics, can be enhanced by such heating. These techniques may also be applicable to aquifer matrices that have been pumped down temporarily.

Solubility enhancement for secondary contaminants is more developed than heating techniques. Organic secondary contaminants may be solubilized by flushing with appropriate ionic or nonionic surfactants or with enzymes. Aqueous surfactant solutions have been effective in removing water insoluble organics from soils, and would be expected to be as effective with aquifer matrices. Various surfactants are already approved for use on cropland as soil penetrants; inasmuch as they are also biodegradable, their use in aquifers should be considered acceptable by regulators. Enzymes are used in a variety of domestic cleaning and clothes washing materials because of their ability to degrade large organic molecules.

A wide variety of organic chelating agents (organic compounds that form soluble complexes with metal cations) can be used to solubilize heavy metals. These agents include ethylenediamine tetraacetic acid and citric acid. Some inorganics can be solubilized by acidic or basic buffers, or with oxidizing or reducing agents, allowing extraction. Electrokinetic techniques are being developed that would be applicable to shallow aquifers for mobilization of ionic contaminants. They would not require injection of reactive

substances to promote mobility, but would use electrical fields to induce movement toward an extraction point.

The laboratory development of in-situ solubilization methods, including chelation, oxidation, and reduction, is in progress. Successful application in the field will depend on general improvements that must include treatment-chemical introduction and monitoring techniques, control and mass balance of contaminants and treatment reagents in the subsurface, and obtaining and maintaining sufficient permeability of the treatment zones. These developments can probably be expected in the next 3 to 10 years and will be widely applicable for groundwater remediation. The eventual savings in remediation times and costs will likely be a full order of magnitude.

H.4.3.5 Improved Techniques to Mobilize and Remove Soil Contamination

Many of the same technologies discussed above in connection with mobilization of contamination in groundwater are also applicable to soil remediation, particularly for soils where the groundwater table extends upward to shallow depths. Successful application of these technologies will require major improvements in general subsurface operations methods, including:

- Techniques for the injection of treatment solutions
- Techniques for monitoring reactions and movement
- Techniques for subsurface hydraulic control
- Techniques to enhance and maintain adequate subsurface permeability

As in the case with groundwater, these developments can probably be expected in the next 3 to 10 years and will be widely applicable for subsurface remediation. The eventual savings in remediation times and costs will probably be a full order of magnitude.

H.4.3.6 Improved In-Situ Treatment Technologies for Plumes and Secondary Sources in Groundwater

In-situ treatment of a groundwater plume tends to be cheaper than pumping and treating because less groundwater must be pumped, secondary sources can be treated simultaneously, and secondary waste

streams are minimized. Both in-situ chemical and in-situ biological remediation technologies are under development.

In-situ chemical oxidation can destroy toxic organics or oxidize secondary organic contamination to the point that solubility increases and the oxidized products desorb and can be pumped to the surface for more complete ex-situ treatment. The candidate oxidants are those that degrade spontaneously to nontoxic products in the environment, such as ozone and hydrogen peroxide.

In-situ biodegradation recently became an available technology. Even so, technology development continues to address the significant limitations previously mentioned. Some examples are:

- For organics that are too water insoluble to desorb significantly, solubilization can be increased with surfactants or enzymes that do not harm the microbes. The desorbed contaminants can then be biodegraded in-situ.
- In areas where low aquifer temperature makes the rate of biodegradation very slow, in-situ heating will accelerate these rates so that bioremediation becomes practical.
- At sites where high levels of dissolved organics or toxic metals are present in the groundwater, or where the contaminants to be treated are refractory to biodegradation, microbes that can tolerate these conditions need to be developed and introduced into the subsurface. These goals are quite difficult, especially spreading microbes through the subsurface (which essentially behaves like a filter).
- In-situ biodegradation may be expected to tie up nonbiodegradable contaminants only temporarily, such as heavy metals and nonmetal radionuclides. Biomass decay may also produce byproducts capable of chelating and mobilizing toxic heavy metals. Methods must be developed for assessing this problem beforehand and for controlling it.

H.4.3.7 Improved In-Situ Treatment Technologies and Stabilization Technologies for Soil

In-situ treatment of soil contamination, by reducing the generation of secondary waste streams, tends to be cheaper than excavation and treating. In addition to in-situ immobilization technology, chemical and biological remediation technologies are under development. Many of the emerging technologies described above for groundwater and aquifer remediation may be applicable to soil and the vadose zone as well.

In-situ vitrification (ISV) is one emerging treatment technology for soils. Melting of the soil minerals and subsequent cooling to an impermeable glass-like mass will immobilize many soil contaminants. During the heating process some organics will volatilize; others will degrade. Any that escape the glass must be captured for treatment. The technology shows great promise for immobilization of radionuclides and for treatment of mixed wastes.

MAWS is a related process in which several waste streams with complementary characteristics are combined in order to take advantage of their separate characteristics. Doing so minimizes the need to add uncontaminated materials. In some cases, two merged streams can be vitrified when it would be impractical to vitrify one of the two alone. The benefit of this approach is that the final waste volume (for example, the wash residues from soil washing) is minimized because few or no additives are used and vitrification itself results in volume reduction.

In-situ biodegradation technology has advanced rapidly. Development continues to address the significant limitations previously mentioned in connection with groundwater. In addition, accessibility of microbes and nutrients to the contaminants sorbed in the soil interstices needs to be improved. General techniques such as soil-fracturing may be inadequate to improve the rate of degradation through access to the soil micro-structure.

H.4.4 Conclusions About Emerging Environmental Restoration Technologies

The conventional approach to groundwater contaminant extraction (pump and treat) is suitable for only a few sites and contaminants. The regions associated with many contaminated DOE sites:

- Are in the vadose zone without water
- Have such low permeabilities that pumping cannot extract the contaminated water
- Have contaminants with low solubilities or volatility and high soil affinities and are difficult to mobilize

The ability to locate primary sources of contaminants effectively, especially before they move into groundwater, and to contain them at those locations is a significant part of any strategy to avoid increasing costs and risks in the future. Emerging characterization technologies can reduce the cost, time, and worker risk associated with restoring sites by minimizing sampling and well costs, by reducing the number of trips

and time in the field to collect potentially unnecessary samples, and by precisely locating contaminated region boundaries to minimize the handling of uncontaminated soil or groundwater.

The potential for significant cost reductions because of the availability of these or other advanced technologies could result in regulatory decisions to undertake more extensive remediation at particular DOE sites than would otherwise be the case. These decisions could result in increasing the waste loads being delivered from environmental restoration activities to waste management. However, this waste load effect is unlikely to be important at a programmatic level for at least two decades because in-situ technologies (which reduce waste loads) have greater potential for emergence and impact between now and that time. For unremediated sites, advanced characterization technologies can make it possible to monitor contaminant transport and provide confidence of the immobility of many contaminants and, therefore, minimal risk to public health.

Development of characterization and in-situ treatment technologies—reducing the need to excavate material for processing onsite or for transport elsewhere for disposal—will achieve the greatest improvement in safe, cost-effective soil remediation and minimization of waste management loading. Exposure risk, remediation cost, and danger to the population, from both contaminant contact and transport hazards, are substantially reduced through applying in-situ technologies. In-situ technologies are being developed and demonstrated for applications in the next 5 to 10 years. Some sites will still be recalcitrant, including those:

- With such poor hydraulic conductivity that most remediation methods would have difficult access
- Where the mix of contaminant chemistry (and subsurface interferences) limits the technology
- For which the extent of contamination, even with the best of innovative technology, would overwhelm financial resources

Although extremely difficult to remediate, situations of the first type (or others where the soil affinity makes the contaminant immobile) may pose less immediate risk. In other words, the same factors that inhibit remediant access may inhibit movement by the contaminants themselves. However, such inhibition is not reliable because of differing physical and chemical characteristics among the contaminants and remediants. Further, almost all sites will have soils that vary significantly in quality and characteristics. Accessibility to remediation injection or extraction will be patchy, and thus long-term "bleeding" of contaminants from isolated pockets of contamination will be a common problem.

These factors stress the importance of continuing research that enhances formation accessibility. This includes work to increase formation hydraulic conductivity and the ability to target, or pinpoint, the insertion of reagents and extraction of fluids. At present, the ability to manipulate groundwater flow is rudimentary. Plans for the application of any in-situ technologies will hinge on significant improvements in subsurface control. Because many technologies will involve powerful reagents and microbes and their nutrients, regulatory approval will depend on presentation of proof that the remediation can be controlled and will not worsen the environmental hazard by replacing one contaminant with another.

With regard to schedule, technologies adequate for soil remediation are expected to be successfully developed during the next 5 to 10 years. Their implementation should be widespread in another 5 to 10 years as they become generally accepted by remediation managers, regulators, and other stakeholders. The large number of possible approaches provides a basis for confidence that one or more approaches will prove successful despite uncertainties that may exist about any particular approach. The extent of soil contamination problems at DOE sites and non-DOE sites also provides confidence of continued private sector interest in commercialization.

On shorter time scales, there is little indication that all or most sites that cannot be remediated by available technologies could be remediated with emerging technologies. Formation accessibility is too difficult and hydraulic control in the subsurface is insufficient to ensure the success of in-situ methods. Short-term control until usable technologies are sufficiently mature, or long-term control and isolation, will be necessary to minimize risk where remediation is currently impossible.

Emerging technologies could mitigate the costs of remediation significantly. In the WM PEIS, DOE assumed a generic process that used new supplies of commercially available equipment and materials. Cost saving could result from the application of technologies discussed in this section. For example, the MAWS vitrification process could be less expensive than the generic vitrification process for certain applications, if on-site waste could be substituted for commercial oxide new material. Similarly, the use of the SEAMIST™ technology would provide better control of test wells, reducing the cost of characterization, and ultimately reducing the cost of pump and treat operations. These technologies are only a small fraction of the remediation technologies now under development within DOE, and many technologies should have numerous applications outside the DOE complex.

H.5 Transportation Technologies

Some of the waste management alternatives considered in the WM PEIS may require extensive transport of radioactive or hazardous materials on or between DOE sites. DOE's Transportation Management Division, with the EM Office of Compliance and Program Coordination, is sponsoring packaging research and development, packaging engineering and analysis, and packaging operations studies to produce a new generation of hazardous materials packaging.

H.5.1 Packaging Research and Development

Packaging research and development includes several related areas of development: development of analytical design codes, evaluation of packaging components, materials characterization, and packaging concepts.

Development of analytical methodologies design codes is the first such area. Structural analysis techniques are developed to predict packaging response accurately. Activities in this area emphasize establishing nonlinear dynamic analysis as an alternative for use in package certification. Specific activities will include investigation of acceptance criteria for inelastic analysis and benchmarking of these analysis codes. Thermal computational techniques are being improved. A better engineering description of hypothetical accident environments through use of new and existing analysis techniques and additional instrumentation is under development.

Development of analytical methodologies and design codes also includes activities to automate the analytical process. Transportation packagings are the final product of an iterative process of design, analysis, interpretation, modification, and redesign. This inherently inefficient design process can be vastly improved by automating evaluation of the structural, thermal, and shielding constraints to produce a more uniform factor of safety and thus more efficient design.

Evaluation of packaging components has already provided data on impact-limiting material and screening methods. A new constitutive plasticity model for wood stress through the crush range is being developed. Verification and refinement of a proposed crush failure theory for general triaxial stress states will be undertaken. A research and testing program for seal materials, begun in 1988, is characterizing the behavior of seal materials commonly used in radioactive material packages under normal and accident conditions,

performance of the seals in nondeformed closures at both high and low temperatures, and response of seals to deformations in the closure region. A topic of particular interest to package designers is short-term closure movements that return to their initial configuration after a few milliseconds, resulting in the so-called "burp" release. Also of interest for many package types is the release of particulate materials instead of gaseous materials.

DOE currently is sponsoring work to establish the fracture mechanics methodology for ferritic materials, thereby extending the range of structural materials potentially usable for package construction.

One new concept is design of "Type B" transport packaging for plutonium and uranium that meets future regulatory requirements. The new package design uses nested cylindrical containment vessels with threaded closures and elastomeric seals and a composite material overpack of metallic wire mesh and ceramic or quartz cloth insulation material.

H.5.2 PACKAGING ENGINEERING AND ANALYSIS

The packaging engineering and analysis programs involve engineering, design, analysis, and testing for packaging development. New packaging concepts emerge to meet specific programmatic requirements. Innovative packaging designs for transporting high activity liquid waste and environmental samples that need cooling during transport are under development. The Beneficial Uses Shipping System (BUSS) cask has been developed for transporting special-form cesium chloride and strontium fluoride capsules and conceptual designs have been completed for packages for offsite shipment of Hanford tank waste liquid samples, Hanford tank waste core samples, and onsite shipment of large volume wastes.

Attachment to Appendix H

Office of Technology Development
FY 1996 Budget Request Work Packages
for the Focus Areas and Crosscutting Programs (Excluding Program Support, Program Direction, and Technology Integration)

Information From the Back-Up to the Budget Submission to the Office of Management and Budget, 10-10-94

Mixed Waste Focus Area

Plasma

- Prepare and conduct pilot-scale demonstration of the plasma arc treatment process (including off-gas system) using nonradioactive surrogates. Determine partitioning of surrogate radionuclides.
- Complete bench-scale testing of the plasma arc treatment process with actual radioactive mixed waste. Develop and demonstrate waste materials handling capabilities, both on the front and back ends of the treatment processes, in preparation for the field demonstration of the plasma hearth process. Test a closed-loop off-gas system with appropriate process monitoring and control (continuous emission monitors and control loop electronics) hardware.
- Facilitate the early field implementation of the plasma hearth process.

Vitrification

- Complete compact vitrification system demonstration integrating melter, off-gas systems, etc. Evaluate and implement closed-loop off-gas systems with complete process monitoring and control systems on the compact vitrification units.
- Modify high-level waste vitrification technology for the treatment of low-level waste. Complete demonstration of polymer solidification for quality assurance and process control of final forms production. Perform field-scale demonstrations on LLMW employing low-temperature waste stabilization processes such as polymer encapsulation and phosphate-based ceramics.

Rocky Flats compliance

- Design a nonradioactive demonstration unit for catalytic wet chemical oxidation (CWCO) system. Begin fabrication of demonstration unit for CWCO process. Test new materials for reactor vessel of CWCO process. Test waste blending to improve process parameters.
- Test more complex waste forms with a supercritical carbon dioxide extraction (SCDE) system. Evaluate enhancements for the SCDE system. Conduct a cold demonstration of SCDE. Begin design of volatilization, low-temperature thermal desorption, full-scale system.
- Continue development of microwave system. Test pelletizing process and select a drying technology. Demonstrate off-gas treatment and monitoring system. Design, fabricate, and install an upgraded bagless posting system. Design, fabricate, and test components of a break-open system. Perform nonradioactive bench-scale tests on surrogates of additional wastes. Perform tests on currently generated by-pass sludge. Perform full-scale tests on spiked surrogate wastes.
- Begin demonstration of macroencapsulation of miscellaneous waste. Conduct a polymer microencapsulation demonstration on radioactive nitrate salt waste. Conduct lab-scale testing of a thermal treatment process for waste. Prepare for radioactive lab-scale tests on surrogate waste of backlog sludge microencapsulation. Conduct a nonradioactive demonstration on new sludges. Conduct nonradioactive bench-scale tests on nonthermal treatment of waste.

Supercritical water oxidation

- Complete nonradioactive testing and demonstration of the supercritical water oxidation (SCWO) pilot plant with DOE hazardous and surrogate mixed wastes.
- Prepare an Environmental Impact Statement and a Preliminary Safety Analysis Report for the radioactive demonstration of the SCWO pilot plant.
- Complete a conceptual design of the SCWO pilot plant for the radioactive demonstration.

Other

- Complete a radioactive demonstration of the Delphi DETOX process to catalytically oxidize the organic constituents of waste streams in a contained reactor.
- Develop advanced effluent control systems, continuous emission monitors, cleanable high-efficiency particulate air filters, and other off-gas treatment and monitoring systems.
- Develop alternative low-temperature treatment technologies for mixed waste, specifically for combustible contaminants.
- Develop intelligent remote sensing systems and survey robots for radioactive storage areas.

- Develop alternative low-temperature final forms for mixed waste.
- Develop processes to refine and/or enhance basic knowledge solutions for the removal of heavy metals and mixed hazardous wastes from soils; use metal oxide particles as reagents for destruction and immobilization of hazardous substances.

Radioactive Tank Waste Remediation Focus Area

- Demonstrate real-time tank integrity inspection and waste mapping technologies with the light-duty utility arm (LDUA):
  - Camera systems, laser range finder, structured light hardware
  - Tank riser interface and confinement system
  - LDUA decontamination system
  - Supervisory control and data acquisition system for LDUA
- Conduct integrated testing and development of waste dislodging and conveyance tools for retrieval of multiple waste types:
  - Waste dislodging and conveyance hydraulic test bed
  - High-pressure water jet scarifier
  - Medium-pressure water jet scarifier
  - Further waste dislodging and conveyance work to plan retrieval operations and meet 99% retrieval minimum from TPA (Hanford Tri-Party Agreement)
- Conduct a hot cell demonstration of characterization of waste, which includes the Raman spectroscopy system:
  - Raman spectroscopy system
  - Further development for a higher resolution scanning Raman spectroscopy system
  - In-situ characterization and on-line monitoring of waste and data analysis methods
- Perform radioactive testing of an out-of-tank mobile evaporator:
  - Fabrication and radioactive testing of evaporator/concentrator compact processing unit (CPU)
- Conduct a radioactive demonstration of a mobile, field maintainable CPU for cesium removal:
  - Complete resin and skid testing and CPU design
  - CPU test unit
  - Cesium extraction resin

- Demonstrate sample retrieval and on-line, in-situ waste analysis with the LDUA system in Idaho:
  - LDUA adaptation for Idaho tanks and sample retrieval
  - Waste dislodging and conveyance tools adaptation for LDUA and Idaho tanks
- Conduct a hot demonstration of solid/liquid separation by using a cross-flow filtration system.
- Demonstrate low-pressure water-jet tools for waste removal from tanks, leading to a radioactive retrieval demonstration at Oak Ridge/Idaho; adapt the waste dislodging and conveyance scarifiers for Oak Ridge gunnite tanks.
- Using actual waste from the Melton Valley Storage Tank Farm, demonstrate sludge and supernatant processing of this waste:
  - Demonstrate sludge dissolution and TRUEX solvent extraction for partitioning of transuranic waste (TRUW) components.
  - Demonstrate sorbent removal of cesium, strontium, and technetium from supernate.
  - Complete sorbent testing for removal of strontium and technetium.
  - Continue development of general site-specific waste processing flowsheets.
  - Adapt sludge/supernate processing system for demonstration on Hanford tank waste.
  - Continue development of waste processing flowsheets.
- Demonstrate in-tank equipment designed to remove scrapped hardware from waste tanks.
- Use analysis techniques and sensors to characterize and monitor chemical and physical conditions within tanks (work includes spectroscopic techniques and LDUA development).
- Develop end-effectors for waste dislodging and conveyance.
- Develop solutions for tank waste by using CPUs.
- Develop waste disposal technologies.
- Refine and enhance basic knowledge solutions in the development of in-situ measurement of fissile, moisture, thermal properties, fission products, and head space gases; identify wide dynamic range tank hot spot.

Subsurface Contaminants Focus Area

Containment

- Demonstrate physical barriers formed from viscous liquids (polybutene and colloidal silica) emplaced under controlled viscosity conditions.

- Evaluate two new flowable bentonite-mineral-water-inorganic grout techniques to reduce the cost of barrier emplacement.
- Demonstrate hydraulic and diffusion barriers in the vadose zone surrounding buried waste.
- Demonstrate surface-controlled emplacement horizontal planar barriers beneath waste sites by using tilt meters and models to predict effectiveness.
- Assess polymer cement, ion-exchange cement, cement glass, and latex cement grouts for vertical subsurface barrier long-term effectiveness.
- Demonstrate four innovative advanced landfill cover designs and compare them with existing U.S. Environmental Protection Agency designs.
- Demonstrate dry barriers by using active/passive ventilation of coarse barrier layer to remove water.
- Demonstrate migration barrier covers by using locally available soils/rocks and synthetic barriers.
- Demonstrate a prototype model for the selection of barrier cover systems by using a decision analysis tool that analyzes tradeoffs to compare the effectiveness, risk, and cost of landfill cover technologies.

Stabilization

- Perform field-scale testing of buried waste encapsulation techniques at arid site burial grounds by injecting naturally occurring cementing solutions to form soil/waste monoliths that immobilize contaminants and are impervious to water migration.
- Initiate in-situ treatment techniques for buried waste (through field testing at a full-scale cold test pit location) that establish a vitrified glass matrix while destroying volatile organics.
- Develop other stabilization technologies (in association with industrial programs).
- Demonstrate long-term monitoring techniques and in-situ monitoring to predict failures, and assess the effectiveness of the stabilization technology by using time domain reflectometry/in-situ moisture monitoring, leachate collection systems, directional well holes, plant and intruder analysis, and subsurface geophysical evaluations.

Containment and stabilization

- Demonstrate active/passive acoustic system for the placement and monitoring of barrier technologies.
- Demonstrate electromagnetic measurement techniques for the monitoring of containment and stabilization activities.
- Demonstrate specialized borehole-deployed geophysical instrumentation for the monitoring of containment and stabilization activities.

Treatment

- Conduct hot bench-scale thermal treatment tests by using a direct current Graphite plasma furnace that can operate in the submerged or transfer arc mode.
- Conduct a hot bench-scale thermal treatment test by using a millimeter wave radiometer to determine spatial resolution of the temperature measurements.
- Conduct hot bench-scale thermal treatment tests by using a microwave plasma analyzer in the off-gas flow from a high-temperature furnace that allows real-time assay of off-gases for metals and organics.
- Conduct hot bench-scale off-gas treatment tests by using nonthermal electrical discharge plasma for the destruction of hazardous chemicals.
- Demonstrate batch/continuous leach technology for uranium-containing soils at Fernald Environmental Management Project (FEMP).
- Demonstrate by laboratory simulation the performance and economics of uranium heap leaching for comparison with the batch-reactor method using transparent leaching columns.
- Demonstrate minimum additive waste stabilization at Pantex by further developing the concept of blending waste in an integrated system centered on vitrification, using the Duramelter, and also including soil washing.
- Demonstrate magnetic techniques on uranium-contaminated soils at FEMP.
- Demonstrate biphasic separation techniques on uranium-contaminated soils at FEMP.
- Demonstrate ex-situ treatment technologies for the removal of mercury from Oak Ridge Reservation.

Removal

- Initiate a hot demonstration for Idaho National Engineering Laboratory (INEL) TRUW waste pits by using a dual-arm cooperative retrieval system that delivers dual manipulator capability to the dig-face and deploys various retrieval support tools.
- Initiate a hot demonstration for INEL TRUW waste pits by using innovative end-effectors and a conveyance system that achieves dust-free dumping and uses a self-guided vehicle to convey retrieved waste to a treatment facility.
- Initiate a hot demonstration by using dig-face characterization that uses multiple sensor data integration and interpretation for real time characterization data in support of retrieval operations.
- Initiate a hot demonstration of TRUW dust monitoring by using laser optical scattering techniques for dust assessment and laser-induced breakdown spectroscopy for real-time composition determination.

- Initiate a hot demonstration of retrieval integration by using a "rad hardened," teleoperated, 60,000-pound class excavator with supervisory control for data transfer and collision avoidance for the integrated system.
- Demonstrate buried waste contamination control in a "hot" environment by using dust generation minimization hardware/procedures and implement dust/contamination control measures (misting, wetting agents, forms, vacuum).

Assessment

- Conduct hot demonstrations of a radiological hazardous materials measurement system that consists of multiple measurement cells and integrates individual measurements to improve quantitative assay capability.
- Demonstrate a combined thermal epithermal neutron system that uses thermal neutrons to interrogate for fissile isotopes in waste drums.
- Demonstrate active passive computed tomography, which uses a high-purity germanium detector for nondestructive assay of gamma-emitting nuclides in sludge, combustibles, and metal matrices with a 55-gallon drum.
- Demonstrate digital radiography by using a high-energy x-ray source installed in a commercial scanner to measure density and nondestructively view the contents of high-density drums.
- Conduct glass/ceramic performance assessment to provide the necessary database and the thermodynamic/kinetic modeling capabilities to make reasonable long-term predictions regarding the performance and durability of low-level waste (LLW)/LLMW vitreous waste forms under potential disposal site conditions.
- Conduct a glass/ceramic composition envelope study to provide a database of vitreous waste form compositions and properties plus an easy-to-use modeling tool by using actual wastes, where available from three DOE sites, or reasonable surrogates to develop vitreous waste forms that are then tested for processability as well as durability characteristics.
- Demonstrate technologies for waste assay during waste handling operations.

Other

- Conduct research on and design advanced monitoring technologies for remediated landfills.
- Refine and enhance basic knowledge solutions in the development of methods and processes for nonintrusive and intrusive site characterization and waste assay.

- Refine and enhance basic knowledge solutions in the development of verification technologies for the emplaced barrier continuity with reduced site disruption; hot spot and full-scale retrieval of untreated waste.
- Refine and enhance basic knowledge solutions in the development of pre-, primary, and secondary ex-situ treatment and recycling secondary waste streams; subsurface contaminant technologies.

Contaminant Plume Containment and Remediation Focus Area (Merged With the Landfill Stabilization Focus Area to Form the Subsurface Contaminants Focus Area)

- Develop, demonstrate, and test reactive barriers and deep subsurface barriers:
  - Demonstrate a reactive barrier for strontium-90 and cesium-137 at an arid site.
  - Demonstrate a reactive barrier for technetium-99 and trichloroethylene at a humid site.
  - Conduct field-scale testing of permeable barriers at a humid site.
  - Develop methods to emplace reactive barrier materials at depths up to 50 feet.
  - Develop methods to extract or rejuvenate reactive materials to prolong barrier life.
  - Develop performance monitoring techniques for reactive barriers and subsurface impermeable barriers.
  - Demonstrate barrier emplacement tools to create an integrated barrier/floor wall.
- Develop and field test technologies for detecting/immobilizing/removing metals and radionuclides in groundwater:
  - Develop in-situ redox manipulation for immobilization of uranium in groundwater at Hanford.
  - Field test the MAG*SEP process for removal of radionuclides from groundwater at Savannah River.
  - Demonstrate the ex-situ biosorption of the uranium process on Fernald groundwater.
  - Develop new methods for the removal of technetium-99 from groundwater.
  - Demonstrate electrokinetic removal of uranium from Oak Ridge groundwater at the pilot scale.
  - Demonstrate electrokinetic methods for migration and removal of heavy metals in groundwater.
  - Develop in-well removal methods (recirculating wells) for various metals.
  - Field test mobile lab-based characterization methods for metals in groundwater, such as laser-based spectroscopy methods.
  - Demonstrate electrokinetic methods for removal of chromium at Sandia.

- Develop and field test detection, extraction, and treatment systems for dense nonaqueous-phase liquids (DNAPLs) in groundwater:
  - Develop and field test advanced extraction systems for DNAPLs by using foam/surfactant mixtures at Paducah or Oak Ridge.
  - Further develop and field test extraction systems for DNAPLs by using heating methods (e.g., radio-frequency heating, steam injection, ohmic heating).
  - Develop and field test DNAPL degradation by using aerobic/anaerobic bioremediation at Hanford.
  - Develop and field test advanced DNAPL detection systems.
- Develop, demonstrate, and evaluate in-situ groundwater treatment technologies for heavy metals, radionuclides, and DNAPLs:
  - Develop contaminant-specific ionic complexant soil flushing solutions.
  - Demonstrate in-well removal methods (recirculating wells) for various metals at the Pinellas Plant.
  - Demonstrate mobile lab-based characterization methods for metals in groundwater, such as laser-based spectroscopy methods.
  - Evaluate and demonstrate biological systems that concentrate tritium from groundwater.
  - Demonstrate DNAPL degradation by using staged aerobic/anaerobic bioremediation at Hanford.
  - Develop methods to reduce chemical contaminants (e.g., uranium and chromium) to an insoluble form by using bioremediation or chemical addition to soil.
  - Develop molecular diffusion and diffusion-related chemical reactions to concentrate tritium from groundwater.
  - Demonstrate advanced extraction systems for DNAPLs by using foam/surfactant mixtures at Paducah or Oak Ridge.
- Develop and demonstrate advanced remediation systems at arid sites (including biologic and chemical treatment and characterization and sensor systems):
  - Conduct a complete demonstration of measurement-while-drilling technology at Savannah River restoration site.
- Develop and demonstrate technologies for heavy metals and radionuclides to minimize secondary waste treatment and reuse treatment fluids:
  - Develop chromatography columns to selectively adsorb contaminant species.
  - Demonstrate MAG*SEP technology on radionuclide- and heavy-metal-contaminated groundwater at the Savannah River Site.

- Demonstrate and test technologies to immobilize or remove heavy metals, radionuclides, and DNAPLs in soil:
  - Demonstrate chromium (VI) immobilization by using gas-phase reducing agents at Savannah River restoration site.
  - Perform pilot-scale test of DNAPL destruction by using in-situ chemical oxidation with peroxide or permanganate at Portsmouth.
  - Perform pilot-scale test of electrokinetic removal of radionuclides from arid soil.
  - Perform pilot-scale test of staged anaerobic/aerobic biodegradation of DNAPLs in soil.
  - Test an ex-situ process of plant uptake and concentration at the pilot scale for radionuclide removal from groundwater.
- Improved subsurface access technology for difficult soil conditions:
  - Enhance cone penetrometer technology as an assay tool for subsurface characterization.
  - Develop horizontal drilling methods that can utilize existing well holes as points of origin.
  - Adapt and demonstrate existing remote sensing techniques for the characterization of contaminant plumes.
- Demonstrate temporary barrier systems for use with in-situ treatment systems.
- Develop and demonstrate in-situ treatment technologies for nonvolatile organic compounds (polychlorinated biphenyls [PCBs], PAHs):
  - Develop and demonstrate bioremediation techniques for degrading polyaromatics.
  - Demonstrate methods to destroy PCBs by using chemical oxidation.
- Develop and demonstrate in-situ remediation (stabilization, biological treatment, electrokinetic treatment, surfactant flushing, etc.), containment technologies (diffusion barriers, reactive barriers, etc.), and barrier technologies for site remediation (contaminants of special interest are DNAPLs and chlorinated organics).
- Develop characterization instruments for pre-, post-, and on-line analysis to determine the type, concentration, and location of contaminants to assist site remediation activities:
  - Demonstrate mobile lab-based characterization methods for metals in groundwater, such as laser-based spectroscopy methods.
  - Demonstrate advanced extraction systems for DNAPLs by using foam/surfactant mixtures at Paducah or Oak Ridge.
  - Demonstrate MAG*SEP technology on radionuclide- and heavy-metal-contaminated groundwater at the Savannah River Site.

- Develop and demonstrate on-line process control for in-situ treatment and mobile labs or onsite testing, and secondary waste minimization and recycling:
  - Demonstrate mobile lab-based characterization methods for metals in groundwater, such as laser-based spectroscopy methods.
  - Conduct a complete demonstration of an advanced volatile organic compound (VOC) remediation system at Hanford, including in-situ air stripping, in-situ chemical oxidation, and/or staged aerobic/anaerobic destruction of VOCs.
- Treat tritium in groundwater and aqueous waste streams and process data for fate and transport modeling.
- Refine and enhance basic knowledge solutions in the development of characterization of subsurface contamination, modeling of contaminants under heterogenous conditions; identifying and quantifying residual DNAPLs contamination in the subsurface and heavy metals in groundwater; lab to field experimentation on micro bio-organisms to analyze survivability and longevity.
- Refine and enhance basic knowledge solutions for groundwater and soils remediation of halogenated hydrocarbons; monitoring technologies for post-closure of the vadose zone; bioremediation technologies of DNAPLs.
- Refine and enhance basic knowledge solutions in the development of the destruction and removal of VOCs by using naturally occurring phenomena; competitive and mass transfer effects on the sorption and desorption of contaminants in soils.
  - Perform pilot-scale test of staged anaerobic/aerobic biodegradation of DNAPLs in soil.
- Refine and enhance basic knowledge solutions in the development of pre-, primary, and secondary ex-situ treatment and recycling secondary waste streams; subsurface contaminant technologies.

Decontamination and Decommissioning Focus Area

- Concrete decontamination: Demonstrate improved processes for the decontamination of surface and volumetric contaminated concrete (field pilot-scale electrokinetic process, field pilot-scale wall process, field pilot-scale coating process).
- Metal decontamination: Demonstrate improved processes for the decontamination of surface and volumetric contaminated metal (field pilot-scale flushing process, field pilot-scale carbon dioxide process, field pilot-scale ultrasonic process, field pilot-scale mechanical process, field pilot-scale chemical process).

- Concrete and metal structure dismantlement: Demonstrate improved processes for size reduction, dismantlement and containment of concrete and metal structures (field pilot-scale telescopic boom process, field pilot-scale overhead platform delivery system, field pilot-scale mobile platform delivery system, field pilot-scale size reduction end effectors, field pilot-scale dismantlement end effectors).
- Metal recycling: Demonstrate improved processes for the conversion of metal with residual contamination into useful products (field pilot-scale stainless steel into waste drums and boxes, field pilot-scale slab casting process, field pilot-scale nickel into stainless steel, field pilot-scale plasma melting process).
- Material stabilization: Demonstrate improved process for the stabilization of asbestos in place.
- Facility stabilization: Demonstrate improved processes for the stabilization of facilities (field pilot-scale fuel pool treatment processes, field pilot-scale fuel pool characterization processes, field pilot-scale plutonium glove-box size reduction process, field pilot-scale glove-box disposition process, field pilot-scale plutonium residue handling process).
- Facility stabilization: Demonstrate improved processes for the stabilization of facilities (field pilot-scale equipment disposition process, field pilot-scale equipment size reduction process, field pilot-scale equipment decontamination process, field pilot-scale equipment in process monitoring process, field pilot-scale glove-box in process monitoring system).
- Material disposition: Demonstrate improved process for the disposition of depleted uranium (field pilot-scale nonmetallic applications, field pilot-scale shielding application).
- Develop advanced worker systems.
- Develop systems for the removal of contaminated paint and other contaminants, such as grease, oil, and PCBs, from concrete and metal surfaces.
- Develop mobile workstations for decontamination and decommissioning (D&D).
- Develop recycling of radioactive contaminated scrap metal.
- Develop decontamination and dismantling end effectors and plasma arcs.
- Develop sampling, imaging, and characterization systems for pre-, post-, and on-line analysis during D&D.
- Develop robotics for D&D.
- Refine and enhance basic knowledge solutions in the development of solvent and material substitution and cryogenic decontamination and cutting.

Crosscutting Programs—Characterization

- Develop process monitors and controls for three candidate mixed waste treatment systems.
- Develop continuous real-time air monitors.
- Develop nondestructive remote techniques to characterize unopened waste containers and final waste forms.
- Develop process monitors and controls for treatment techniques other than the three candidate mixed waste treatment systems (e.g., supercritical oxidation).
- Detect tank leaks, head space gases (volatile and poisonous), and water content of waste tank matrices (for safety and public health issues).
- Test tank imaging technology for retrieval operations in a radioactive environment.
- Develop methods for less expensive and faster hot cell analysis and in-situ tank waste analysis (chemical analysis).
- Conduct in-situ testing of physical properties of tank waste.
- Develop on-line process monitoring and control for tank waste retrieval, transfer, and treatment operations.
- Develop field-deployable, real-time chemical and geophysical sensors and in-situ surface-based deployment systems to identify subsurface contaminants (DNAPLs) in support of the expedited site characterization process:
  - Develop performance monitoring techniques for reactive barriers.
  - Field test mobile lab-based characterization methods for metals in groundwater, such as laser-based spectroscopy methods.
  - Develop and field test advanced DNAPL detection systems.
  - Modify and adapt high-resolution geophysical technologies to better identify contaminant plumes (e.g., DNAPLs).
  - Enhance decision support and data fusion of optimal sampling; develop additional capabilities to map subsurface contaminant plumes.
- Develop large-area scanning and mapping systems for detection of uranium and other contaminants on facility and land surfaces.
- Develop nondestructive assay techniques to assay contaminants in constrained areas such as inside pipes and equipment.
- Transfer airborne deployment sensors from the classified community and configure them for environmental applications.

- Develop real-time sensor systems for decontamination of concrete surfaces to identify PCBs, uranium, plutonium, tritium, fission products, and mercury in the near-surface layer of concrete.
- Develop real-time sensor systems to characterize metal scrap contaminated with technetium-99 and activation products such as cobalt-60.
- Develop continuous real-time monitors for radioactivity in liquid streams.

Crosscutting Programs—Efficient Separations

- Develop/adapt radionuclide separation technologies for application to liquid mixed wastes.
- Develop technologies to remove volatile species (e.g., mercury, chlorides, organics) and therefore simplify treatment of mixed wastes.
- Complete the development and demonstration of cesium/strontium removal technologies to meet milestones for LLW pretreatment facilities; evaluate and integrate separation pretreatment processing schemes to meet LLW glass performance specifications:
  - Develop a baseline sludge treatment to determine the feasibility of meeting milestones at Richland; develop alternative sludge pretreatment technologies to ensure the minimization of high-level waste volume.
  - Accelerate sludge treatment efforts to meet the fiscal year 1998 Tri Party Agreement milestone at Hanford; emphasize the hot testing of actual tank wastes to evaluate behavior and HLW volume reduction under both alkaline (baseline) and acid conditions.
  - Develop technologies to remove technetium and TRUW from tank waste to improve waste form performance and to meet requirements for vitrification.
- Develop and adapt separation agents for cleanup of soils containing contaminants other than plutonium and uranium (e.g., technetium, heavy metals).
- Provide sorbents for incorporation into reactive barriers used for plume mitigation.
- Evaluate feasibility/cost of tritium removal technology (D&D) for cleanup of groundwater:
  - Perform pilot-scale test of electrokinetic removal of radionuclides from arid soil.
- Demonstrate tritium removal technologies from waste storage basins.
- Demonstrate improved residue treatment technology to meet Rocky Flats schedule.
- Expand and adapt sludge leaching technologies to D&D of solids.
- Evaluate separation need for recycle of wash liquids (D&D, soil) and process chemicals.

Crosscutting Programs—Robotics

- Develop systems to automatically handle drums of mixed waste on the front end of the mixed waste treatment process.
- Develop robotic systems to automatically inspect stored drums of mixed waste.
- Develop and demonstrate a back-end materials handling system at a waste treatment facility.
- Develop automated analytical chemistry modules for radionuclides, metals, organics, and inorganics.
- Develop a cooperating manipulators (dual-arm) system for D&D and tank waste applications.
- Develop automated analytical chemistry modules for radionuclides, metals, organics, and inorganics.
- Develop a mobile system to automatically measure and record chemical and radiological contamination on internal surfaces (e.g., walls, hot cells) of buildings.

Appendix I

Update of Site-Specific Waste Volumes for LLMW, LLW, and TRUW

Appendix I in the Final WM PEIS is a completely new appendix written specifically for the Final; therefore, there are no marginal rules or shading to indicate changes. Appendix I from the Draft WM PEIS has been combined with Appendix C in the Final.

U.S. Department of Energy
Waste Management Programmatic Environmental Impact Statement

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Acronyms, Abbreviations, and Elements

The following is a list of acronyms, abbreviations (including units of measure), and elements used in this document.

Acronyms

Ames	Ames Laboratory
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
BCL	Battelle Columbus Laboratory
Bettis	Bettis Atomic Power Laboratory
BNL	Brookhaven National Laboratory
Charleston	Charleston Naval Shipyard
DOE	U.S. Department of Energy
ER	Environmental Restoration
ETEC	Energy Technology Engineering Center
FEMP	Fernald Environmental Management Project
Fermi	Fermi National Accelerator Laboratory
GA	General Atomics
GJPO	Grand Junction Projects Office
Hanford	Hanford Site
HLW	high-level waste
IDB	Integrated Data Base
INEL	Idaho National Engineering Laboratory
ITRI	Inhalation Toxicology Research Institute
K-25	Oak Ridge K-25 Site
KAPL-K	Knolls Atomic Power Laboratory (Kesselring)
KAPL-N	Knolls Atomic Power Laboratory (Niskayuna)
KAPL-S	Knolls Atomic Power Laboratory (Schenectady)
KAPL-W	Knolls Atomic Power Laboratory (Windsor)
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LDRs	land disposal restrictions
LEHR	Laboratory for Energy-Related Health Research
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste

Mare Is	Mare Island Naval Shipyard
Mound	Mound Plant
MWIR	Mixed Waste Inventory Report
NEPA	National Environmental Policy Act
Norfolk	Norfolk Naval Shipyard
NR	Naval Reactor
NRF	Naval Reactor Facility
NTS	Nevada Test Site
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
Pantex	Pantex Plant
Pearl H	Pearl Harbor Naval Shipyard
PGDP	Paducah Gaseous Diffusion Plant
Pinellas	Pinellas Plant
PORTS	Portsmouth Gaseous Diffusion Plant
Ports Nav	Portsmouth Naval Shipyard
PPPL	Princeton Plasma Physics Laboratory
Puget So	Puget Sound Naval Shipyard
RFETS	Rocky Flats Environmental Technology Site
RMI	RMI Titanium Company
SLAC	Stanford Linear Accelerator Center
SNL-CA	Sandia National Laboratories (California)
SNL-NM	Sandia National Laboratories (New Mexico)
SRS	Savannah River Site
TBE	Teledyne Brown Engineering
TRUW	transuranic waste
UofMO	University of Missouri
WAC	WIPP Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WM	Waste Management
WM PEIS	Waste Management Programmatic Environmental Impact Statement
WVDP	West Valley Demonstration Project
Y-12	Oak Ridge Y-12 Plant

Abbreviations

Ci	curie(s)
ft^3	cubic foot (feet)
kg	kilogram(s)
m^3	cubic meter(s)
yr	year(s)

Elements

Ac	actinium
Am	americium
Ba	barium
Bi	bismuth
C	carbon
Ce	cerium
Cm	curium
Co	cobalt
Cr	chromium
Cs	cesium
Eu	europium
Fe	iron
Mn	manganese
Ni	nickel
Np	neptunium
Pa	protactinium
Pb	lead
Pm	promethium
Po	polonium
Pr	praseodymium
Pu	plutonium
Ra	radium
Rh	rhodium
Ru	ruthenium
Sb	antimony
Sm	samarium
Sr	strontium
Tc	technetium
Te	tellurium
Th	thorium
Tl	thallium
U	uranium
Y	yttrium
Zr	zirconium

APPENDIX I
Update of Site-Specific Waste Volumes for LLMW, LLW, and TRUW

I.1 Introduction

The Draft WM PEIS used the best available data for waste inventory, projected waste generation, and waste classification for estimates of the waste loads at the DOE sites when the analyses were prepared. Since that time, the Department has continued to update these estimates as part of an ongoing effort to improve the quality of information available for decision making.

Accordingly, DOE reviewed more recent waste load data for low-level mixed waste (LLMW), low-level waste (LLW), and transuranic waste (TRUW) to determine whether it needed to revise the analyses for the Final WM PEIS. For high-level waste (HLW), DOE used updated data in the Final WM PEIS that are generally consistent with recent HLW program estimates. Hazardous waste (HW) data, however, were not revised because DOE determined that the HW data used for the analyses in the Draft WM PEIS are sufficient to determine whether DOE's decisions should continue to rely on commercial management of HW, unlike the management alternatives for other waste types.

Selected reanalyses were performed for LLMW, LLW, and TRUW where warranted, and the results of the reanalyses have been incorporated into the Final WM PEIS. This appendix identifies the criteria DOE used to decide to reanalyze using the more recent data, compares the waste load data used in the Draft WM PEIS with the more recent data, and describes DOE's conclusions about the need to use the more recent data for specified sites. This information is contained in sections I.2, I.3, and I.4 for LLMW, LLW, and TRUW, respectively.

All alternatives were reanalyzed consistently for the sites identified as requiring reanalysis as a result of DOE's review. Health risks were reanalyzed for all sites selected for reanalysis. Cost and other parameters were reanalyzed only where changes in impacts were considered to be potentially large based on changes in waste volume. The appropriate sections of Volumes I and II of the Final WM PEIS were revised to incorporate all results of the reanalyses.

I.1.1 SOURCES OF WASTE LOAD ESTIMATES

Analyses presented in the Draft WM PEIS used existing inventory and projected waste generation data for each site from several sources that are specific to the waste types. The sources of the prior estimates were the:

- Mixed Waste Inventory Report (MWIR) for 1994 (DOE, 1994) and updates from some sites—used for LLMW
- Integrated Data Base (IDB) for 1992 (DOE, 1992), Waste Management Information System (ORNL 1992), and updates from some sites—used for LLW
- MWIR for 1993 (DOE, 1993) and IDB for 1992 (DOE, 1992)—used for TRUW

The more recent information appears in the sources listed below. This information was compared with estimates used in the Draft WM PEIS to determine where reanalysis was warranted and was used for all of the reanalyses presented in the Final WM PEIS.

- MWIR for 1995 (DOE, 1995a)—used for LLMW
- IDB Report-1994 (DOE, 1995b)—used for LLW
- MWIR for 1995 (DOE, 1995a) and Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report (BIR-2) for 1995 (DOE, 1995c)—used for TRUW

The data for TRUW were taken from two sources, MWIR 1995 and BIR-2, with most of the new information being taken from MWIR 1995. MWIR 1995 contains information on waste as it currently exists, specifying treatability groups, and is therefore more relevant to the WM PEIS analyses for calculating impacts from consolidating or decentralizing treatment of TRUW throughout the DOE complex. The information on as-generated waste forms is readily available from MWIR 1995, but is not readily extracted from the BIR-2 data. Some of the BIR-2 waste loads reflect some level of treatment, since they are intended to represent the volume of wastes in the forms in which they might be disposed of at WIPP. The BIR-2 was used in developing the *Waste Isolation Pilot Plant Disposal Phase Draft Supplemental Environmental Impact Statement* (WIPP SEIS-II; DOE, 1996b). For impacts at potential treatment sites, the Draft WIPP SEIS-II scaled the analysis presented in the Draft WM PEIS to reflect BIR-2 and other more recent information, as explained in the Draft WIPP SEIS-II. Thus, information on as-generated waste forms was not required for the WIPP analysis. BIR-2 was used in the Final WM PEIS, however, for its radiological profiles and for more definitive waste volume estimates for the years that are not covered by MWIR.

A BIR-3 database was published in June 1996 (DOE, 1996a). BIR-3 waste volumes and hazardous constituent inventories are unchanged from BIR-2, although the radionuclide inventories at some sites are changed slightly. This database was not available at the time of this analysis; however, the differences between BIR-3 and BIR-2 are minor and therefore BIR-2 data were considered sufficient for purposes of reanalysis involving TRUW.

I.1.2 COMPLEXWIDE CHANGES

A comparison of the data used in the Draft WM PEIS and the more recent data shows that when waste volumes are summed across the complex, the total estimated volumes in the more recent data changed by -15%, -45%, and +27% for LLMW, LLW, and TRUW, respectively. These changes do not include any estimates for waste transferred from environmental restoration (ER) activities to WM treatment facilities. The comparison also revealed differences in waste volumes at individual sites, as well as changes in their waste treatment category and radiological profiles. Each site was reviewed with regard to whether new waste load information was likely either (1) to cause an appreciable change in site-specific impacts identified in the Draft WM PEIS, or (2) to result in a change that could significantly alter the comparison of the alternatives.

I.1.3 ALTERNATIVES CONSIDERED

In order to determine whether to update waste load information, alternatives were selected for each waste type that were determined to be most sensitive to changes in waste load data. The alternatives used for each waste type are as follows.

For LLMW, DOE's determination regarding the need for reanalysis is based on the potential impacts associated with the Decentralized Alternative, comparing the data used in the Draft WM PEIS with the more recent data reported for each site. For LLW, DOE used either the Decentralized Alternative or Regionalized Alternative 2 impact estimates, whichever were higher (i.e., more conservative), as the best indicator of the effect of the more recent data. The Decentralized Alternative analyzes the data as reported by each site, without the averaging produced by the consolidation of waste inherent in the Regionalized or Centralized Alternatives. However, for LLW, the Regionalized Alternative 2 analyzes treatment with volume reduction,

which tends to generate higher risk estimates for treatment than the Decentralized Alternative, which assumes minimum treatment.

For TRUW, DOE's determination regarding the need for reanalysis is based on the potential impacts associated with Regionalized Alternative 2 for all sites except WIPP. Regionalized Alternative 2 assumes treatment to Land Disposal Restrictions, which generates higher potential risk estimates for the offsite public than the Decentralized Alternative (assumes treatment to WIPP Waste Acceptance Criteria) or the Regionalized 1 Alternative (includes less intensive treatment technologies than Regionalized Alternative 2). Treatment under the Centralized Alternative, which potentially generates the highest risk estimates at WIPP, was reviewed to determine the need to reanalyze impacts at WIPP.

I.1.4 CRITERIA FOR REANALYSIS

Using the specified alternative for each waste type (e.g., Decentralized, Regionalized 2, or Centralized Alternatives), DOE examined the potential changes in impacts that could be associated with changes in waste volume and radioactivity between the Draft WM PEIS and more recent data on a site-by-site basis. For the sites not analyzed as major sites in the Draft WM PEIS, changes in waste loads did not warrant reclassifying these sites as major sites, and they were removed from further consideration for reanalysis.

For the 17 major sites, DOE used two criteria to identify the need for reanalysis: (1) waste volume was used as an indicator of change for those impacts that are likely to vary with the amount of waste to be managed (e.g., worker risks, air quality, infrastructure, and economic impact); and (2) total radioactivity or the activity of key radionuclides were used as indicators of the degree to which new estimates would affect measures of potential human health risk and water quality. Using these criteria, DOE determined that reanalysis was warranted where potential changes to impacts (for either the Decentralized, Regionalized 2, or Centralized Alternatives, depending on the waste type) were large enough to substantially affect the site-specific results presented in the Draft WM PEIS or where the changes would likely affect comparisons among the alternatives. In a few instances, an individual impact area for a given site was projected to change enough to warrant reanalysis of that particular impact area, although other impact areas were not sufficiently changed to warrant full reanalysis. In these instances, results from the Draft WM PEIS data were retained, and the estimates for the impact area from the more recent data were noted in the appropriate sections of Volume I of the Final WM PEIS.

At sites where DOE determined it should update waste loads, it was not necessary to use these new waste loads in all alternatives. Updated waste volumes were used only in alternatives where these sites treat their own wastes. In Regionalized and Centralized Alternatives where these sites ship their waste to other sites for management, increases and decreases in waste loads from all contributing sites tend to balance out. There was therefore no need to universally update waste loads at Regionalized or Centralized management sites. Tables 6.3-1 through 6.3-7, 7.3-1 through 7.3-14, and 8.3-1 through 8.3-6 define shipment configurations for LLMW, LLW, and TRUW, respectively. These tables document the percent of waste received from off site. Percentages reported in these tables reflect updated waste loads in all alternatives regardless of whether the actual impact analyses were updated.

Table I.1-1 Summary of Sites Identified for Reanalysis

Site	LLMW	LLW	TRUW
ANL-E	V_d		
BNL		NPD	
FEMP			
Hanford			R_i
INEL			
LANL			
LLNL			
NTS	NPD	NPD	
ORR		R_i	
Pantex		V_d	
PGDP			
PORTS			
RFETS			
SNL-NM			
SRS			R_d
WVDP		NPD	
WIPP			R_d

Key: NPD = no previous data; V_d = volume decrease; R_i = radioactivity increase; R_d = radioactivity decrease.

Potential chemical emissions from treatment and chemical concentrations in the groundwater from disposal were not used as criteria for reanalysis of sites. Generally, chemical-related impacts were not large in the Draft WM PEIS or would be addressed through technology adjustments.

Sections I.1.4.1 and I.1.4.2 describe how each criterion was applied. Table I.1-1 summarizes the sites and waste types identified for reanalysis as a result of the review. The table also identifies the primary basis for the decision to reanalyze, as will be explained in the following sections.

I.1.4.1 Changes in Waste Volume

Volume Decreases. More recent data reveal a decrease in volumes of some waste types at some sites, although such decreases are relatively small. Where a decrease in volume occurred at a site for any waste

type, the Draft WM PEIS data were retained for those sites for purposes of analysis, since the higher volumes would tend to generate greater impacts. However, large decreases in waste volumes were reported for ANL-E and Pantex for LLMW and LLW, respectively, and these sites were thus identified for reanalysis.

No Previous Data. Sites previously reporting no or negligible volumes for any waste type in the Draft WM PEIS but reporting any increases in more recent data were identified for reanalysis due to the potential for error in the prior data. The sites identified for reanalysis on this basis were NTS (for LLMW) and BNL, NTS, and WVDP (for LLW).

Volume Increases. Sites previously reporting some waste volumes and reporting increases in those volumes were considered individually. Potential effects of the increased waste volumes were estimated for several parameters: (1) worker risk from radiological exposure or physical hazards, (2) criteria air pollutant emissions, (3) infrastructure effects, and (4) socioeconomic impact in the region of influence. These four impact areas are roughly proportional to the volume of waste being treated or disposed of (i.e., the impacts increase as the volume increases).

However, an economy of scale is generally expected as volumes increase; an increase of one unit of waste would require less than one unit of resource or personnel for treatment or disposal. As described in Appendix C, Section C.3.2.2.5, an economy-of-scale factor was used in the WM PEIS to extrapolate from capacity to cost or resource curves whenever waste estimates fell outside the limits of the curves. The basic formula used was:

$$\text{New Resources} = \text{Old Resources} \times (\text{New Volumes/Old Volumes})^{0.7}$$

This economy-of-scale adjustment was used to estimate the increases in impacts that might be expected from increases in waste volumes, except in the case of air quality. If criteria pollutants were released from construction equipment or commuters' vehicles, the adjustment was applied, since emissions were directly related to resources (workers), which follows the economy-of-scale relationship above. Emissions from a facility are directly proportional to volume, however, so an economy-of-scale adjustment was not made in projecting emissions from facilities.

A review of the sites that reported increases in waste volumes from the estimates used in the Draft WM PEIS resulted in no additional sites being identified for full reanalysis. However, a potential increase

was projected for air emissions for treatment of LLW at ANL-E sufficient to warrant identification in the discussion of air quality in Chapter 7 (LLW) of Volume I.

I.1.4.2 Changes in Radioactivity

More recent information on radionuclide profiles for LLMW, LLW, and TRUW was reviewed for each site to identify the potential for any changes in the health risk impact analyses. Changes in radionuclide profiles were examined for their potential to affect both waste treatment and disposal results for LLMW and LLW. For TRUW, the review focused only on the treatment because disposal of TRUW is outside the scope of this PEIS. The methodology that was used in the Draft WM PEIS for determining the radionuclide content of the air emissions and of the wastes disposed was applied to the more recent data for consistency in the comparisons.

For waste treatment impacts, potential increases in the offsite maximally exposed individual (MEI) cancer fatality risk were considered to be representative of all risk endpoints. Radionuclides in air emissions contributing to the highest risks were evaluated. A threshold of one in one million (E–06) was selected as a conservative indicator of the need to reanalyze human health risk impacts. This threshold is consistent with guidelines established by the U.S. Environmental Protection Agency (EPA, 1991).

For waste disposal impacts, increases in long-lived radionuclides (half-life greater than 300 years) were reviewed. This approach recognizes that groundwater contamination by radionuclides in waste in disposal facilities requires longer time frames because movement of the contaminants into groundwater occurs over many lifetimes. Changes in these radionuclides in terms of their potential to cause exceedances in Drinking Water Standards, which are related to human health risk, were used as the indicator.

The following criteria and rules were established to identify sites at which reanalysis was necessary as a result of more recent information on radionuclide profiles.

- Where the more recent data for a particular site ***did not result in*** (1) an offsite MEI cancer fatality risk estimate above a probability of E–06 or (2) an exceedance of drinking water standards, one of two courses was followed:
  - If the Draft WM PEIS had predicted (1) an offsite MEI cancer fatality risk much less than E–06 or (2) no exceedance of drinking water standards, then the change was not considered significant, and no reanalysis was needed.

  - If the Draft WM PEIS had predicted (1) an offsite MEI cancer fatality risk only slightly less than or greater than E-06 or (2) an exceedance of drinking water standards, then the original analysis was retained to preserve the conservative nature of the WM PEIS. An exception was made in cases where the risk estimates decreased considerably when the more recent data were used.
- Where the more recent data for a particular site ***resulted in*** (1) an offsite MEI cancer fatality risk estimate above a probability of E-06 or (2) an exceedance of drinking water standards, one of two courses was followed:
  - If the Draft WM PEIS had predicted (1) an offsite MEI cancer fatality risk only slightly less than or greater than E-06 or (2) an exceedance of drinking water standards, then the change was not considered sufficient to warrant a full reevaluation; however, the appropriate sections of Volume I were revised to indicate that an analysis using the more recent data is likely to show an increase in human health risks and that the extent of mitigation measures to prevent exceedances is likely to be greater than indicated by the Draft WM PEIS analysis.
  - If the Draft WM PEIS analysis originally resulted in (1) an offsite MEI cancer fatality risk much lower than E-06 or (2) no exceedance of drinking water standards, this constituted a significant change, and a full risk reanalysis was performed.

As a result of this review, a full reanalysis was conducted for LLW at ORR, and for TRUW at Hanford, SRS, and WIPP. Revisions to the discussion of risk were made to Volume I for (1) LLNL for LLMW, (2) FEMP and LANL for LLW, and (3) INEL and RFETS for TRUW. Potential exceedances of drinking water standards were noted in Volume I for (1) LLMW at FEMP, Hanford, SNL-NM, and SRS and (2) LLW at Hanford and SRS.

I.1.5 UNCERTAINTIES

Periodic updates of data on waste loads at the sites will continue in the future. Circumstances that may alter waste volume or radioactivity level estimates include the following:

- Changes in DOE's site missions that are not reasonably foreseeable at this time may occur in the future.
- Changes in regulations and statutes concerning the definitions of waste types may occur. For instance, if a "below regulatory concern" level is established for radionuclides, significant volumes of waste currently managed as low-level radioactive waste could be disposed of in solid (nonhazardous and nonradioactive) waste landfills.
- The success of pollution prevention efforts could reduce rates of waste generation.

- Waste management activities that result in opening, sorting, and surveying the contents of containers currently reported to be at full capacity may reveal actual volumes of waste less than those of the containers. These activities will provide better information on the relationship between the mass of the waste and its volume.
- Waste characterization techniques may affect the waste type assigned to a given inventory. Some waste currently classified as TRUW, for instance, may not contain 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste and may require reclassification as LLMW or LLW. Conversely, some LLW could be reclassified as TRUW.
- Waste characterization could result in different assignments to treatability groups, which dictate the type of treatment necessary. Emissions and associated risks to workers and the public may vary significantly, depending on treatment technology.
- Volume reduction of LLMW and LLW during treatment may result in a residue with sufficient concentrations of transuranic elements to warrant reclassification of the residue as TRUW. Regardless of classification, DOE may choose to manage certain waste streams together, even though they are different waste types, because they have similar characteristics and pose similar risks, such as alpha LLW and TRUW.
- Ongoing characterization of the contaminated sites will result in better estimates of ER-transferred waste. Likewise, increased program maturity will lead to more consistent reporting.

Some wastes included in the estimates used for analysis in the WM PEIS may have already been treated or disposed of, because DOE's waste management activities are an ongoing effort. Although the information used for analysis at any point in time may be subject to updates in the future, waste management decisions must nevertheless be based on currently available information. DOE will consider new information as it becomes available and will determine the need for additional NEPA reviews as appropriate.

I.2 LLMW Inventory Update

This section addresses the changes in LLMW volume at each DOE site as reported in MWIR 95. The more recent data were used to reanalyze the projected source terms on waste feedstock inputs to some of the treatment facilities, facility air emissions, and disposal volumes for the LLMW Decentralized, Regionalized, and Centralized Alternatives. The results of the new analysis were then compared with the results in the Draft WM PEIS, which were derived using the MWIR 94 data, to determine the need for any complete reanalysis. Radiological profiles for LLMW at individual sites were unchanged in the more recent data. As

a result, changes in the radiological content of site air emissions are generally proportional to the changes in site waste volumes reported in this section.

Table I.2-1 presents a site-by-site comparison of the current waste inventory volume plus the projected 20-year waste volume for each site as reported in MWIR 94 and MWIR 95. Overall, the 1995 data show an approximate 15% decrease in the total amount (from 226,000 to 193,000 m^3) of LLMW that will need treatment across the DOE complex. The lower total is due primarily to large reported waste reductions at ANL-E, Hanford, and PORTS. Of the 42 sites that have (or will generate) LLMW, 27 showed increases in the expected amount of LLMW as reported in the 1995 data.

I.2.1 Analysis of LLMW Alternatives

To assess how the more recent estimates of LLMW treatment volumes may affect the WM PEIS, the Decentralized Alternative was analyzed as the best indicator of potential effects of changes in volume because the data can be analyzed for each site without the consolidations inherent in the Regionalized and Centralized Alternatives. The updated estimates for LLMW for each site and each waste treatment category were entered into the same computational model (WASTE_MGMT) used to analyze LLMW data in the Draft WM PEIS. The model uses the annual projected volume of LLMW at each site (derived from the site's waste inventory and projected waste generation), the radiological and chemical contaminant profile of the waste, and specific operating parameters for treatment facilities to estimate feedstock volumes for individual treatment and disposal facilities and radionuclide and chemical air emissions. The model results derived using the MWIR 95 waste volume data were then compared with the results using estimates derived from the MWIR 94 data. The comparison assumed equivalent radionuclide and chemical profiles and the same treatment facility parameters for the MWIR 95 and the MWIR 94 estimates. In the Decentralized Alternative, in which every site treats its own waste, the changes in radionuclide and chemical contaminant levels correlated directly with the changes in the input treatment volume. However, this relationship does not apply to contaminant levels in site air emissions from treatment facilities or treatment and disposal shipping volumes when there are changes in treatment categories. This is because changes in treatment categories result in the use of different treatment technologies.

A comparison of the Draft WM PEIS (MWIR 94) and more recent (MWIR 95) treatment volumes expected at the various treatment sites for the LLMW Regionalized Alternatives is given in Table I.2-2. This table shows that, in general, the difference in waste volume between the Draft WM PEIS and more recent data

decreases at Regionalized and Centralized sites, reflecting the complexwide decrease in LLMW reported in the more recent data. This table thus illustrates that the Decentralized Alternative is the most sensitive to potential changes in impacts related to changes in waste volume, because each site treats its own waste. Thus impacts estimated in the Draft WM PEIS are expected to bound those estimated from the more recent data. Costs and transportation impacts, which are tabulated at the national level in the WM PEIS for the purposes of comparison of alternatives, rather than at sites, would similarly not increase, since volumes overall do not increase.

Tables I.2–3 and I.2–4 compare, for the Decentralized and Centralized Alternatives respectively, the disposal volumes and radionuclide concentrations at various disposal sites derived from the 1994 and 1995 data. Across the complex, disposal volumes after treatment of LLMW are predicted to decrease by approximately 15% when 1995 data are used. However, there is a predicted 35% increase in the overall, complexwide disposal volume, due primarily to the 37,000 m^3 of final-form waste (waste that does not require additional treatment) from Puget Sound Naval Shipyard (Puget So) reported with Hanford's disposal inventory.

I.2.2 RADIOLOGICAL PROFILES

Tables I.2–5 and I.2–6 compare the total annual radiological air emissions (Ci/yr) expected at each site under the Decentralized and Centralized Alternatives, respectively. These tables compare the air emissions predicted for each site using estimates of LLMW based on MWIR 94 and MWIR 95 data. Total complexwide radiological air emissions are predicted to increase about 15% on the basis of 1995 data for alpha-emitting radionuclides and nearly 300% for tritium emissions due primarily to increases at LLNL.

For consolidation of waste in the Regionalized and Centralized Alternatives, the tritium-bearing wastes at western sites pose the only potential major increase in risks to the MEI. The emissions of tritium increase by a factor of 3 to 4 at several sites, which could increase MEI risks by the same factor. Only one site other than LLNL, Hanford, has MEI risks that are within a factor of 3 to 4 of 1E–06. Since waste from LLNL is treated at Hanford in the Regionalized and Centralized Alternatives, the increased tritium could affect Hanford emissions in a similar manner as at LLNL. This is discussed further in Section I.2.3.

For disposal, only Hanford is sensitive to increases in long-lived radionuclides from additional wastes in the Regionalized and Centralized Alternatives (other Regionalized or Centralized disposal sites either

Table I.2-1. Comparison of Low-Level Mixed Waste Treatment Volumes

Site	Estimated Inventory + 20 Years Generation (m^3)			Site	Estimated Inventory + 20 Years Generation (m^3)		
	Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c]		Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c]
Ames	0.4	0.2	-2.0	Mare Is	52	84	+1.6
ANL-E[d]	8,400	159	-52.8	Mound	80	100	+1.3
BCL	0.1	12[e]	+120.0	NTS[d]	0.3	3,000[e]	7,500
Bettis	48	4,800	+100.0	Norfolk	6	300	+50.0
BNL	190	30	-6.3	ORR[f]	59,000	50,000	-1.2
Charleston	3	9	+3.0	PGDP	600	1,000[e]	+1.7
Colonie	11	15	+1.4	Pantex	690	2,200	+3.2
ETEC	3.7	17[e]	+4.6	Pearl H	6	130	+21.7
FEMP	2,600	2,700[e]	+1.0	Pinellas	0.02	NR	NA
GA	43	69[e]	+1.6	PORTS	33,000	15,500[e]	-2.1
GJPO	1.5	0.8[e]	-1.9	Ports Nav	1	11	+11.0
Hanford[g]	36,000	12,000	-3.0	PPPL	0.02	9.4	+94.0
INEL	35,000	28,000	-1.3	Puget So[h]	230	3,000	+13.0
KCP	0.8	0.2	-4.0	RMI	29	32[e]	+1.1
KAPL-K	80	76	-1.1	RFETS	21,000	22,900[e]	+1.1
KAPL-S	100	64	-1.6	SNL-NM	100	290	+2.9
KAPL-W	40	75	+1.9	SRS	20,000	37,000[e]	+1.9
LEHR	7	NR	NA	SLAC	NR	6	NA
LBL	280	34	-8.2	UofMO	2	5	+2.5
LLNL	4,300	7,500	+1.7	WVDP	55	220	+4.0
LANL	2,800	1,000	-2.8	**Total Complex**	226,000	193,000	-1.2

NR = no data reported; NA = not applicable; no data to compare.
Notes: Charleston = Charleston Naval Shipyard; ETEC = Energy Technology Engineering Center; FEMP = Fernald Environmental Management Project, GA = General Atomic; GJPO = Grand Junction Projects Office; KAPL-K = Knolls Atomic Power Laboratory-Kesselring; KAPL-S = Knolls Atomic Power Laboratory-Schenectady; KAPL-W = Knolls Atomic Power Laboratory-Windsor; LEHR = Laboratory for Energy-Related Health Research; Mare Is = Mare Island Naval Shipyard; Norfolk = Norfolk Naval Shipyard; Pearl H = Pearl Harbor Naval Shipyard; Ports Nav = Portsmouth Naval Shipyard; RFETS = Rocky Flats Environmental Technology Site; RMI = RMI Titanium Company; and UofMO = University of Missouri.
[a] For LLMW, data used in the Draft WM PEIS are from 1994 MWIR (DOE, 1994).
[b] For LLMW, more recent data are from 1995 MWIR (DOE, 1995b).
[c] Factor of change is the ratio of more recent data (1995 MWIR) to data in the Draft WM PEIS. Positive values indicate that the more recent data are greater than data in the Draft WM PEIS; negative values indicate that the more recent data are less than data in the Draft WM PEIS.
[d] These sites are evaluated in the Final WM PEIS using data from the 1995 MWIR (DOE, 1995b).
[e] These site estimates include Environmental Restoration wastes. Such wastes may not be transferred to WM facilities.
[f] Volume excludes 15,400 m^3 of grouted pond sludge that is being shipped for commercial disposal.
[g] Volume excludes 114,600 m^3 of wastewater to be generated and managed under the HLW program.
[h] Volume excludes 37,000 m^3 of waste in final form assumed to be shipped directly for disposal at Hanford as generated (see Table I.2-3).

Sources: DOE (1994, 1995b).

Table I.2-2. Comparison of Total Volumes of LLMW Proposed to be Treated at Treatment Sites (m^3)

Site	Alternative									
	41 Treatment Sites (Decentralized)		11 Treatment Sites (Regionalized 1)		7 Treatment Sites (Regionalized 2 or 3)		4 Treatment Sites (Regionalized 4)		1 Treatment Site (Centralized)	
	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95
Ames	0.4	0.2								
ANL-E	8,400	159								
BCL	0.1	12								
Bettis	48	4,800								
BNL	190	30								
Charleston	3	9								
Colonie	11	15								
ETEC	3.7	17								
FEMP	2,600	2,700	11,100	2,900						
GA	43	69								
GJPO	1.5	0.8								
Hanford	36,000	12,000	36,200	15,100	40,800	22,700	40,800	22,700	225,000	191,500
INEL	35,000	28,000	35,000	31,000	35,000	31,100	59,600	56,600		
KCP	0.8	0.2								
KAPL-K	80	75								
KAPL-S	100	64								
KAPL-W	40	75								
LEHR	7	0.0								
LBL	280	34								

Table I.2–2. Comparison of Total Volumes of LLMW Proposed to Be Treated at Treatment Sites (m^3)—Continued

Site	Alternative									
	41 Treatment Sites (Decentralized)		11 Treatment Sites (Regionalized 1)		7 Treatment Sites (Regionalized 2 or 3)		4 Treatment Sites (Regionalized 4)		1 Treatment Site (Centralized)	
	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95
LLNL	4,300	7,500	4,680	7,700						
LANL	2,800	1,000	2,900	1,290	3,590	3,490				
Mare Is	52	84								
Mound	80	100								
NTS	0.4	3,000								
Norfolk	6	300								
ORR	59,000	50,000	59,000	50,000	59,600	51,000	104,000	75,200		
PGDP	600	1,000	600	1,000						
Pantex	690	2,200	690	2,200						
Pearl H	6	130								
Pinellas	0.02	0.0								
PORTS	33,000	15,500	33,600	21,300	44,700	24,200				
Ports Nav	1	11								
PPPL	0.1	9.4								
Puget So	230	3,000								
RMI	29	32								
RFETS	21,000	22,900	21,000	22,000	21,000	22,000				
SNL-NM	100	290								
SRS	20,000	37,000	20,000	37,300	20,000	37,300	20,000	37,300		

Table I.2-2. Comparison of Total Volumes of LLMW Proposed to Be Treated at Treatment Sites (m^3)—Continued

Site	Alternative									
	41 Treatment Sites (Decentralized)		11 Treatment Sites (Regionalized 1)		7 Treatment Sites (Regionalized 2 or 3)		4 Treatment Sites (Regionalized 4)		1 Treatment Site (Centralized)	
	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95	MWIR 94	MWIR 95
SLAC	0.0	6								
UofMO	2	5								
WVDP	55	220								

Notes: Blanks indicate that no treatment (other than aqueous treatment) occurs at a site. The total volumes under each alternative will vary due to rounding. These values are 226,000 m^3 using data from MWIR 94 and 193,000 m^3 using MWIR 95, as shown in Table I.2-1.

Table I.2-3. Comparison of Volumes and Radionuclide Concentrations in LLMW Disposed of Under the Decentralized Alternative

Site	Volume (m^3/yr)			Major Radionuclide[e]	Concentration (Ci/yr)		
	Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c,d]		Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c,d]
ANL-E	577	3.0	-190	U-238	4.8	0.05	
				Ni-59	2.1	0.022	
				Tc-99	0.4	0.0041	
				Total	7.3	0.076	-96
BNL	8.4	0.7	-12.0	U-238	0.1	0.019	
				Ni-59	0.046	0.0085	
				Tc-99	0.0086	0.0016	
				Total	0.155	0.029	-5.3
FEMP	108	96	-1.1	U-238	0.44	0.53	
				Tc-99	0.0067	0.0080	
				Th-232	0.0037	0.0043	
				Total	0.45	0.54	+1.2
Hanford[f]	1,250	4,290	3.4	Ni-59	4.4	40	
				U-238	0.87	7.6	
				Total	5.3	47.6	+9.0
INEL	655	1,000	1.5	Ni-59	100	160	
				U-238	18	29	
				Nb-94	5	7	
				Total	123	196	+1.6
LANL	67	29	-2.3	Pu-240	0.072	0.019	
				Ni-59	0.036	0.013	
				Total	0.11	0.032	-3.4
LLNL	187	175	-1.1	U-238	1.3	2	
				Ni-59	0.84	0.53	
				Total	2.1	2.5	+1.2
NTS	90	208	2.3	U-238	0.35	0.0024	
				Total	0.35	0.0024	-146
ORR	2,040	1,770	-1.2	U-238	29	63	
				Ni-59	13	8.9	
				Total	44	74	+1.7
PDGP	22	23	1.0	U-238	29	27	
				Tc-99	8.7	8.1	
				Th-232	0.24	0.22	
				Total	38	35	-1.1
Pantex	20	62	3.1	Ni-59	0.013	0.029	
				Total	0.013	0.029	+2.2

Table I.2-3. Comparison of Volumes and Radionuclide Concentrations in LLMW Disposed of Under the Decentralized Alternative—Continued

Site	Volume (m^3/yr)			Major Radionuclide[e]	Concentration (Ci/yr)		
	Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c,d]		Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c,d]
PORTS	590	336	-1.7	U-238	0.56	0.20	
				Tc-99	0.17	0.058	
				Th-232	0.0046	0.0016	
				Total	0.73	0.26	-2.8
RFETS	1,390	1,240	-1.1	Pu-240	4.6	0.68	
				Pu-239	1.3	0.19	
				U-238	0.12	0.018	
				Total	6.0	0.88	-6.8
SNL-NM	1.4	6.1	+3.3	Ni-59	0.047	0.12	
				Pu-240	0.0098	0.042	
				Total	0.057	0.16	+2.8
SRS	552	929	+1.7	Ni-59	13	45	
				U-238	0.43	1.8	
				Total	13	47	+3.6
WVDP	0.0	3.6	NA	Ni-59	0.0	0.07	
				U-238	0.0	0.016	
				Total	0.0	0.086	NA
Total	7,560	10,200	1.35	Total	240	404	+1.7

Note: NA = not applicable; no data to compare.

[a] For LLMW, data used in the Draft WM PEIS are from MWIR 94 (DOE, 1994). Includes volume from smaller sites.

[b] For LLMW, more recent data are from MWIR 95 (DOE, 1995b). Includes volume from smaller sites.

[c] Factor of change is the ratio of more recent data (1995 MWIR) to data used in the Draft WM PEIS. Positive values indicate the more recent data are greater than data used in the Draft WM PEIS; negative values indicate that the more recent data are less than data used in the Draft WM PEIS.

[d] Changes in radiological concentration may differ from changes in volume due to changes in treatment categorization.

[e] Major radionuclides include only isotopes with half-lives ($t_{1/2}$) > 300 years.

[f] Includes 3,700 m^3/yr of final-form waste from Puget Sound Naval Shipyard.

Table I.2-4. Comparison of Volumes and Radionuclide Concentrations in LLMW Disposed of Under the Centralized Alternative

Site	Volume (m^3/yr)			Major Radionuclide[d]	Concentration (Ci/yr)		
	Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c]		Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c]
Hanford[e]	7,590	10,100	1.3	Ni-59	140	260	
				U-238	86	130	
				Tc-99	12	11	
				Total	238	401	+1.7

[a] For LLMW, data used in the Draft WM PEIS are from MWIR 94 (DOE, 1994).
[b] For LLMW, more recent data are from MWIR 95 (DOE, 1995b).
[c] Factor of change is the ratio of more recent data (1995 MWIR) to data used in the Draft WM PEIS. Positive values indicate that the more recent data are greater than data used in the Draft WM PEIS; negative values indicate that the more recent data are less than data used in the Draft WM PEIS.
[d] Major radionuclides include only isotopes with half-lives ($t_{1/2}$) > 300 years.
[e] Includes 3,700 m^3/yr of final-form waste from Puget Sound Naval Shipyard.

Table I.2-5. Comparison of Radiological Air Emissions for LLMW: Decentralized Alternative

Site	Radionuclide Contributing Greatest Risk: Total Alpha Radioactivity[a]	Draft WM PEIS Data[b] (Ci/yr)	More Recent Data[c] (Ci/yr)	Factor of Change[d]
ANL-E	U-238 Total alpha	4.7E-05 1.7E-04	4.3E-05 1.6E-04	-1.09 -1.1
BNL	U-238 Total alpha	1.0E-06 3.3E-06	1.3E-07 4.5E-07	-7.7 -7.3
FEMP	U-238 Total alpha	3.7E-06 1.1E-05	3.4E-06 1.0E-05	-1.09 -1.1
Hanford	Pu-238 Total alpha	8.6E-04 1.2E-03	5.0E-04 6.4E-04	-1.7 -1.9
INEL	Tritium Total alpha	2.8E+02 6.4E-04	1.1E+03 2.3E-03	3.9 3.6
LANL	Tritium Total alpha	2.3E+02 2.3E-05	1.2E+02 1.8E-05	-1.9 -1.3
LLNL	Tritium Total alpha	1.1E+04 5.0E-05	3.7E+04 5.3E-05	3.4 1.1
NTS	U-238 Total alpha	2.1E-07 4.9E-06	1.0E-07 3.9E-07	-2.1 -13
ORR	U-238 Total alpha	3.1E-04 1.1E-03	7.3E-05 8.6E-04	-4.2 -1.3
Pantex	Tritium Total alpha	1.0E+02 3.7E-06	2.5E+02 6.1E-06	2.5 1.6
PGDP	U-238 Total alpha	1.8E-04 6.1E-04	2.0E-04 6.0E-06	1.1 -1.02
PORTS	U-238 Total alpha	3.2E-06 9.5E-06	1.9E-06 5.6E-06	-1.7 -1.7
RFETS	Pu-238 Total alpha	1.5E-05 1.6E-04	1.8E-05 2.0E-04	1.2 1.3
SNL-NM	Tritium Total alpha	5.9E+00 8.4E-07	2.6E+01 1.7E-06	4.4 2.0
SRS	Tritium Total alpha	1.5E+03 1.1E-04	5.9E+03 2.6E-04	3.9 2.4
WVDP	Pu-238 Total alpha	1.5E-07 7.4E-07	2.0E-05 2.5E-05	130 34

Footnotes appear on next page.

Table I.2-5. Comparison of Radiological Air Emissions for LLMW: Decentralized Alternative—Continued

[a] Radioactivity is for alpha-emitting radionuclides only. Tritium and other non-alpha emitting radionuclides are not included in this sum because of the small size of their dose conversion factor. Tritium and other nuclides are included separately in this table at sites where they contribute significantly to the health risk.
[b] For LLMW, Draft WM PEIS values calculated on the basis of data from 1994 MWIR (DOE, 1994).
[c] For LLMW, more recent values calculated on the basis of data from 1995 MWIR (DOE, 1995b).
[d] Factor of change is the ratio of more recent data (1995 MWIR) to data in the Draft WM PEIS. Positive values indicate that the more recent data are greater than data in the Draft WM PEIS; negative values indicate that the more recent data are less than data in the Draft WM PEIS.

Table I.2-6. Comparison of Radiological Air Emissions Under the Centralized Alternative (Ci/yr) (Alpha-Emitting Radionuclides Only)

Site	Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c]
Hanford	4.0E-03	4.5E-03	+1.13

[a] For LLMW, Draft WM PEIS values calculated on the basis of data from 1994 MWIR (DOE, 1994).
[b] For LLMW, more recent values calculated on the basis of data from 1995 MWIR (DOE, 1995b).
[c] Factor of change is the ratio of more recent data (1995 MWIR) to data in the Draft WM PEIS. Positive values indicate that the more recent data are greater than the Draft WM PEIS data; negative values indicate that the more recent data are less than data in the Draft WM PEIS.

receive very little additional waste for disposal or have very low predicted concentrations of radionuclides in the groundwater over the period of analysis). The effect of the radiological increases for disposal at Hanford is discussed in Section I.2.3.

I.2.3 Conclusions About LLMW Sites With Waste Load Increases

Two sites—ANL-E and NTS—required reevaluation based on volume or radionuclide changes. The reanalyses are discussed below.

Ten additional sites with volume or radiological increases were reviewed and did not require further reevaluation: FEMP, Hanford, INEL, LLNL, Pantex, PGDP, RFETS, SNL-NM, SRS, and WVDP. However, the pertinent LLMW risk and water quality sections of Chapter 6, Volume I, were revised to note continuing management requirements for the disposal of uranium at FEMP, Hanford, and SRS and for the disposal of plutonium at SNL-NM. The risk sections of Chapter 6 were also revised to note the continuing requirement to carefully manage treatment of tritium-bearing wastes at LLNL and Hanford.

The four other major LLMW sites did not experience volume increases that caused large risks of cancer fatalities to the offsite MEI (exceeding one in one million) or radiological changes that would cause exceedances of water quality standards.

As noted earlier, sites other than the 17 major sites were not considered for evaluation. However, the radionuclides at these sites were included in the radiological profiles assessed for decentralized disposal. Volume changes at these sites, as discussed, did not affect the Regionalized or Centralized Alternatives. Radiological effects in treatment were assumed to correlate with volume changes and similarly would not affect Regionalized or Centralized Alternatives for treatment.

The following discussion of the sites expands upon the data in Tables I.2-7, I.2-8, and I.2-9, which are found at the end of Section I.2.3.2. The tables provide site comparisons showing the change for key parameters between the waste load data used in the Draft WM PEIS and more recent waste load data, including:

1. Change in volumes (see Table I.2-7). This relies on the waste volume tables presented in this section.
2. Change in both the emission of the radionuclide that has the greatest contribution to risk and the total radioactivity emission to the air for alpha-emitting radionuclides (see Table I.2-8). Non-alpha-emitting

radionuclides, such as tritium, are not included in the total radioactivity because their dose conversion factors for inhalation are several orders of magnitude less than those of the typical alpha emitter, and thus the tritium contributes little risk in most cases. However, in those cases where tritium may pose a significant potential risk at a particular site, it is listed separately in the table. The table also shows a projected new offsite population MEI risk by multiplying the MEI risk from the Draft WM PEIS by the factor of change for both the radionuclide that has the greatest contribution to risk and the total overall alpha radioactivity.

3. Increases in those long-lived radionuclides proposed for disposal at a site (see Table I.2-9). The table also shows projected new concentrations in the groundwater for the long-lived radionuclides and discusses whether these concentrations are likely to exceed water quality guidelines. The projected new concentrations are derived by multiplying the change factor by the previous concentrations in the groundwater. Because the water guidelines are risk-based, values lower than the guidelines are assumed to be protective of human health.

I.2.3.1 Sites Requiring Reevaluation

ANL-E

Volumes: As shown in Table I.2-2, the predicted 20-year volume of LLMW decreased at ANL-E from 8,400 m^3 to 159 m^3—a factor of 52.8. This is a much greater decrease than for any other major site and could cause the presentation of very inaccurate impact information. Although impacts predicted using data in the Draft WM PEIS are conservative, they would overestimate impacts and justify a reevaluation.

Radionuclides: Although radionuclide concentrations are not predicted to increase, the substantial decrease in volumes requires that impacts be reevaluated for their effect on health risks to the offsite population.

Conclusions: Reevaluate all LLMW impacts at ANL-E.

NTS

Volumes: As shown in Table I.2-1, the predicted 20-year volume of LLMW increased at NTS from 0.4 to 3,000 m^3—a factor of 7,500. This very large increase justifies a reevaluation.

Radionuclides: Although radionuclide concentrations are not predicted to increase, the substantial increase in volumes requires that impacts be reevaluated for their effect on health risks to the offsite population.

Conclusions: Reevaluate all LLMW impacts at NTS.

I.2.3.2 Sites Not Requiring Reevaluation

FEMP

Volumes: LLMW increased by a factor of 1.04, which results in an increase in workers and resources of 1.03, considering economy of scale. The Decentralized Alternative was used to estimate effects from volume increases.

The estimate of worker risk at FEMP presented in the Draft WM PEIS is 0.17 worker fatalities from treatment and disposal physical hazards and 0.0006 worker fatalities from radiological exposure. The increases in fatalities would thus be 0.005 (physical hazards) and 0.00002 (radiological exposure). These increases are small.

The most limiting criteria air pollutant is NO_2 emitted during construction operations. The concentration is estimated to reach 22% of the standards, so NO_2 emissions would increase to approximately 23% of the standards, which is still well below the standards.

For infrastructure, required acreage would increase from 8.5 to 8.8 acres; water, wastewater, and power, which were estimated to be 6.5% or less of capacity, would increase to 6.7% or less; and job increases would be less than 0.05% of employment in the region. These increases are all small.

Radionuclides: For more recent waste data, the projected offsite MEI risk of cancer fatalities from air emissions is less than one in one million (< E-06). In the Draft WM PEIS, concentrations of U-238 in the groundwater exceeded standards assuming unconstrained disposal; increases in U-238 reported for more recent data could increase the exceedance of groundwater standards by a factor of 1.2 in the absence of any mitigating measures.

Conclusions: The continuing requirement to carefully manage U-238 in disposal has been noted in the risk and water quality sections of Chapter 6, Volume I, of the Final WM PEIS. No further evaluation is required for volume or radionuclide changes.

HANFORD

Volumes: Overall volumes decreased at the Hanford Site. An increase in disposal volumes, noted in Table 1.2–3, is caused by disposal of macro-encapsulated lead components from naval vessels. Disposal of these components will not cause large resource-related impacts. Radionuclide-related impacts are discussed below.

Radionuclides: For more recent waste data, the projected offsite MEI risk from air emissions under the Decentralized Alternative is less than one in one million (< 1.0E–06). For air emissions under the Regionalized and Centralized Alternatives, the overall increase in tritium releases for the DOE complex could cause the MEI risk at Hanford to increase from current projections of 3E–07 to 5E–07, to 1E–06. This potential increase has been noted in Chapter 6. For disposal, concentrations of U-238 in the groundwater exceeded standards in the Draft WM PEIS, assuming unconstrained disposal; increases in U-238 reported for more recent data could increase the exceedance of groundwater standards by a factor of 9 for the Decentralized Alternative and 1.5 for the Centralized Alternative in the absence of any mitigating measures.

Conclusions: The continuing requirement to carefully manage U-238 in disposal has been noted in the risk and water quality sections of Chapter 6, Volume I, of the Final WM PEIS. No further evaluation is required for volume or radionuclide changes.

INEL

Volumes: LLMW disposal volumes increased by a factor of 1.5, which results in an increase in workers and resources of 1.33, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases. Only disposal was considered.

The estimate of worker risk in the Draft WM PEIS from disposal at INEL is 0.05 worker fatalities from treatment and disposal physical hazards and 0.14 worker fatalities from radiological causes. The increases in fatalities would be 0.01 (physical hazards) and 0.05 (radiological exposures). These increases are small.

Disposal operations produce localized, fugitive emissions and were not a significant contributor to adverse air quality.

For infrastructure, approximately 25% of the resources are required for disposal, as shown by the cost tables in Volume II. Disposal volume increases would therefore have less effect than the 33% resource increase. Because existing requirements for acreage are 56 acres; water, wastewater, and power requirements are estimated to be less than 13% of capacity; and jobs generated by the entire LLMW activity are only 1.6% of jobs in the region—the additional requirements for increased disposal volumes are small.

Radionuclides: Radionuclide increases at INEL are not predicted to exceed water quality standards. Air emissions from disposal are not significant contributors to risk; projected offsite MEI risk from treatment air emissions using more recent waste data is less than one in one million.

Conclusions: No further evaluation is required for volume or radionuclide changes.

LLNL

Volumes: LLMW volume increased by a factor of 1.7, which results in an increase in workers and resources of 1.4, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases.

The estimate of worker risk at LLNL in the Draft WM PEIS is 0.29 worker fatalities from treatment and disposal physical hazards and 0.05 worker fatalities from radiological exposures. The increases in fatalities would be 0.12 (physical hazards) and 0.02 (radiological exposure). These increases are small.

The most limiting criteria air pollutant is CO emitted during construction. This is estimated to reach 39% of the standards, so CO emissions would increase to approximately 55%, which is well below the standards.

For infrastructure, required acreage would increase from 12.6 to 17.6 acres; water, wastewater, and power, which were estimated to be 1.2% or less of capacity, would increase to 1.7% or less; and job increases would be less than 0.01% of employment in the region. These increased requirements are all small.

Radionuclides: For disposal, radionuclides that increase at LLNL are not predicted to exceed water quality standards. Air emissions from treatment had predicted risks of cancer fatalities to the offsite MEI in excess

of one in one million in the Draft WM PEIS (i.e., 3E-06); these risks could increase by a factor of 3.4 based upon increases in the radionuclide (tritium) that has the greatest contribution to risk. This has been noted in the risk sections of Chapter 6, Volume I. However, since the previous analysis also noted exceedances of one in one million for risk of fatality during treatment, requiring mitigation through management of tritium, no further quantitative reevaluation beyond disclosing this in the risk presentations was considered necessary.

Conclusions: No further evaluation is required for volume or radionuclide changes.

PANTEX

Volumes: LLMW volume increased by a factor of 3.2, which results in an increase in workers and resources of 2.3, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases.

The estimate of worker risk at Pantex in the Draft WM PEIS is 0.04 worker fatalities from treatment and disposal physical hazards and 0.0006 worker fatalities from radiological exposures. The increases in fatalities would thus be 0.06 (physical hazards) and 0.0008 (radiological exposures). These increases are small.

The most limiting criteria air pollutants are NO_2 and particulates emitted during facility operations. These are estimated to reach 1% of the standards, so emissions would increase to approximately 3.2%, which is well below the standards.

For infrastructure, required acreage would increase from 3.6 to 8.3 acres; water, wastewater, and power, which were estimated to be 0.3% or less of capacity, would increase to 0.7% or less; and job increases would be less than 0.1% of employment in the region. These increases are all small.

Radionuclides: For more recent waste data, projected offsite MEI risk of fatality from air emissions is less than one in one million ($<$ 1.0E-06). Radionuclides that increase at Pantex are not predicted to exceed water quality standards.

Conclusions: No further evaluation is required for volume or radionuclide changes.

PGDP

Volumes: LLMW volume increased by a factor of 1.67, which results in an increase in workers and resources of 1.43, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases.

The estimate of worker risk at PGDP in the Draft WM PEIS is 0.02 worker fatalities from treatment and disposal physical hazards and 0.0004 worker fatalities from radiological exposures. The increases in fatalities would be 0.02 (physical hazards) and 0.0002 (radiological exposure). These increases are small.

The most limiting criteria air pollutant is NO_2 emitted during construction operations. This is estimated to reach 7% of the standards, so NO_2 would increase emissions to approximately 10%, which is well below the standards.

For infrastructure, required acreage would increase from 2.3 to 3.3 acres; water, wastewater, and power, which were estimated to be 0.09% or less of capacity, would increase to 0.13% or less; and job increases would be less than 0.1% of employment in the region. These increases are all small.

Radionuclides: For more recent waste data, projected offsite MEI risk of fatality from air emissions is less than one in one million (< 1.0E–06). For disposal, there are no radionuclides that increase, so the more recent waste data are not predicted to cause an exceedance of water quality standards.

Conclusions: No further evaluation is required for volume or radionuclide changes.

RFETS

Volumes: LLMW volume increased by a factor of 1.09, which results in an increase in workers and resources of 1.06, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases.

The estimate of worker risk at RFETS in the Draft WM PEIS is 0.69 worker fatalities from treatment and disposal physical hazards and 0.003 worker fatalities from radiological exposures. The increases in risk of fatality fatalities would be 0.04 (physical hazards) and 0.0002 (radiological exposure). These increases are small.

The most limiting criteria air pollutant is CO emitted during construction operations. This is estimated to reach 169% of the standards, so CO would increase emissions to approximately 179% of standards. This increase is a small change to a value already well over standards.

For infrastructure, required acreage would increase from 32.9 to 34.9 acres; water, wastewater, and power, which were estimated to be 33.3% or less of capacity, would increase to 35.3% or less; and job increases would be less than 0.004% of employment in the region. These are all small changes.

Radionuclides: For more recent waste data, projected offsite MEI risk of fatality from air emissions is less than one in one million (< 1.0E–06). For disposal, there are no radionuclides that increase, so the more recent waste data are not predicted to cause an exceedance of water quality standards.

Conclusions: No further evaluation is required for volume or radionuclide changes.

SNL-NM

Volumes: LLMW volume increased by a factor of 1.8, which results in an increase in workers and resources of 1.51, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases.

The estimate of worker risk at SNL-NM in the Draft WM PEIS is 0.006 worker fatalities from treatment and disposal physical hazards and 0.0003 worker fatalities from radiological exposures. The increases in risk of fatality fatalities would be 0.003 (physical hazards) and 0.0002 (radiological exposure). These increases are small.

Criteria air pollutants are still 0% of the standards, so increases are negligible.

For infrastructure, required acreage would increase from 0.83 to 1.3 acres; water, wastewater, and power, which were estimated to be 0.3% or less of capacity, would increase to 0.45% or less; and job increases would be less than 0.1% of employment in the region. These increases are all small.

Radionuclides: For more recent waste data, projected offsite MEI risk of fatality from air emissions is less than one in one million (< 1.0E–06). In the Draft WM PEIS, concentrations of plutonium in the groundwater exceeded standards assuming unconstrained disposal; increases in plutonium reported for more

recent data could increase the exceedance of groundwater standards by a factor of 2.0 in the absence of any mitigating measures.

Conclusions: The continuing requirement to carefully manage plutonium in disposal has been noted in the risk and water quality sections of Chapter 6, Volume I, of the Final WM PEIS. No further evaluation is required for volume or radionuclide changes.

SRS

Volumes: LLMW volume increased by a factor of 1.85, which results in an increase in workers and resources of 1.54, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases.

The estimate of worker risk at SRS in the Draft WM PEIS is 0.43 worker fatalities from treatment and disposal physical hazards and 0.15 worker fatalities from radiological exposures. The increases in fatalities would be 0.23 (physical hazards) and 0.08 (radiological exposure). These increases are not considered so large as to require a reevaluation on the basis of volumes.

The most limiting criteria air pollutant is CO emitted during facility operations. This is estimated to reach 10% of the standards, so the CO would increase emissions to approximately 18%, which is well below the standards.

For infrastructure, required acreage would increase from 22.6 to 35 acres; water, wastewater, and power, which were estimated to be 1.5% or less of capacity, would increase to 2.3% or less; and job increases would be less than 0.16% of employment in the region. These increases are all small.

Radionuclides: For more recent waste data, projected offsite MEI risk of fatality from air emissions is less than one in one million (< 1.0E–06). In the Draft WM PEIS, concentrations of U-238 in the groundwater exceeded standards assuming unconstrained disposal; increases in U-238 reported for more recent data could increase the exceedance of groundwater standards by a factor of 4.2 in the absence of any mitigating measures.

Conclusions: The continuing requirement to carefully manage U-238 in disposal facilities has been noted in the risk and water quality sections of Chapter 6, Volume I, of the Final WM PEIS. No further evaluation is required for volume or radionuclide changes.

WVDP

Volumes: LLMW volume increased by a factor of 4, which results in an increase in workers and resources of 2.6, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases.

The estimate of worker risk at WVDP in the Draft WM PEIS is 0.005 worker fatalities from treatment and disposal physical hazards and 0.003 worker fatalities from radiological exposures (no LLMW was disposed of at WVDP). The increases in fatalities would be 0.008 (physical hazards) and 0.004 (radiological exposures). These increases are small.

Criteria air pollutants are still 0% of the standards, so increases are negligible.

For infrastructure, required acreage would increase from 1.5 to 3.9 acres; water, wastewater, and power, which were estimated to be 4% or less of capacity, would increase to 10% or less; and job increases would be less than 0.01% of employment in the region. These increases are all small.

Radionuclides: For more recent waste data, projected offsite MEI risk of fatality from air emissions is less than one in one million (< 1.0E–06). Disposal was not evaluated for LLMW in the Draft WM PEIS because all LLMW at WVDP was categorized as alpha waste, which is transported to SRS for disposal in the Decentralized Alternative. In the more recent data, volumes of 3.6 cubic meters per year of nonalpha waste are listed for disposal. This quantity of LLMW was considered to be too small for analysis of a separate LLMW disposal facility; continued shipment to SRS with alpha LLMW was considered more reasonable.

Conclusions: No further evaluation is required for volume or radionuclide changes.

Table I.2-7. Sites Identified for Reanalysis Based on Changes in LLMW Volumes

Site	No Change	Decrease	Increase (Factor)	Reanalyze	Comment
ANL-E		●		●	**Very large decrease; impacts from Draft WM PEIS data are excessively large; reevaluate site.**
BNL		●			
FEMP			● (1)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
Hanford		●			
INEL			● (1.5)		Increases are for disposal volumes only.
LANL		●			
LLNL			● (1.7)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
NTS			● (7,500)	●	**Large increase—reevaluate site.**
ORR		●			
Pantex			● (3.2)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
PGDP			● (1.7)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
PORTS		●			
RFETS			● (1.1)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
SNL-NM			● (1.8)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
SRS			● (1.9)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
WVDP			● (4)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.

Table I.2–8. Sites Identified for Reanalysis Based on Changes in Radioactivity—Air Emissions as Indicators of Potential Changes in Health Risk

Site	Radioactivity Driver in Decentralized Alternative: Total Alpha Radioactivity[a]	Change (Factor)	Prior MEI Risk	Projected New MEI Risk	Reanalyze	Comment
ANL-E	U-238 Total alpha	-1.09 -1.1	7.2E-09	< 7.2E-09 < 7.2E-09		Projected new risk is < 1.0E-06
BNL	U-238 Total alpha	-7.7 -7.3	1.6E-10	< 1.6E-10 < 1.6E-10		Projected new risk is < 1.0E-06
FEMP	U-238 Total alpha	-1.09 -1.1	4.9E-10	< 4.9E-10 < 4.9E-10		Projected new risk is < 1.0E-06
Hanford	Pu-238 Total alpha	-1.7 -1.9	3E-08	< 3E-08 < 3E-08		Projected new risk is < 1.0E-06
INEL	Tritium Total alpha	3.9 3.6	6.5E-09	2.7E-08 2.5E-08		Projected new risk is < 1.0E-06
LANL	Tritium Total alpha	-1.9 -1.3	6.2E-08	< 6.2E-08 < 6.2E-08		Projected new risk is < 1.0E-06
LLNL	Tritium Total alpha	3.4 1.1	2.5E-06	8.5E-06 2.7E-06		Draft WM PEIS and more recent projections exceed E-06 as noted in Chapter 6, Volume I.
NTS	U-238 Total alpha	-2.1 -13	0	0		Projected new risk is < 1.0E-06
ORR	U-238 Total alpha	-4.2 -1.3	3.3E-08	< 3.3E-08 < 3.3E-08		Projected new risk is < 1.0E-06
Pantex	Tritium Total alpha	2.5 1.6	2.9E-09	7.3E-08 4.6E-08		Projected new risk is < 1.0E-06
PGDP	U-238 Total alpha	1.1 -1.02	1.3E-08	1.4E-08 1.3E-08		Projected new risk is < 1.0E-06
PORTS	U-238 Total alpha	-1.7 -1.7	3.4E-10	< 3.4E-10 < 3.4E-10		Projected new risk is < 1.0E-06
RFETS	Pu-238 Total alpha	1.2 1.3	9.1E-10	1.1E-09 1.2E-09		Projected new risk is < 1.0E-06
SNL-NM	Tritium Total alpha	4.4 2.0	5.4E-09	2.4E-08 1.1E-08		Projected new risk is < 1.0E-06
SRS	Tritium Total alpha	3.9 2.4	1.7E-08	6.6E-08 4.1E-08		Projected new risk is < 1.0E-06
WVDP	Pu-238 Total alpha	130 34	3.8E-12	4.9E-10 1.3E-10		Projected new risk is < 1.0E-06

[a] Radioactivity is for alpha-emitting radionuclides only. Tritium and other non-alpha emitting radionuclides are not included in this sum because of the small size of their dose conversion factor. Tritium and other nuclides are included separately in this table at sites where they contribute significantly to the health risk.

Table I.2–9. Sites Identified for Reanalysis Based on Changes in Radioactivity—Exceedances of Drinking Water Standards as an Indicator of Changes in Groundwater Impacts From LLMW Disposal

Site	Long-lived Radionuclides Increasing	Factor of Change	Groundwater Concentration as % of Drinking Water Standard (%)		Comment
			Draft WM PEIS	Projected New	
ANL-E	None	NA	NA	NA	No increases.
BNL	None	NA	NA	NA	No increases.
FEMP	Tc-99 Th-232 U-238	1.2 1.2 1.2	0 0 400	0 0 480	Will not exceed standards. Will not exceed standards. Draft WM PEIS concentrations exceeded standards in disposal alternatives — new values increase exceedance, but do not change basic results: U-238 would be managed to meet standards. Reevaluation not required.
Hanford	Ni-59 Decentralized Ni-59 Centralized U-238 Decentralized U-238 Centralized	9 1.86 9 1.5	0 0 400 10,000	0 0 3,600 15,000	Will not exceed standards. Will not exceed standards. Draft WM PEIS concentrations exceeded standards in every alternative — new values increase exceedance but do not change basic results: DOE would need to manage U-238 to meet standards. Reevaluation not required.
INEL	Ni-59 U-238	1.6 1.6	0 0	0 0	Will not exceed standards.
LANL	None	NA	NA	NA	No increases.
LLNL	U-238	1.5	0	0	Will not exceed standards.
NTS	None	NA	0	0	No increases.
ORR	U-238	2.2	5–10	11–22	Will not exceed standards.
Pantex	Ni-59	2.2	0	0	Will not exceed standards.
PGDP	None	NA	NA	NA	No increases.
PORTS	None	NA	NA	NA	No increases.
RFETS	None	NA	NA	NA	No increases.
SNL-NM	Ni-59 Pu-240	2.5 2.0	0 900	0 1,800	Will not exceed standards. Draft WM PEIS concentrations exceeded standards in Decentralized Alternative — new value increases exceedance, but Pu-240 would be managed to meet standards. Reevaluation not required.
SRS	Ni-59 U-238	3.7 4.2	0 600	0 2,520	Will not exceed standards. Draft WM PEIS concentrations exceeded standards in every alternative — new values increase exceedance. DOE would need to manage U-238 to meet standards. Reevaluation not required.
WVDP	NA	NA	NA	NA	No disposal evaluated; waste is proposed for shipment to SRS for disposal.

I.3 LLW Inventory Update

The IDB for 1992 (DOE, 1992) and its supporting electronic database, the Waste Management Information System (ORNL, 1992), were used in preparing the LLW analysis in the Draft WM PEIS. These sources contained LLW data reported throughout the DOE complex for 1991. This section presents data published in the IDB Report–1994 (containing data reported for 1994 [DOE, 1995b]) and compares these data to the data used in the Draft WM PEIS.

In 1995, the IDB updated the site-specific LLW characterization data, including generation rates and existing inventory (DOE, 1995b). These data are compared with data in the Draft WM PEIS in Table I.3–1. A comparison of the data reported in these two sources, the IDB Report–1994 and the Draft WM PEIS, indicates that waste generation rates decreased at most sites. Major LLW generating sites in 1994 were Hanford, Idaho National Engineering Laboratory (INEL), the K-25 Site (K-25), Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), Savannah River Site (SRS), Y-12 Plant (Y-12), West Valley Demonstration Project (WVDP), and the Naval Reactor (NR) sites, which include Bettis Atomic Power Laboratory (Bettis), Knolls Atomic Power Laboratory (KAPL) (all facilities), and the Naval Reactor Facility (NRF). Combined waste generation rates at these sites were decreased by a total of 45%, compared with the earlier estimates in the Draft WM PEIS. No LLW generation rates or inventories were reported for PGDP and PORTS in the IDB Report–1994. The waste at these sites falls under the Environmental Restoration (ER) Program.

DOE facilities with small quantities of LLW generated in 1994 included Ames Laboratory (Ames), Argonne National Laboratory-East (ANL-E), Brookhaven National Laboratory (BNL), Fermi National Accelerator Laboratory (Fermi), Inhalation Toxicology Research Institute (ITRI), Kansas City Plant (KCP), Lawrence Berkeley Laboratory (LBL), Lawrence Livermore National Laboratory (LLNL), Mound Plant (Mound), Nevada Test Site (NTS), Pantex Plant (Pantex), Pinellas Plant (Pinellas), Princeton Plasma Physics Laboratory (PPPL), Rocky Flats Environmental Technology Site (RFETS), Stanford Linear Accelerator Center (SLAC), and Sandia National Laboratories-California (SNL-CA).

The volumes of waste managed at different facilities under the various alternatives are represented by the "feedstock" volume. Feedstock volume is the amount entering the treatment or disposal system and is calculated in the WM PEIS as being equal to the waste inventory in storage at a given site plus the annual waste generation rate multiplied by 20 years of waste generation. Table I.3–2 presents total feedstock volumes in the Draft WM PEIS and those calculated from the IDB Report–1994.

Overall, the total reported feedstock volume of LLW decreased by 45%. Approximately one quarter of this decrease can be accounted for by the fact that both PORTS and PGDP did not report any LLW WM volumes in the IDB Report–1994, because wastes at PGDP and PORTS are ER wastes. Table I.3–2 also compares the total annual radionuclide activity of waste as reported in the Draft WM PEIS with that reported in the 1995 IDB. Here, reported complexwide treatment activities increased by about 80% overall.

I.3.1 ANALYSIS OF LLW ALTERNATIVES

For LLW, DOE used either the Decentralized Alternative or Regionalized Alternative 2 impact estimates as the best indicator of the effect of the more recent data on determining which sites should be reanalyzed (see Section I.1.3). However, five alternatives were used to compare estimates of disposal volumes using the more recent LLW data. LLW inventories, generation rates, and activities were entered into the WASTE_MGMT computational model (ANL, 1996a) to determine volumes and radionuclides disposed of under the Decentralized Alternative, three Regionalized Alternatives (Regionalized 2, 4, and 5), and Centralized Alternative 5. New waste treatability categories, volumes, and activities were developed from the IDB Report–1994. LLW radionuclide distributions were assumed to be similar to those used in the Draft WM PEIS; total activities were changed to reflect the updated information.

Updated disposal volumes at each site under the Decentralized Alternative are presented in Table I.3–3 and compared to those used in the Draft WM PEIS. The volumes represent disposal over the 10-year treatment and disposal time frame evaluated in the WM PEIS. No estimates of LLW for disposal at NTS, BNL, or WVDP were reported in the Draft WM PEIS analysis (this is reflected in the second column) because there was no waste on site and only onsite wastes were assumed to be disposed of at these sites under the Decentralized Alternative. Data for these sites were taken from the IDB Report–1994 for use in the Final WM PEIS analyses.

The complexwide decrease in disposal volumes of about 40%, using minimum treatment in the Decentralized Alternative, reflects the overall decrease in LLW generated and stored in the DOE complex as reported in the IDB Report–1994 and is comparable to the 45% decrease in treatment volumes. Disposal volumes under three Regionalized Alternatives (Regionalized 2, 4, and 5) and Centralized Alternative 5, calculated using the more recent data, are shown in Table I.3–4 and are compared with disposal volumes in the Draft WM PEIS. These particular alternatives represent maximum treatment of LLW using volume reduction technologies. The complexwide disposal volumes decrease by about 35% following volume

reduction when the more recent data from the IDB Report–1994 are used, and this decrease is less than the 45% decrease in treatment volumes. The difference reflects not only changes in treatment volumes, but also changes in treatment categories, which can affect the amount of volume reduction occurring at a treatment site.

For LLW, conclusions about the need for reanalysis are based on either the Decentralized Alternative or Regionalized Alternative 2 impact estimates as the best indicator's of the effect of the more recent data. The Decentralized Alternative uses data reported by each site, without the averaging produced by consolidation of waste in the Regionalized or Centralized Alternatives. However, treatment with volume reduction, under Regionalized Alternative 2, would pose greater risks to the offsite population than the Decentralized Alternative, which utilizes minimum treatment. So Regionalized Alternative 2 is used to evaluate air emission impacts to the offsite population.

As noted in Table I.3–3, disposal volumes at sites under the Decentralized Alternative generally decrease. Accordingly, if these sites ship their waste to regionalized and centralized management sites, volumes would also generally decrease. Therefore, it is not anticipated that the more recent data would cause major new impacts or changes to the comparison of alternatives for the Regionalized or Centralized Alternatives. The exceptions are for volume reduction sites as shown in Table I.3–4. Using the more recent data, the percentage of waste suitable for volume reduction as compared with the percentage unsuitable for reduction has decreased at some sites, leading to larger disposal volumes—particularly at INEL and ORR, for some alternatives. Since the greater disposal volumes associated with the minimum treatment alternatives were evaluated at these same sites, impacts of the greater disposal volumes were analyzed in the Draft WM PEIS. Therefore there was no need to reevaluate Regionalized or Centralized Alternatives based upon larger disposal volumes. Costs and transportation impacts, which are calculated at the national level in the Draft WM PEIS for the purposes of comparison of alternatives, would similarly not increase, since volumes overall do not increase.

I.3.2 RADIOLOGICAL PROFILES

Total activities of radionuclides disposed under the Decentralized Alternative, Regionalized Alternatives 2, 4, and 5, and Centralized Alternative 5 are shown in Tables I.3–5 and I.3–6. The total activity of radionuclides disposed of across the DOE complex increases by almost a factor of 2 when the more recent data are used.

The total activity (in curies) of long-half-life radionuclides (half-lives greater than 300 years) contained within disposed waste has the potential to cause future health risks after disposal. The activity of these radionuclides determines the potential risks to an individual or group of receptors using groundwater contaminated by disposal.

Activities for selected long-half-life radionuclides disposed under the Decentralized Alternative and Centralized Alternative 5, calculated by using the more recent data, are compared with the data used in the Draft WM PEIS in Tables I.3–7 and I.3–8. Centralized Alternative 5 assumes all wastes are treated and disposed of at Hanford; thus, disposal activities represent the aggregate total activity from disposal of all LLW. Changes at individual sites are evaluated in the Decentralized Alternative.

As shown by comparing values for the Decentralized Alternative in Tables I.3–5 and I.3–7 with values for Regionalized and Centralized disposal in Tables I.3–6 and I.3–8, analysis of sites using the Decentralized Alternative provides a representative estimate of potential impacts anticipated at most sites using more recent data. Exceptions are at ORR and Hanford, which have increased radioactivity in the Regionalized or Centralized Alternatives. As further discussed in Section I.3.3, ORR is reevaluated for this and other increases, while the increases causing exceedances at Hanford are discussed further in Chapter 7, Volume I.

Pantex has also been chosen for reevaluation of LLW impacts (see Section I.3.3). This selection was not predicated on changes in expected radionuclide concentrations but rather on substantial decreases in the expected volumes of waste needing treatment.

Table I.3–9 lists both the air emissions for the radionuclide that made the greatest contribution to risk in the Draft WM PEIS and the total emission to the air of alpha-emitting radionuclides for each site caused by treatment of LLW. This table compares the air emissions modeled by using the 1992 IDB and IDB Report–1994 data. Total complexwide radiological air emissions are predicted to increase by a factor of 1.7 when the more recent data are used. Analysis of air emissions in the Regionalized Alternative 2 provides estimates of impacts for more recent data at the sites that are most sensitive to air emissions, with the exception of sites affected by thermal treatment of tritium. For greater consolidation of waste in Regionalized and Centralized Alternatives, the increase in tritium-bearing waste, primarily at eastern sites, poses the only potential major increase in risks. This increase in tritium-bearing waste affects emissions at FEMP in Regionalized Alternative 2 and then transfers to PORTS in Regionalized Alternative 4 and Centralized Alternatives 3 and 4, to ORR in Regionalized Alternative 5, and to Hanford in Centralized Alternative 5. This is further discussed in Section I.3.3 and in the risk section of Chapter 7, Volume I.

Table I.3-1. Comparison of Site-Specific LLW Characterization Data

Site	Generation Rate (m^3/yr)		Inventory (m^3)	
	Draft WM PEIS Data[a]	More Recent Data[b]	Draft WM PEIS Data[a]	More Recent Data[b]
Ames	4	4.5	26	53.6
ANL-E	290	669	884	284
BNL[c]	--[d]	254	--	556
FEMP[e]	ER[f]	ER	ER	ER
Fermi	72	61.3	44.7	83.2
Hanford	4,450[g]	4,500	0	50.6
INEL[h]	5,091	3,200	3,520	14,100
KCP	1	18	4	116
LANL	7,480	1,900	0	0
LBL	62	14.6	53.1	19
LLNL	140	77	780	730
Mound	1,840	910	1,580	8,860
NR Sites[i]	1,516	1,050	0	0
NTS[c]	--	70.8	--	269
ORR[c]	10,200	12,600	48,000	19,000
PGDP	2,230	ER	5,270	ER
Pantex[c]	304	122	33,600	209
Pinellas	63	52.1	16	66
PORTS	4,790	ER	1,480	ER
PPPL	11	42.4	2.1	3
RFETS	1,930	503	2,350	5,320
RMI	2,410	--	2,540	--
SLAC	14	81.3	2,200	242
SNL-NM	92	31	680	51
SRS	25,200[j]	10,500	11,100	1,655
WVDP[c]	--	1,370	--	14,300
Total	68,100	38,000	114,000	65,000

Notes: Fermi = Fermi National Accelerator Laboratory; RMI = RMI Titanium Company; SNL-NM = Sandia National Laboratories-New Mexico.

[a] For LLW, Draft WM PEIS values calculated on the basis of data from 1992 IDB (DOE, 1992), WMIS (ORNL, 1992), and updates from some sites.

[b] For LLW, more recent values calculated on the basis of data from IDB Report-1994 (DOE, 1995b).

[c] These sites were evaluated in the Final WM PEIS using data from the IDB Report-1994.

[d] -- = no data reported.

[e] FEMP is an LLW treatment and shipping site. No WM LLW is currently reported there.

[f] ER = Environmental Restoration wastes not under Waste Management Program.

[g] Excludes Hanford grout waste stream.

[h] INEL data include ANL-W and NRF.

[i] NR sites are Bettis and KAPL (all facilities).

[j] Excludes SRS saltstone waste stream.

Sources: DOE (1992, 1995a); ORNL (1992).

Table I.3-2. Comparison of LLW Feedstock Volume and Annual Activity

Site	Inventory Plus 20-yr Generation (m^3)			Annual Activity (Ci/yr)		
	Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c]	Draft WM PEIS Data[a]	More Recent Data[b]	Factor of Change[c]
Ames	106	144	+1.4	0.02	0.0001	-20
ANL-E	6,680	13,700	+2.0	229	16	-14
BNL[d]	NR[e]	5,640	+[f]	NR	574	+
FEMP	ER[g]	ER	NA[h]	ER	ER	NA
Fermi	1,490	1,310	-1.1	1.11	6	+5.4
Hanford	89,000	90,000	+1.02	7,750	6,040	-1.3
INEL[i]	105,000	78,000	-1.3	138,000	270,000	+2.0
KCP	24	476	+19.8	0.11	0.23	+2.1
LANL	150,000	38,000	-3.9	385,000	9,690	-40
LBL	1,290	319	-4.1	1,600	120	-13
LLNL[j]	3,600	1,670	-1.9	24,500	3,650	-6.7
Mound	38,400	27,000	-1.4	6,060	1,400,000	+233
NR Sites[k]	30,300	21,000	-1.4	369,000	91,000	-4.1
NTS[d]	NR	1,690	+	NR	0.09	+
ORR[d,l]	252,000	271,000	+1.1	830	5,420	+6.5
PGDP	49,900	ER	NA	1.0	ER	NA
Pantex[d]	39,700	2,650	-15	19	NR	*[m]
Pinellas	1,280	1,110	-1.2	9,830	10,200	+1.04
PORTS	97,300	ER	NA	0.1	ER	*
PPPL	220	851	+3.8	0.119	9,560	+80,000
RFETS	41,000	15,400	-2.7	11	1.10	-10
RMI	50,700	NR	*	0.01	NR	*
SLAC	2,480	1,890	-1.3	0.01	0.1	0
SNL-NM[n]	2,520	670	-3.8	202	1.1	-180
SRS	515,000	211,000	-2.4	81,000	960	-82
WVDP[d]	NR	41,700	+	NR	NR	NA
Total	1,480,000	810,000	-1.8	1,023,000	1,804,000	+1.8

Footnotes appear on next page.

Table I.3-2. Comparison of LLW Feedstock Volume and Annual Activity —Continued

[a] For LLW, Draft WM PEIS values calculated on the basis of data from 1992 IDB (DOE, 1992), WMIS (ORNL, 1992), and updates from some sites.
[b] For LLW, more recent data are from IDB Report-1994 (DOE, 1995b).
[c] Factor of change is the ratio of more recent data (IDB Report-1994) to Draft WM PEIS data. Positive values indicate that the more recent data are greater than data in the Draft WM PEIS; negative values indicate that the more recent data are less than data in the Draft WM PEIS.
[d] These sites, NTS, BNL, WVDP, ORR, and Pantex, were analyzed in the Final WM PEIS by using the more recent data from the IDB Report-1994 (DOE, 1995b).
[e] NR = no data reported.
[f] + = the IDB Report-1994 reports a volume or activity, whereas no data were reported in the earlier data set used in the Draft WM PEIS.
[g] ER = Environmental Restoration wastes not under Waste Management Program.
[h] NA = not applicable; no data to compare.
[i] Includes ANL-W and NRF data.
[j] Includes SNL-CA data.
[k] NR sites include Bettis and KAPL.
[l] ORR = Oak Ridge Reservation and includes ORNL, K-25, Y-12, and ORISE.
[m] * = Draft WM PEIS data set reported a volume or activity where no data were reported in the IDB Report-1994 (DOE, 1995b).
[n] Includes ITRI.

Table I.3-3. Comparison of Disposal Volumes Under the Decentralized Alternative

Site	Disposal Volume (m^3)		Factor of Change[c]
	Draft WM PEIS Data[a]	More Recent Data[b]	
ANL-E	9,100	16,600	+1.8
BNL	NA[d]	5,760	+[e]
Hanford	94,400	96,800	+1.03
INEL	94,100	80,700	-1.2
LANL	163,000	51,600	-3.2
LLNL	8,320	4,850	-1.7
NTS	NA	1,830	+
ORR	243,000	294,000	+1.2
Pantex	40,000	2,910	-14
PGDP	53,800	528	-102
PORTS	231,000	80,000	-4.8
RFETS	45,000	16,900	-2.7
SNL-NM	2,750	733	-3.8
SRS	568,000	230,000	-2.6
WVDP	NA	49,500	+
Total	1,550,000	930,000	-1.7

[a] For LLW, Draft WM PEIS values calculated on the basis of data from 1992 IDB (DOE, 1992), WMIS (ORNL, 1992), and updates from some sites.
[b] For LLW, more recent data are from IDB Report-1994 (DOE, 1995b).
[c] Factor of change is the ratio of more recent data (IDB Report-1994) to data in the Draft WM PEIS. Positive values indicate that the more recent data are greater than data in the Draft WM PEIS; negative values indicate that the more recent data are less than data in the Draft WM PEIS.
[d] NA = not applicable. No WM LLW was reported for these sites in the data set originally used. Data for these sites from the IDB Report-1994 were used in the Final WM PEIS analysis.
[e] + indicates that an LLW volume exists for this site in the IDB Report-1994 data set, whereas none was reported in the data set used in the Draft WM PEIS.

Table I.3-4. Comparison of Alternatives' Disposal Volumes

Site	Disposal Volume (m^3)														
	Decentralized			Regionalized 2			Regionalized 4			Regionalized 5			Centralized 5		
	Draft WM PEIS Data	More Recent Data	Factor of Change[a]	Draft WM PEIS Data	More Recent Data	Factor of Change[a]	Draft WM PEIS Data	More Recent Data	Factor of Change[a]	Draft WM PEIS Data	More Recent Data	Factor of Change[a]	Draft WM PEIS Data	More Recent Data	Factor of Change[a]
ANL-E	9,100	16,600	+1.8												
BNL	NA	5,760	+												
FEMP				0	0	No change									
Hanford	94,400	96,800	+1.03	20,700	24,000	+1.2	20,900	24,600	+1.2	20,900	24,600	+1.2	826,000	502,000	-1.6
INEL	94,100	80,700	-1.2	51,000	73,000	+1.4	51,000	73,000	+1.4	59,700	74,000	+1.3			
LANL	163,000	51,600	-3.2	50,900	32,300	-1.6	71,800	40,100	-1.8	63,700	38,900	-1.7			
LLNL	8,320	4,850	-1.7	6,200	2,090	-3.0									
NTS	NA	1,830	+	0	0	No change	6,180	1,970	-3.1	6,180	1,970	-3.1			
ORR	243,000	294,000	+1.2	49,100	133,000	+2.7	216,000	264,000	+1.2	214,000	264,000	+1.2			
Pantex	40,000	2,910	-14	7,890	2,910	-2.7									
PGDP	53,800	528	-102	41,500	525	-79									
PORTS	231,000	80,000	-2.9	123,000	130,000	+1.1									
RFETS	45,000	16,900	-2.7	12,000	4,590	-2.3									
SNL-NM	2,750	733	-3.8												
SRS	568,000	230,000	-2.5	455,000	100,000	-4.5	455,000	100,000	-4.5	455,000	100,000	-4.5			
WVDP	NA	49,500	+												
Total	1,550,000	930,000	-1.7	804,000	502,000	-1.6	809,000	502,000	-1.6	807,000	502,000	-1.6	812,000	502,000	-1.6

Note: Blanks indicate that site not used for disposal under this alternative.

[a] Factor of change is the ratio of more recent data (IDB Report-1994) to Draft WM PEIS data. Positive values indicate that the more recent data are greater than data in the Draft WM PEIS; negative values indicate that the more recent data are less than data in the Draft WM PEIS.

Table I.3-5. Comparison of Disposal Activities Under the Decentralized Alternative (Curies)

Site	Draft WM PEIS Data	More Recent Data	Factor of Change[a]
ANL-E	5.30E+03	4.60E+02	-12
BNL	NA[b]	1.21E+04	NA
Hanford[c]	1.55E+05	1.21E+05	-1.3
INEL	2.76E+06	7.60E+06	+2.8
LANL	7.72E+06	1.94E+05	-40
LLNL	6.37E+05	8.99E+04	-7.1
NTS	NA[b]	3.67	+
ORR	5.92E+04	1.27E+05	+2.2
PGDP	2.50E+01	5.97	-4.2
Pantex	2.47E+03	9.55E-01	-2,600
PORTS	7.51E+06	3.45E+07	+3.9
RFETS	2.33E+02	4.57E+01	-5.1
SNL-NM	5.12E+03	2.43E+01	-210
SRS[c]	1.79E+06	2.36E+05	-7.8
WVDP	NA[b]	1.44E+04	+
Total	2.06E+07	4.27E+07	+2.1

Note: NA = not applicable.
[a] Factor of change shows the factor of increase or decrease in disposal activity, comparing more recent data to data in the Draft WM PEIS. Positive values indicate that more recent data are greater than data in the Draft WM PEIS; negative values indicate that more recent data are less than data in the Draft WM PEIS.
[b] No WM LLW was reported for these sites in the data set originally used. Data for these sites and for ORR from the IDB Report-1994 were used in the Final WM PEIS analysis.
[c] Excludes Hanford grout waste and SRS saltstone waste streams.

Table I.3–6. Comparison of Disposal Activities Under the Regionalized and Centralized Alternatives

Site	Disposal Activity (Ci)											
	Regionalized 2			Regionalized 4			Regionalized 5			Centralized 5		
	Draft WM PEIS Data	More Recent Data	Factor of Change[a]	Draft WM PEIS Data	More Recent Data	Factor of Change[a]	Draft WM PEIS Data	More Recent Data	Factor of Change[a]	Draft WM PEIS Data	More Recent Data	Factor of Change[a]
ANL-E	--	--	--	--	--	--	--	--	--	--	--	--
BNL	--	--	--	--	--	--	--	--	--	--	--	--
Hanford[b]	1.55E+05	1.21E+05	-1.3	2.87E+05	2.11E+05	-1.4	2.87E+05	2.11E+05	-1.4	2.02E+07	4.21E+07	+2.1
INEL	2.76E+06	7.60E+06	+2.8	2.76E+06	7.60E+06	+2.8	2.76E+06	7.60E+06	+2.8	--	--	--
LANL	7.73E+06	1.94E+05	-40	7.73E+06	1.94E+05	-40	7.72E+06	1.94E+05	-40	--	--	--
LLNL	3.59E+05	8.99E+04	-4.0	--	--	--	--	--	--	--	--	--
NTS	0	0	None	2.27E+05	5.43E+01	-4,200	2.27E+05	5.43E+01	-4,200	--	--	--
ORR	5.92E+04	1.27E+05	+2.2	7.45E+06	3.45E+07	+4.6	7.45E+06	3.45E+07	+4.6	--	--	--
PGDP	2.50E+01	5.97	-4.2	--	--	--	--	--	--	--	--	--
Pantex	2.47E+03	9.55E+00	-2,600	--	--	--	--	--	--	--	--	--
PORTS	7.39E+06	3.45E+07	+4.7	--	--	--	--	--	--	--	--	--
RFETS	2.33E+02	4.57E+01	-5.1	--	--	--	--	--	--	--	--	--
SNL-NM	--	--	--	--	--	--	--	--	--	--	--	--
SRS[b]	1.79E+06	2.36E+05	-7.8	1.79E+06	2.29E+05	-7.8	1.79E+06	2.29E+05	-7.8	--	--	--
WVDP	--	--	--	--	--	--	--	--	--	--	--	--
Total	2.02E+07	4.21E+07	+2.1	2.02E+07	4.21E+07	+2.1	2.02E+07	4.21E+07	+2.1	2.02E+07	4.21E+07	+2.1

Note: NA = not applicable; -- = site not used for this alternative.

[a] Factor of change shows the factor of increase or decrease in disposal activity, comparing more recent data to data in the Draft WM PEIS. Positive values indicate that the more recent data are greater than data in the Draft WM PEIS; negative values indicate that more recent data are less than data in the Draft WM PEIS.
[b] Excludes Hanford grout waste and SRS saltstone waste streams.

Table I.3–7. Comparison of Disposal Activities—Selected Long-Half-Life Nuclides: Decentralized Alternative

Disposal Site/ Nuclide	Disposal Activity (Ci)		Factor of Change[a]
	Draft WM PEIS Data	More Recent Data	
ANL-E			
Ni-59	2.68	0.365	-7.3
Tc-99	1.62	0.103	-16
Th-232	0.00133	0.0105	+7.9
U-235	0.000125	0.000997	+8.0
U-238	9.79	1.87	-5.2
Pu-240	0.0282	0.00168	-18
Total	14.9	2.35	-6.2
BNL[b]			
Ni-59	ND[c]	6.06	d
Tc-99	ND	3.72	d
U-238	ND	22.1	d
Pu-240	ND	0.0605	d
Total	ND	33.8	d
Hanford			
Tc-99	3.44	2.94	-1.2
Th-232	0.434	1.65	+3.8
U-235	0.0410	0.156	+3.8
U-238	52.8	201	+3.8
Pu-240	2.29	1.96	-1.2
Total	59.0	208	+3.5
INEL			
Ni-59	5,500	14,300	+2.6
Tc-99	0.0896	13.1	+150
Pu-240	0.0597	8.75	+150
Total	5,500	14,300	+2.6
LANL			
Tc-99	115	3.02	-38
Th-232	26.8	56	+2.1
U-235	2.53	5.29	+2.1
U-238	3,260	6,830	+2.1
Pu-240	89.4	0.0474	-1,900
Total	12,300	6,900	-1.8
LLNL			
Tc-99	22.6	0.712	-31
U-235	0.00971	0	d
U-238	150	4.28	-35
Pu-240	0.181	2.07	+11
Total	184	7.41	-25

Table I.3-7. Comparison of Disposal Activities—Selected Long-Half-Life Nuclides: Decentralized Alternative—Continued

Disposal Site/ Nuclide	Disposal Activity (Ci)		Factor of Change[a]
	Draft WM PEIS Data	More Recent Data	
NTS[b]			
Tc-99	ND	0.00011	d
Pu-240	ND	0.0000734	d
Total	ND	0.000183	d
ORR[b]			
Tc-99	1.72	95.7	+56
Th-232	0.283	0.585	+2.1
U-235	0.0268	0.0553	+2.1
U-238	35	644	+18
Pu-240	1.09	1.05	None
Total	38.2	788	+21
PGDP			
Tc-99	0.0922	0.00652	-14
U-238	7.36	0.0396	-190
Np-237	0.0670	--[e]	d
Total	7.52	0.0494	-152
Pantex[b]			
Th-232	0.356	0.000130	-2,700
U-235	0.0336	0.0000123	-2,700
U-238	43.3	0.0159	-2,700
Total	43.7	0.0016	-2,700
Portsmouth			
Ni-59	14,700	1,410	-10
Tc-99	0.00481	0.00334	-1.4
Th-232	0.0122	0	d
U-235	0.00116	0	d
U-238	1.5	0	d
Pu-240	0.431	2.06	+4.8
Total	14,700	1,410	-10
RFETS			
Th-232	0.0579	0.00125	-46
U-235	0.00547	0.000118	-46
U-238	7.04	0.152	-46
Pu-240	1.48	0.317	-4.7
Total	8.58	0.470	-18

Table I.3-7. Comparison of Disposal Activities—Selected Long-Half-Life Nuclides: Decentralized Alternative—Continued

Disposal Site/ Nuclide	Disposal Activity (Ci)		Factor of Change[a]
	Draft WM PEIS Data	More Recent Data	
SNL-NM			
Tc-99	6.07	0.0291	-210
Th-232	0.00819	0	d
U-235	0.000774	0	d
U-238	37.9	0.177	-210
Pu-240	0.210	0	d
Total	47.2	0.221	-210
SRS			
Ni-59	1,790	12.8	-140
Tc-99	1,270[f]	0.192	-10,000
Th-232	1.37	5.11	+3.7
U-235	0.129	0.483	+3.7
U-238	299	622	+2.1
Pu-240	5.89	0.913	-6.8
Total	3,380	641	-5.3
WVDP[b]			
Tc-99	ND	0.423	d
Pu-240	ND	0.287	d
Total	ND	0.71	d

[a] Factor of change is the ratio of more recent data (IDB Report-1994) to Draft WM PEIS data. Positive values result when the more recent data are greater than the Draft WM PEIS data; negative values result when more recent data are less than the Draft WM PEIS data.
[b] More recent data were used for analysis of BNL, NTS, ORR, Pantex, and WVDP in the Final WM PEIS.
[c] ND = no data reported for this site.
[d] Either data set (IDB Report-1994 or Draft WM PEIS) showed zero for the indicated nuclide.
[e] Np-237 was not included in the radionuclide inventory for the more recent data comparison.
[f] SRS Tc-99 activities in the Draft WM PEIS Data column include activity in saltstone. Excluding this waste stream leaves 30 Ci of Tc-99 disposed at SRS. The change from Draft WM PEIS data to more recent is still greater than 1/100.

Table I.3-8. Comparison of Disposal Activities—Selected Long-Half-Life Nuclides: Centralized Alternative 5

Disposal Site/ Nuclide	Disposal Activity (Ci)		Factor of Change[a]
	Draft WM PEIS Data	More Recent Data	
Hanford			
Ni-59	22,100	16,100	-1.4
Ni-63	3,160,000	2,290,000	-1.4
Tc-99	179	120	-1.5
Sm-151	5,540	800	-7.0
Th-232	29.4	65.0	+2.2
U-235	2.78	6.15	+2.2
U-238	3,900	8,530	+2.1
Np-237	0.0670	0[b]	c
Pu-240	101	15.8	-6.4
Total	3,190,000	2,320,000	-1.4

[a] Factor of change is the ratio of more recent data (IDB Report-1994) to Draft WM PEIS data. Positive values result when the more recent data are greater than data in the Draft WM PEIS; negative values result when the more recent data are less than data in the Draft WM PEIS.
[b] Np-237 was not included in the radionuclide inventory for the more recent data comparison.
[c] Either data set (IDB Report-1994 or Draft WM PEIS) showed zero for the indicated nuclide.

Table I.3-9. Comparison of Radiological Air Emissions for LLW: Regionalized Alternative 2

Site	Radionuclide Contributing Greatest Risk: Total Alpha Radioactivity[a]	Draft WM PEIS Data[b] (Ci/yr)	More Recent Data[c] (Ci/yr)	Factor of Change[d]
ANL-E	U-238 Overall	4.1E-08 9.0E-08	2.2E-09 4.8E-09	-19 -19
BNL	U-238 Overall	NA	9.5E-08 2.0E-07	NA
FEMP	Tritium Total alpha	1.3E+04 9.4E-08	8.5E+04 1.3E-07	6.5 1.4
Hanford	Pu-238 Total alpha	3.0E-05 6.8E-05	3.3E-06 1.3E-05	-9.1 -5.2
INEL	Co-60 Total alpha	7.4E-02 1.9E-06	1.9E-02 2.2E-06	-3.9 1.2
LANL	U-238 Total alpha	9.4E-03 1.15E+02	1.9E-02 1.2E-01	2.0 -958
LLNL	Tritium Total alpha	2.8E+04 1.0E-04	1.4E+00 1.3E-06	-2.0E+04 -77
NTS	Pu-238 Total alpha	NA	6.5E-11 1.3E-10	NA
ORR	C-14 Total alpha	4.4E-03 3.8E-05	6.1E-03 1.3E-04	1.4 3.4
Pantex	Tritium Total alpha	2.5E-01 8.2E-06	1.3E+00 2.0E-10	5.2 -4.1E+04
PGDP	U-238 Total alpha	2.7E-06 8.1E-06	6.0E-18 1.8E-10	-4.5E+11 -4.5E+04
PORTS	Co-60 Total alpha	2.1E-01 6.0E-06	1.1E-03 1.2E-05	-190 2.0
RFETS	Pu-238 Total alpha	1.1E-05 4.2E-04	1.3E-06 4.7E-05	-8.5 -8.9
SNL-NM	U-238 Total alpha	4.3E-09 1.3E-07	NA	NA
SRS	Tritium Total alpha	3.8E+02 1.3E-03	3.6E-02 5.0E-03	-1.1E+04 3.8
WVDP	Pu-238 Total alpha	NA	1.4E-07 2.9E-07	NA

Footnotes appear on next page.

Table I.3-9. Comparison of Radiological Air Emissions for LLW: Regionalized Alternative 2—Continued

[a] The radioactivity is for alpha-emitting radionuclides only. Tritium and other non-alpha emitting radionuclides are not included because of the small size of their dose conversion factor. Tritium and other nuclides are included separately in this table at sites where they contribute significantly to the health risk.

[b] For LLW, Draft WM PEIS values calculated on the basis of data from the 1992 IDB (DOE, 1992).

[c] For LLW, more recent values calculated on basis of data from the IDB Report-1994 (DOE, 1995b).

[d] Factor of change is the ratio of more recent data (IDB Report-1994) to data in the Draft WM PEIS. Positive values indicate that the more recent data are greater than data in the Draft WM PEIS; negative values indicate that the more recent data are less than data in the Draft WM PEIS.

I.3.3 CONCLUSIONS ABOUT LLW SITES WITH WASTE LOAD INCREASES

Five sites—BNL, NTS, WVDP, ORR, and Pantex—required reevaluation based on volume or radionuclide changes. These are discussed below.

Four additional sites with volume or radiological increases were reviewed and did not require further reevaluation—ANL-E, FEMP, Hanford, and SRS. However, the sections of Chapter 7, Volume I, that discuss risk were revised for FEMP, Hanford, and PORTS to note the requirement to mitigate potential air emission impacts if volume reduction using thermal treatment technologies is employed rather than other methods such as compaction. (Volume reduction is only employed at FEMP in Regionalized Alternative 2.) The health risk and water quality sections of Chapter 7, Volume I, were revised to note continuing management requirements for the disposal of uranium at the Hanford Site and SRS. The air quality section in Chapter 7 was revised for ANL-E to note that criteria air pollutants may approach air quality standards using the more recent data.

The more recent estimates of LLW volume at the other seven major LLW sites did not result in large impacts or risks or radiological changes that would cause exceedances of water quality standards or risks of cancer fatalities to the offsite MEI that exceeded one in one million.

Sites that are not major sites were not considered for evaluation. These sites are assumed to perform minimum levels of treatment and ship to other sites for more intensive treatment or disposal in every alternative. Therefore, impacts at these sites are not large. The radionuclides at these sites, however, were included in the radiological profiles of major sites that treat or dispose of their waste in the Decentralized and Regionalized Alternatives and were reviewed in evaluating these major sites.

The discussion of the sites which follows amplifies upon Tables I.3-10, I.3-11, and I.3-12, which are found at the end of Section I.3.3.2. The tables provide site comparisons showing the change for key parameters between the waste load data used for the Draft WM PEIS and newer waste load data, including:

1. Change in volumes (Table I.3-10). This discussion relies on the waste volume tables presented in this section.
2. Change in both the emission of the radionuclide that has the greatest contribution to risk in the Draft WM PEIS and the total radioactivity emission to the air for alpha-emitting radionuclides (Table I.3-11). As discussed in Section I.2, non-alpha-emitting radionuclides, such as tritium, are not included in the total radioactivity for the same reasons as for LLMW. If tritium or other non-alpha emitters pose a

significant potential risk at a particular site, they are listed separately in the table. The table also shows a projected new MEI risk by multiplying the MEI risk from the Draft WM PEIS by the factor of change for both the driving radionuclide and the total overall alpha radioactivity.

3. Increase in those long-lived radionuclides proposed for disposal at a site (Table I.3-12). The table also shows projected new concentrations in the groundwater for the long-lived radionuclides and discusses whether this concentration is likely to exceed water quality guidelines. The projected new concentrations are derived by multiplying the change factor by the previous concentrations in the groundwater. Since the water guidelines are risk-based, values lower than the guidelines are assumed to be protective of human health.

1.3.3.1 Sites Requiring Reevaluation

BNL, NTS, AND WVDP

Volumes: Previous data used in the Draft WM PEIS did not report LLW volume at BNL, NTS, or WVDP. More recent data for stored and projected generation of LLW at these sites are shown in Table I.3-1. This requires a new analysis to determine all LLW impacts at these sites.

Radionuclides: Radionuclide profiles are available for the more recent waste data, supporting an analysis for radiologically caused risks and impacts.

Conclusion: Reevaluate all LLW impacts at BNL, NTS, and WVDP, and revise the WM PEIS accordingly.

ORR

Volumes: LLW increased by a factor of 1.07, which results in an increase in workers and resources of 1.04, considering economy of scale. The Decentralized Alternative and Regionalized Alternative 2 were used to estimate effects from waste increases, depending on which caused greater impacts.

The existing estimate using Draft WM PEIS data of worker risk at ORR is 0.51 worker fatalities from physical hazards (Regionalized Alternative 2) and 0.52 worker fatalities from radiological exposures (Regionalized Alternative 2). The increases in fatalities based on the new data would thus be 0.02 fatalities for both physical hazards and radiological exposure. These increases are small.

The most limiting criteria air pollutant is NO_2 emitted during facility operations. This is estimated to reach 27% of the standards, so the increase would be approximately 2%, reaching 29% of standards.

For infrastructure, required acreage would increase from 81 to 84 acres; water, wastewater, and power, which were estimated to be 7% or less of capacity, would increase to 7.3% or less; and job increases would be less than 0.1% of employment in the region. These increases are all small.

Radionuclides: For more recent waste data, projected offsite MEI risk of cancer fatality from air emissions in Regionalized Alternative 2 is less than one in one million (< 1.0E–06). However, wastes causing increased tritium emissions noted at FEMP could pass to ORR in the Regionalized Alternative 5, potentially raising projected MEI risks at ORR. For disposal, most radionuclide increases reported for the more recent data are not predicted to cause exceedances of groundwater standards; however, concentrations of Tc-99, which increased by a factor of 56 in the more recent waste data, could cause groundwater standards to be exceeded. This constitutes a change in the impact situation at ORR and justifies reevaluation.

Conclusions: No further evaluation is required for impacts affected by volume changes. Impacts resulting from increased radionuclide concentrations were reevaluated. Volume data, which are also used for new risk calculations, were revised in Volume I to reflect more recent data for LLW at ORR.

PANTEX

Volumes: As shown in Table I.3–2, predicted 20-year volumes of LLW decreased at Pantex from 39,700 to 2,650 m^3—a factor of -15. This decrease is several-fold greater than for any other major site and had the potential for resulting in very inaccurate impact information. Although impacts predicted using the Draft WM PEIS data are conservative, the magnitude of the change justifies a reevaluation.

Radionuclides: Although radionuclide concentrations are not predicted to increase, the substantial decreases in volumes should also be reevaluated for their effect on risks.

Conclusions: Reevaluate all LLW impacts at Pantex, and revise WM PEIS accordingly.

I.3.3.2 Sites Not Requiring Reevaluation

ANL-E

Volumes: LLW volumes increased by a factor of 2.05, which adjusts to an increase in workers and resources of 1.65, considering economy of scale. The Decentralized Alternative was used to estimate effects from waste increases.

The existing estimate using Draft WM PEIS data of worker risk at ANL-E is 0.11 worker fatalities from physical hazards and 0.07 worker fatalities from radiological exposures. The increases in fatalities would thus be 0.07 (physical hazards) and 0.05 (radiological exposures). These increases are small.

The most limiting criteria air pollutant is NO_2 emitted during construction of the new facilities. Nitrogen dioxide was previously estimated to reach 58% of the standards, so the waste increase could cause it to approach the standards at 96%. Since this increase is based on emissions from standard construction equipment and workers commuting to work on a typical construction project, it was not cause for a full reevaluation. A note was added to Chapter 7, Volume I, however, advising of the potential for equipment and vehicular emissions approaching guidelines at ANL-E.

Required acreage for infrastructure would increase from 4 to 6.8 acres; water, wastewater, and power, which were estimated to be 8% or less of capacity, would increase to 13% or less; and job increases would be less than 0.02% of employment in the region. These increases are all small.

Radionuclides: Since volume reduction treatment is not considered at ANL-E, air emissions are not a major source for risk using either previous or more recent waste data. For disposal, those radionuclides that increase at ANL-E using more recent data are not predicted to cause water quality standards to be exceeded in the groundwater.

Conclusions: No further evaluation is required for volume or radionuclide increases resulting from more recent waste data.

FEMP

Volumes: Volumes for waste generated at FEMP did not change using the more recent data; these volumes continue to be categorized as ER waste and are not evaluated in the WM PEIS. Volumes of waste shipped to FEMP for treatment decreased. Therefore, no reevaluation is required based upon volumes.

Radionuclides: There was no disposal of LLW evaluated at FEMP. Air emissions for volume reduction had predicted risks of cancer fatalities in excess of one in one million for the offsite MEI in the Draft WM PEIS (i.e., 4E-06); these risks could increase if volume reduction was pursued using thermal technologies and no mitigation, since both total radioactivity and the activity of the radionuclide with greatest contribution to risk increased in the more recent data by factors of 65 and 1.4, respectively. This potential increase in risk has been noted in the risk sections of Chapter 7, Volume I.

Conclusions: Because volume reduction of LLW is not a regulatory treatment requirement and because the previous data also noted exceedances of one in one million for risk of cancer fatality if volume reduction were employed, no further quantitative reevaluation beyond disclosing this in the risk presentations was considered necessary. No further evaluation is required for volume or radionuclide changes.

HANFORD

Volumes: LLW increased by a factor of 1.02, which adjusts to an increase in workers and resources of 1.014, considering economy of scale. The Decentralized Alternative and Regionalized Alternative 2 were used to estimate effects from waste increases, depending on which had caused greater impacts.

The existing estimate using Draft WM PEIS data of worker risk at Hanford is 0.44 worker fatalities from physical hazards (Regionalized Alternative 2) and 0.5 worker fatalities from radiological exposures (Regionalized Alternative 2). The increases in fatalities based on the new data would thus be 0.006 fatalities for physical hazards and 0.007 fatalities for radiological exposure. These increases are small.

The most limiting criteria air pollutants are NO_2 and particulates emitted during operation of the facilities. These were previously estimated to reach 1% of the guidelines, so the increase would not reach 2% of standards.

Required acreage for infrastructure would increase from 11.6 to 11.8 acres; water, wastewater, and power, which were estimated to be 5.5% or less of capacity, would increase to 5.6% or less; and job increases would be less than 0.01% of employment in the region. These increases are small.

Radionuclides: For more recent waste data, projected offsite MEI risk of cancer fatality from air emissions in the Regionalized Alternative 2 is less than one in one million (< 1.0E–06). However, overall increases in tritium emissions noted at FEMP could also increase tritium emissions at Hanford in the Centralized Alternative 5 when eastern waste is shipped to Hanford. When potential offsetting decreases from LLNL are considered, the current MEI risk of 2E–06 could increase to 4E–06. In the Draft WM PEIS, concentrations of U-238 in the groundwater exceeded standards assuming unconstrained disposal; increases in U-238 reported for more recent data could increase the exceedance of groundwater standards by a factor of 3.8 in the absence of any mitigating measures.

Conclusions: The continuing requirement to carefully manage tritium treatment and U-238 in disposal has been noted in the appropriate risk and water quality sections of Chapter 7, Volume I, of the Final WM PEIS. No further evaluation is required for volume or radionuclide changes.

PORTS

Volumes: Volumes decreased; therefore no reevaluation is required.

Radionuclides: Radionuclide increases in the Decentralized Alternative and Regionalized Alternative 2 do not cause large increases in risk. However, the tritium emission increases at FEMP would pass to PORTS in the Regionalized Alternative 4 and Centralized Alternatives 3 and 4, potentially increasing the current MEI risk of 2E–06 to 2E–05.

Conclusions: The continuing requirement to carefully manage tritium emissions has been noted in the risk section of Chapter 7, Volume I.

SRS

Volumes: Volumes decreased at SRS; therefore no reevaluation is required.

Radionuclides: For more recent waste data, projected offsite MEI risk of cancer fatality from air emissions is less than one in one million (< 1.0E–06). In the Draft WM PEIS, concentrations of U-238 in the groundwater exceeded standards assuming unconstrained disposal; increases in U-238 reported for more recent data could increase the exceedance of groundwater standards by a factor of 2.1 in the absence of any mitigating measures.

Conclusions: The continuing requirement to carefully manage U-238 in disposal has been noted in the risk and water quality sections of Chapter 7, Volume I, of the Final WM PEIS. No further evaluation is required for volume or radionuclide changes.

Table I.3-10. Sites Identified for Reanalysis Based on Changes in LLW Volumes

Site	No Change	Decrease	Increase Factor	Reanalyze	Comment
ANL-E			● (2.05)		Increases in all worker fatalities <0.5. Priority air pollutants approach standards, noted in Chapter 7, Volume 1, on vehicular emissions; all infrastructure impact changes small. Reanalysis not warranted.
BNL			●	●	**Large increase - reevaluate site.**
FEMP	●				
Hanford			● (1.02)		Increases in all worker fatalities <0.5. Criteria pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
INEL		●			
LANL		●			
LLNL		●			
NTS			●	●	**Large increase - reevaluate site.**
ORR			● (1.07)		Increases in all worker fatalities <0.5. Criteria air pollutants remain well below standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
Pantex		●		●	**Large decrease - Reevaluate site.**
PGDP		●			
PORTS		●			
RFETS		●			
SNL-NM	●				
SRS		●			
WVDP			●	●	**Large increase - reevaluate site.**

Table I.3-11. Sites Identified for Reanalysis Based on Changes in Radioactivity—LLW Air Emissions as Indicators of Potential Changes in Health Risk

Site	Radioactivity Driver in Regionalized Alternative 2: Total Alpha Radioactivity[a]	Change (Factor)	Old MEI Risk of Cancer Fatalities	Projected New MEI Risk of Cancer Fatalities	Reanalyze	Comment
ANL-E	U-238 Total alpha	-19 -19	1.4E-11	< 1.4E-11		Projected new risk is < E-06
BNL	NA	NA	NA	NA		NA
FEMP	Tritium Total alpha	6.5 1.4	4.4E-06	2.9E-05 6.2E-06		Draft WM PEIS and more recent projections exceed E-06 as annotated in Chapter 7, Volume I.
Hanford	Pu-238 Total alpha	-9.1 -5.2	7.3E-11	< 7.3E-11 < 7.3E-11		Projected new risk is < E-06
INEL	Co-60 Total alpha	-3.9 1.2	1.7E-10	< 1.7E-10 < 2.0E-10		Projected new risk is < E-06
LANL	U-238 Total alpha	2.0 -958	8.2E-07	1.7E-06 <8.2E-07		Draft WM PEIS and more recent projections exceed E-06 as annotated in Chapter 7, Volume I.
LLNL	Tritium Total alpha	-2E+04 -77	6.3E-06	< 6.3E-06 < 6.3E-06		Projected new risk is < E-06
NTS	NA	NA	NA	NA		NA
ORR	C-14 Total alpha	1.4 3.4	4.6E-10	6.4E-10 1.6E-09		Projected new risk is < E-06
Pantex	Tritium Total alpha	5.2 -4.1E+04	9.1E-12	4.7E-11 < 9.1E-12		Projected new risk is < E-06
PGDP	U-238 Total alpha	-4.5E+11 -4.5E+04	2.1E-10	< 2.1E-10 < 2.1E-10		Projected new risk is < E-06
PORTS	Co-60 Total alpha	-190 2.0	6.6E-09	< 6.6E-09 1.3E-08		Projected new risk is < E-06
RFETS	Pu-238 Total alpha	-8.5 -8.9	2.5E-09	< 2.5E-09 < 2.5E-09		Projected new risk is < E-06
SNL-NM	NA	NA	NA	NA		NA
SRS	Tritium Total alpha	-1.1E+04 3.8	5.7E-09	< 5.7E-09 < 2.2E-08		Projected new risk is < E-06
WVDP	NA	NA	NA	NA		NA

[a] Tritium and other non-alpha emitting radionuclides are not included in this overall sum because of the small size of their dose conversion factor. Tritium and other nuclides are included separately in this table at sites where they contribute significantly to the potential health risk.

Table I.3-12. Sites Identified for Reanalysis Based on Changes in Radioactivity—Exceedances of Drinking Water Standards as an Indicator of Changes in Groundwater Impacts From LLW Disposal

Site	Long-lived Radionuclides Increasing	Factor of Change	Groundwater Concentration as % of Drinking Water Standards (%)		Comment
			Draft WM PEIS	Projected New	
ANL-E	Th-232 U-235	7.9 8.0	0 0	0 0	Will not exceed standards.
BNL	NA	NA	NA	NA	**No previous data — reevaluate.**
FEMP	NA	NA	NA	NA	LLW disposal not evaluated.
Hanford	Th-232 Th-232 U-235 U-235 U-238 U-238	3.8 decentralized 2.2 centralized 3.8 decentralized 2.2 centralized 3.8 decentralized 2.1 centralized	0 0 1 7 600 9,000	0 0 3.8 15.4 2,280 18,900	Will not exceed standards for Th-232 or U-235. For U-238, Draft WM PEIS concentrations exceeded standards in every alternative; new values increase exceedance but do not change basic results: DOE would need to carefully manage U-238 to meet standards. Reevaluation not required.
INEL	Ni-59 Tc-99 Pu-240	2.6 150 150	0 0 0	0 0 0	Will not exceed standards.
LANL	Th-232 U-235 U-238	2.1 2.1 2.1	0 0 0	0 0 0	Will not exceed standards.
LLNL	Pu-240	11	0	0	Will not exceed standards.
NTS	None	NA	0	0	No increases.
ORR	Tc-99 Th-232 U-235 U-238	56 2.1 2.1 18	4 0 0 0	224 0 0 0	**Tc-99 increase causes standard exceedance — reevaluate site.**
Pantex	None	NA	NA	NA	No increases.
PGDP	None	NA	NA	NA	
PORTS	Pu-240	4.8	0	0	Will not exceed standards.
RFETS	None	NA	NA	NA	No increases.
SNL-NM	None	NA	NA	NA	No increases.
SRS	Th-232 U-235 U-238	3.7 3.7 2.1	0 0 700–900	0 0 1,470–1,890	Will not exceed standards. Will not exceed standards. Draft WM PEIS concentrations exceeded standards in every alternative; new values increase exceedance but do not change basic results: DOE would need to carefully manage U-238 to meet standards. Reevaluation not required.
WVDP	NA	NA	NA	NA	**No previous data — reevaluate site.**

I.4 TRUW Inventory Update

Potential health risks to workers and the general public from TRUW, as described in Chapter 8 of the Draft WM PEIS, were estimated on the basis of data on inventory and generation rates published during 1992 and 1993 (DOE, 1992, 1993). This section assesses the effect of using the more recent data (DOE, 1995b,c).

The more recent data were collected from each site that will store or generate TRUW. The data include estimates of the volumes of TRUW that DOE currently proposes to dispose of at WIPP and quantities of TRUW that DOE does not currently plan to dispose of at WIPP. TRUW not destined for WIPP under the proposed action in WIPP SEIS-II (DOE, 1996b) includes small quantities of nondefense TRUW from the ARCO Roy F. Weston Site, LBL, and WVDP, as well as TRUW contaminated with polychlorinated biphenyls and RH-TRUW (in excess of WIPP's disposal limits) at certain sites. Appendix B discusses the TRUW that would be generated from ER activities.

For updated wasteload information, DOE reviewed two databases that are now available containing information on TRUW: the MWIR 95 and the BIR-2. DOE also reviewed a third version of the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report* [WIPP BIR-3] (DOE 1996a), which was published in June 1996, and the IBD Report–1994 (DOE, 1995b), published September 1995. Although the radionuclide inventories at some sites are changed slightly, the waste volumes and hazardous constituent inventories in WIPP BIR-3 are unchanged from WIPP BIR-2. The WIPP BIR-3 and the IDB Report–1994 databases were not available at the time of the WM PEIS analysis; however, the changes in WIPP BIR-3 and the IDB Report–1994 are minor, and, therefore, WIPP BIR-2 data were considered sufficient for analytical purposes. Most of the new information was taken from MWIR 1995. MWIR 1995 contains information on waste as it currently exists, specifying treatability groups, and is therefore more relevant to the WM PEIS analyses for calculating impacts from consolidating or decentralizing treatment of TRUW throughout the DOE complex. The information on as-generated waste forms is readily available from MWIR 1995 but is not readily extracted from the BIR-2 data. Some of the BIR-2 data reflect some level of treatment at some sites, since they are intended to represent the volume of the wastes in the forms they might be disposed of at WIPP.[1] BIR-2 was used in the Final WM PEIS, however, for its radiological profiles and for more definitive waste volume estimates for the years that are not covered by MWIR.

[1] For impacts at potential treatment sites, the Draft WIPP SEIS-II scaled the analysis presented in the Draft WM PEIS to reflect BIR-2 and other more recent information, as explained in the Draft WIPP SEIS-II.

A comparison of MWIR 95 with more recent site information at Hanford for RH-TRUW (22,000 m^3 in BIR-2 vs 160 m^3 in MWIR 95) showed that it was more appropriate to use BIR-2 data for that site. The largest waste streams at Hanford will not be generated until after the 5-year period covered by MWIR 95 and, thus, do not appear in MWIR 95. The projected TRUW volume for Hanford was taken from BIR-2 and appropriately modified for a 20-year time period to give a value of 51,500 m^3. For all other sites DOE used information from MWIR 95 and the 20-year projection methodology developed for LLMW in the Draft WM PEIS. The total sitewide radiological profile for inventory waste was taken from BIR-2 for all sites, and it was assumed that projected wastes at each site would have the same radiological content (Ci/kg) as the site's inventory wastes.

The wastes at each site are divided into different treatment categories. The wastes in each category at a site are assumed to have an identical radiological content per kilogram. Note that this assumption can produce quite a different result than an assumption based on radiological content per cubic meter due to the large differences in the apparent densities of wastes in each waste category. The MWIR 95 database has the appropriate mass information for each waste stream to determine average radioactivity values (Ci/kg) for each treatment category of waste. These apparent densities are assumed to be independent of the site.

Table I.4–1 presents the latest estimated volumes of TRUW from waste management activities at sites where TRUW is currently located and expected to be generated that DOE plans to dispose of at WIPP. The new Departmentwide TRUW volume (using BIR-2 data for Hanford and MWIR 95 data for all other sites) is approximately 135,000 m^3 (i.e., 116,000 + 19,000 ≈ 135,000 m^3) compared with the previously reported 110,000 m^3 (i.e., 97,000 + 9,100 ≈ 110,000 m^3). The increase in volume mainly resulted from an overall increase in volume estimates for Hanford, LANL, and ORR. Table I.4–2 provides total volumes of TRUW to be treated under various site configurations.

The more recent data in MWIR 95 also includes more detailed information regarding the characteristics of TRUW for each waste stream. With this information, waste streams were grouped into categories to facilitate efficient treatment of the TRUW streams considered in the study. The waste categories include aqueous liquids, organic liquids, solid process residues, soils, debris, special, inherently hazardous, and unknown. For each waste treatment level, TRUW in each waste category would be treated in a specific treatment train that includes a series of treatment technologies, including solidification, shredding, thermal treatment, and packaging (see Figures 8.2–1 through 8.2–3).

The quantities of waste (waste load) to be processed in TRUW management facilities were calculated on the basis of the updated TRUW inventory and generation data. The waste categories of special, inherently hazardous, and unknown streams are not included in waste load calculations. These wastes are assumed to be set aside to await special processing and characterization. Releases of radionuclides were then evaluated, and the volume of treated TRUW requiring storage was estimated. Methods of the calculations were described in a supporting document for this study (ANL, 1996b).

I.4.1 Analysis of TRUW Alternatives

To assess how the more recent TRUW waste load data may affect the WM PEIS, potential changes to impacts under Regionalized Alternative 2 were analyzed at all sites except WIPP. Under Regionalized Alternative 2, treatment to meet land disposal restrictions generates higher impacts than the Decentralized Alternative or Regionalized Alternative 1, which involve less intensive treatment. For WIPP, the Centralized Alternative involves the greatest impacts and was the basis for the review of WIPP.

Volumes change by similar or equal percentages for sites treating under Regionalized Alternative 3, as for Regionalized Alternative 2 (or the Centralized Alternative at WIPP), as noted in Table I.4–2. Therefore, the review of sites under Regionalized Alternative 2, and of WIPP under the Centralized Alternative, is more sensitive to potential changes to impacts that might result from the new waste load data.

Costs and transportation impacts, which are tabulated in the WM PEIS at the national level, rather than at sites, for the purposes of comparison of alternatives, would not experience major changes, since overall volumes only increase by 27%.

I.4.2 Radiological Profiles

The releases of radionuclides were estimated by using the more recent data. For purposes of illustration, Table I.4–3 compares estimated profiles, using more recent data and the data used in the Draft WM PEIS, for contaminants released from treatment facilities at sites considered in the representative Regionalized and Centralized Alternatives.

Table I.4–1. Comparison of TRUW Treatment Volumes (m^3)

Site	Contact-Handled TRUW				Remote-Handled TRUW			
	Draft WM PEIS Data[a]	BIR More Recent Data[b]	MWIR 95 More Recent Data	Factor of Change[c]	Draft WM PEIS Data[a]	BIR More Recent Data[b]	MWIR 95 More Recent Data	Factor of Change
Ames*	NR	0.3	0.01	NA	NR	NR	NR	NA
ANL-E	960	100	140	-6.9	340	NR	NR	NA
BCL*	NR	NR	NR	NA	NR	480	95	NA
Bettis*	NR	90	78	NA	NR	4.8	1.1	NA
ETEC	0.02	1.7	1.7	+85	NR	0.9	0.4	NA
Hanford	19,000	36,000	13,100	+1.9	6,300	15,500	280	+2.5
INEL[d]	38,000	29,300	40,000	+1.1	610	1,100	300	-2.0
KAPL*	NR	NR	NR	NA	NR	NR	1.2	NA
LANL	11,000	16,300	17,000	+1.5	89	160	190	+2.1
LBL	1	NR	1	1	NR	NR	NR	NA
LLNL	1,700	740	670	-2.5	NR	NR	NR	NA
Mound	1,500	270	270	-5.6	NR	NR	NR	NA
NTS	610	630	620	+1.0	NR	NR	NR	NA
ORR	1,000	1,500	1,600	+1.6	1,700	2,800	1,900	+1.1
PGDP	14	1.4	1.5	-9.3	NR	NR	NR	NA
Pantex*	NR	0.6	0.6	NA	NR	NR	NR	NA
RFETS	6,200	3,800	3,000	-2.1	NR	NR	NR	NA
SNL-NM	1	14	6.2	+6.2	NR	NR	2	NA
SRS	17,000	7,700	16,600	1	NR	NR	21	NA
TBE*	NR	0.2	NR	NA	NR	NR	NR	NA
USAMC*	NR	2.5	NR	NA	NR	NR	NR	NA
UofMO	2	1	0.9	-2.2	NR	NR	NR	NA
WVDP	0.5	160	36	+72.0	NR	350	480	NA
Total	97,000	96,300	94,000		9,100	20,300	3,300	

Notes: Volume data are rounded; NR indicates that the volume is either zero or unreported in the database indicated. * = new sites; NA = not applicable; TBE = Teledyne Brown Engineering; USAMC = U.S. Army Materiel Command.

[a] Inventory + 20 years generation (DOE, 1992; 1993).

[b] Inventory + 20 years generation (adjusted from BIR-2 [DOE, 1995c] by scaling the projected waste generation).

[c] Factor of change is the ratio of MWIR 95 data to Draft WM PEIS data. Positive values result when MWIR 95 data are greater than data in the Draft WM PEIS; negative values result when MWIR 95 data are less than data in the Draft WM PEIS. For Hanford, the factor of change is the ratio of BIR data to the Draft WM PEIS data.

[d] Includes TRUW from Argonne National Laboratory-West.

Table I.4-2. Comparison of Total Volumes of TRUW to Be Treated in Various Site Configurations (m^3)

Site	16 Treatment Sites[a] (Decentralized Alternative)			6 Treatment Sites (Regionalized Alternative 2)			4 Treatment Sites (Regionalized Alternative 3)			3 Treatment Sites[c] (Centralized Alternative)		
	Draft WM PEIS Data	More Recent Data	Factor of Change[b]	Draft WM PEIS Data	More Recent Data	Factor of Change[b]	Draft WM PEIS Data	More Recent Data	Factor of Change[b]	Draft WM PEIS Data	More Recent Data	Factor of Change[b]
ANL-E	1,300	140	-9.3									
ETEC	0.02	2.1	+105.0									
Hanford	25,000	51,000	+2.0	27,000	52,000	+1.9	27,000	52,000	+1.8	7,000	16,000	+2.3
INEL	39,000	40,000	+1.0	40,000	41,000	+1.0	57,000	61,000	+1.1			
LANL	11,000	17,000	+1.5	11,000	17,000	+1.5						
LBL[d]	1		NA									
LLNL	1,700	670	-2.5									
Mound	1,500	270	-5.6									
NTS	610	620	+1.0									
ORR	2,700	3,500	+1.3	2,000	1,900	-1.1	2,000	1,900	-1.1	2,000	1,900	-1.1
PGDP	14	1.5	-9.3									
RFETS	6,200	3,000	-2.1	6,200	3,000	-2.1						
SNL-NM	1	8.2	+8.2									
SRS	17,000	16,600	NA	20,000	19,000	-1.1	20,000	19,000	-1.1			
UofMO	2	0.9	-2.2									
WVDP[e]	0.5		NA									
WIPP			NA							97,000	116,000	+1.2

Note: Blanks indicate that no treatment (other than aqueous treatment) occurs at a site. NA = not applicable. Draft WM PEIS Total Volumes are 106,000 m^3 and total volumes for more recent data are 135,000 m^3, including WVDP, for every alternative. Site totals may not add to these values due to rounding.

[a] LBL and WVDP, which have nondefense and commercial TRUW, are not included in this table.

[b] Factor of change is the ratio of MWIR 95 data to Draft WM PEIS data. Positive values result when MWIR 95 data are greater than data in the Draft WM PEIS; negative values result when MWIR 95 data are less than data in the Draft WM PEIS.

[c] One treatment site for contact-handled TRUW and two treatment sites for remote-handled TRUW.

[d] LBL is a nondefense TRUW site; its TRUW was not included in the more recent data.

[e] WVDP is primarily a nondefense TRUW site; its TRUW was not included in this table.

Table I.4-3. Comparison of Radiological Air Emissions for TRUW: Regionalized Alternative 2

Site	Radionuclide Contributing Greatest Risk: Total Alpha Radioactivity[a]	Draft WM PEIS Data[b] (Ci/yr)	More Recent Data[c] (Ci/yr)	Factor of Change[d]
Hanford				
CH	Pu-238	1.24E-03	9.69E-02	78
	Pu-239	1.58E-03	3.32E-02	21
	Total alpha CH	1.4E-02	2.1E-01	15
RH	Pu-241	1.5E-01	9.2E-05	-1,630
	Total alpha RH	7.4E-01	4.8E-03	-154
INEL				
CH	Am-241	2.84E-02	1.55E-01	5.5
	Total alpha	1.6E-01	5.0E-01	3.1
LANL				
CH	Am-241	1.25E-01	3.31E-02	-3.8
	Total alpha	8.7E-01	5.7E-01	-1.5
ORR				
RH	Cm-244	7.2E-03	1.8E-03	-4
	Total alpha	1.2E-02	3.1E-03	-3.9
RFETS				
CH	Am-241	5.6E-03	2.1E-02	3.7
	Total alpha	4.5E-02	1.5E-01	3.3
SRS				
CH	Pu-238	2.4E+00	1.6E-03	-1,500
	Total alpha	2.8E+00	2.8E-02	-100
WIPP				
CH	Pu-238	2.5E+00	5.3E-01	-4.7
	Total alpha	4.1E+00	1.6E+00	-2.6

[a] Radioactivity is for alpha-emitting radionuclides only. Tritium and other non-alpha emitting radionuclides are not included in this sum because of the small size of their dose conversion factor. Tritium and other nuclides are included separately in this table at sites where they contribute significantly to the health risk.
[b] For TRUW, Draft WM PEIS values are calculated on the basis of data from 1992 IDB (DOE, 1992) and 1993 MWIR (DOE, 1993).
[c] For TRUW, more recent values are calculated on the basis of data from MWIR 95 (DOE, 1995b) except for Hanford, which uses data from the BIR-2.
[d] Factor of change is the ratio of more recent data (MWIR 95) to data in the Draft WM PEIS. Positive values result when the more recent data are greater than data in the Draft WM PEIS; negative values result when the more recent data are less than data in the Draft WM PEIS.

I.4.3 CONCLUSIONS ABOUT TRUW SITES WITH WASTE LOAD INCREASES

Three sites—Hanford, SRS, and WIPP—required reevaluation based on volume or radionuclide changes. These are discussed below.

Six additional sites with volume or radiological increases were reviewed and did not require further reevaluation—INEL, LANL, ORR, RFETS, SNL-NM, and WVDP. However, the pertinent TRUW risk sections of Chapter 8, Volume I, were revised to note the continuing requirement to carefully manage TRUW at INEL and RFETS for air emissions if treatment to meet Land Disposal Restrictions is employed. The other major TRUW sites did not experience volume increases that caused significant new impacts or risks or radiological changes that would cause risks of cancer fatality to the offsite MEI to exceed one in one million.

Sites other than the major sites were not reviewed; however, the radionuclides at these sites were included in the radiological profiles at major sites reviewed in Regionalized Alternative 2, and at WIPP in the Centralized Alternative. Corrections to the total volume of TRUW ($\approx$110,000 m^3) analyzed in the Draft WM PEIS for the three sites undergoing reanalysis for TRUW yield a total volume of about 132,000 m^3, very near the new Departmentwide estimate for TRUW of 135,000 m^3.

The discussion of the sites which follows amplifies upon Tables I.4–4 and I.4–5, which are found at the end of Section I.4.3.2. The tables provide site comparisons showing the change for key parameters between the data used for the Draft WM PEIS and more recent data, including:

1. Change in volumes (Table I.4–4). These changes are based on the waste volume tables presented in this section.
2. Change in both the radionuclide in the air emissions which contributed the highest risk to the offsite MEI for the analyses in the Draft WM PEIS and for the total air emission radioactivity from alpha-emitting radionuclides (Table I.4–5). The table also shows a projected new offsite MEI risk by multiplying the offsite MEI risk from the Draft WM PEIS by the factor of change for both the radionuclide that has the greatest contribution to risk and the total overall alpha radioactivity.

I.4.3.1 Sites Requiring Reevaluation

Hanford

Volumes: Contact-handled and remote-handled TRUW at Hanford, both of which would be treated at Hanford in the Regionalized Alternatives, increased by a factor of 1.9 and 2.5, respectively, for an average increase of 2.04. This results in an increase in workers and resources of 1.65, considering economy of scale.

The existing estimate in the Draft WM PEIS data of worker risk for Hanford is 0.51 worker fatalities from physical hazards and 0.13 worker fatalities from radiological exposures. The increases in fatalities based on the new data would thus be 0.33 for physical hazards and 0.08 for radiological exposure. These increases are not considered so large as to require a reevaluation based upon volumes.

The most limiting criteria air pollutants are NO_2 and particulates emitted during operation of the facilities. These were previously estimated to reach 2% of the standards, so the increase would reach 4% of standards.

For infrastructure, required acreage would increase from approximately 25 to 41 acres; water, wastewater, and power, which were estimated to be 7.8% or less of capacity, would increase to as much as 13%; and job increases would be less than 0.25% of employment in the region. These increases are all small.

Radionuclides: The radionuclide that makes the greatest contribution to cancer risk to the offsite MEI from air emissions increased by a factor of 78, leading to a predicted increase in risk in excess of one in one million (i.e., 3E–06) from a previous risk considerably less than one in one million. Therefore the impacts related to the radiological content of the waste should be reevaluated.

Conclusion: Reevaluate risks based on large radionuclide increases. Volume data, which are also used for new risk calculations, were revised in Volume I to reflect more recent data for Hanford.

SRS

Volumes: There were no changes in predicted 20-year volumes; therefore, a reevaluation based upon volumes is not required.

Radionuclides: A very large decrease in the offsite radionuclide contributing the highest risk to the offsite MEI (factor of -1,500), at a site that had high risks to the offsite MEI and the offsite population, justifies a reevaluation.

Conclusion: Reevaluate risks based on large radionuclide decreases.

WIPP

Volumes: Contact-handled TRUW, which is treated at WIPP in the Centralized Alternative, increased by a factor of 1.20, which results in an increase in workers and resources of 1.14, considering economy of scale. The Centralized Alternative was used to estimate effects from waste increases.

The existing estimate in the Draft WM PEIS data of worker risk for WIPP is 0.44 worker fatalities from physical hazards and 0.16 worker fatalities from radiological exposures. The increases in fatalities would thus be 0.09 (physical hazards) and 0.03 (radiological exposures). These increases are small.

The most limiting criteria air pollutant is particulates emitted during facility operations. This is estimated to reach 25% of the standard, so the more recent data would increase particulate emissions to just 30% of the standard.

For infrastructure, required acreage for treatment facilities would increase from approximately 8 to 10 acres; and infrastructure capacity for water, wastewater, and power, which were estimated to potentially require as much as 82% of current capacity (for wastewater treatment capacity), could increase to 98%. Job increases would be less than 0.06% of employment in the region. These changes for infrastructure are to be expected for a site that would require new facilities if a new mission such as TRUW treatment is implemented. However, the changes from volume increases in the more recent data are not large in comparison to those already disclosed in the WM PEIS. Consequently, they do not warrant a more detailed reevaluation in the programmatic document.

Radionuclides: A very large decrease in the radionuclide contributing the highest risk to the offsite MEI at SRS (factor of -1,500) carries over to WIPP as a factor of 4.7 decrease in the Centralized Alternative despite increases that occurred at Hanford. WIPP had high risks to the offsite MEI and to the offsite population using the Draft WM PEIS data; this change justifies a reevaluation.

Conclusion: Reevaluate risks based on large radionuclide decreases. The new volume data, which are used for risk calculations, were revised to reflect more recent data for WIPP.

I.4.3.2 Sites Not Requiring Reevaluation

INEL

Volumes: Contact-handled TRUW treated at INEL in the Regionalized Alternatives increased by a factor of 1.05, which results in an increase in workers and resources of 1.034, considering economy of scale. Regionalized Alternative 2 was used to estimate effects from waste increases.

The existing estimate in the Draft WM PEIS data of worker risk for INEL is 1.6 worker fatalities from physical hazards and 0.3 worker fatalities from radiological exposures. The increases in fatalities would thus be 0.05 (physical hazards) and 0.01 (radiological exposures). These increases are small.

The most limiting criteria air pollutant is particulates emitted during facility operations. This is estimated to reach 10% of the standard, so the more recent data would increase particulate emissions to just 11% of the standard.

For infrastructure, required acreage would increase from 28 to 29 acres; water, wastewater, and power, which were estimated to be 6.6% or less of capacity, would increase to 6.8% or less; and job increases would be less than 0.03% of employment in the region. These increases are all small.

Radionuclides: The radionuclide contributing the greatest risk to the offsite MEI increased by a factor of 5.5, leading to predicted risk of cancer fatalities for the more recent data in excess of one in one million (5.0E–06). The previously predicted risk to the offsite MEI using data in the Draft WM PEIS was slightly below one in one million (9.1E–07). This increase was not sufficient to require a quantitative reevaluation,

because the risks were already predicted to be essentially at one in one million; however, this increase has been noted in the pertinent sections in Chapter 8, Volume I, to highlight the need for management of air emissions if intensive treatment of TRUW is employed.

Conclusion: No further evaluation is required for volume or radionuclide changes.

LANL

Volumes: Contact-handled TRUW treated at LANL in the Regionalized Alternative 2 increased by a factor of 1.55, which results in an increase in workers and resources of 1.36, considering economy of scale. The Regionalized Alternative 2 was used to estimate effects from waste increases.

The existing estimate in the Draft WM PEIS data of worker risk for LANL is 0.84 worker fatalities from physical hazards and 0.14 worker fatalities from radiological exposures. The increases in fatalities would thus be 0.30 (physical hazards) and 0.05 (radiological exposures). These increases are not considered so large as to require a reevaluation based upon volumes.

The most limiting criteria air pollutant is particulates emitted during facility operations. This is estimated to reach 5% of the standard, so the more recent data would increase particulate emissions to 7%, which is well below the standard. One additional air quality concern would be radionuclides, which were at 134% of the standard using the Draft WM PEIS data. Radionuclide concentrations would vary based upon radiological characteristics rather than volume, however. As noted in the table for TRUW air emissions, total curies for radionuclides in air emissions decreased; therefore air quality for radionuclides would improve. The conclusion is that a reevaluation based upon volumes as they affect air impacts is not required.

For infrastructure, required acreage would increase from 15 to 20 acres; water, wastewater, and power, which were estimated to be 1.2% or less of capacity, would increase to 1.6% or less; and job increases would be less than 0.18% of employment in the region. These increases are all small.

Radionuclides: Curies for radionuclides making the highest contribution to risk and air quality decreased; therefore a reevaluation based on radionuclides is not required.

Conclusion: No further evaluation is required for volume or radionuclide changes.

ORR

Volumes: Remote-handled TRUW treated at ORR in the Regionalized Alternatives increased by a factor of 1.12, which results in an increase in workers and resources of 1.08, considering economy of scale. The Regionalized Alternative 2 was used to estimate effects from remote-handled TRUW increases. Increases of contact-handled TRUW, which is shipped to other sites for treatment, would not cause large impacts at ORR and were not further evaluated.

The existing estimate in the Draft WM PEIS data of worker risk for ORR is 0.21 worker fatalities from physical hazards and 0.09 worker fatalities from radiological exposures. The increases in fatalities would thus be 0.02 (physical hazards) and 0.004 (radiological exposures). These increases are small.

The most limiting criteria air pollutant is NO_2 emitted during facility operations. This is estimated to reach 1% of the standard, so the more recent data would increase NO_2 emissions to just 1.1% of the standard.

For infrastructure, required acreage would increase from 6 to 7 acres; water, wastewater, and power, which were estimated to be 0.09% or less of capacity, would increase to 0.1% or less; and job increases would be less than 0.01% of employment in the region. These increases are small.

Radionuclides: For more recent waste data, projected offsite MEI risk from air emissions is less than one in one million (< 1.0E-06).

Conclusion: No further evaluation is required for volume or radionuclide changes.

RFETS

Volumes: Volumes decrease at RFETS; therefore no additional evaluation is required.

Radionuclides: The radionuclide contributing the greatest risk to the offsite MEI increased by a factor of 3.7, leading to predicted offsite risk using the more recent data in excess of one in one million (5.6E-06). The previously predicted risk to the offsite MEI using data in the Draft WM PEIS was already above one in one million (1.5E-06). This increase was not sufficient to require a quantitative reevaluation, since the risks were already predicted to be above one in one million; however, this has been noted in the pertinent

sections in Chapter 8, Volume I, to highlight the need for management of air emissions if treatment to meet Land Disposal Restrictions of TRUW is employed.

Conclusion: No further evaluation is required for volume or radionuclide changes.

SNL-NM and WVDP

Volumes: Previously estimated small volumes of contact-handled TRUW (1 m^3 at SNL-NM and 0.5 m^3 at WVDP) are now estimated at 6.2 m^3 and 36 m^3, respectively. In addition, 480 m^3 of remote-handled TRUW are now reported at WVDP; none appeared in the Draft WM PEIS data. However, the West Valley Demonstration Project Act (42 U.S.C. 2021a) defines TRUW as "material contaminated with [transuranic] elements . . . in concentrations of 10 nanocuries per gram or in such other concentrations as the [Nuclear Regulatory] Commission may prescribe." One of the agreements in the Stipulation of Compromise Settlement between DOE and the Coalition on West Valley Nuclear Wastes and the Radioactive Waste Campaign (U.S. District Court, Western District of New York, May 27, 1987) is that DOE will seek a determination from the NRC as to whether WVDP waste containing material with an atomic number greater than 92 in concentrations greater than 10 nanocuries per gram is TRUW based on the definition in the WVDP Act. The West Valley Completion EIS (DOE, in preparation) indicates that, in the event that an alternative which includes on-premises disposal of this waste is ultimately selected, DOE will request a determination from NRC that a major portion of the material currently managed as TRUW can be classified as LLW. Since these sites are only considered for storage until another site is available, after which TRUW would be packaged and shipped, impacts are small for managing these new wastes and will not affect the comparison of alternatives. For example, the total worker risk at PGDP, which stores and packages for shipment volumes of contact-handled TRUW comparable to those now predicted at SNL-NM and WVDP, is 0.01 fatalities. Management of remote-handled TRUW at ANL-E, which involves volumes similar to those now predicted for WVDP, entails total worker risk estimates of 0.1 fatalities. DOE determined that these new waste estimates at SNL-NM and WVDP did not affect the programmatic comparison of alternatives and would not present major new impacts. Consequently, these sites were not selected for reevaluation.

Radionuclides: Radionuclides do not cause large risks at sites where only packaging and shipping are conducted.

Conclusion: No further evaluation is required for volume or radionuclide changes.

Table I.4–4. Sites Identified for Reanalysis Based on Changes in TRUW Volumes

Site	No Change	Decrease	Increase (Factor)	Reanalyze	Comment
ANL-E		●			
Hanford			● (CH 1.9; RH 2.5)		Increases in all worker fatalities < 0.5. Criteria air pollutants well within standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
INEL		● (RH)	● (CH1.05)		Increases in all worker fatalities < 0.5. Criteria air pollutants well within standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
LANL			● (CH 1.55; RH 2.1)		Increases in all worker fatalities < 0.5. Criteria air pollutants well within standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
LLNL		●			
NTS	●				
ORR			● (CH 1.6; RH 1.12)		ORR ships CH TRUW to other sites for treatment - change does not affect alternatives and has minor effect on impacts for RH TRUW. Increases in all worker fatalities < 0.5. Criteria air pollutants well within standards. Negligible increases in infrastructure impacts. Reanalysis not warranted.
PGDP		●			
RFETS		●			
SNL-NM			● (6.2)		TRUW is packaged and shipped in all alternatives; changes do not affect decisions.
SRS	●				
WVDP			● (CH 72; RH >480)		TRUW is packaged and shipped in all alternatives; changes do not affect decisions.
WIPP			● (1.13)		

Table I.4-5. Sites Identified for Reanalysis Based on Changes in Radioactivity— TRUW Air Emissions as Indicators of Potential Changes in Health Risk

Site	Radioactivity Driver in Regionalized Alternative 2: Total Alpha Radioactivity[a]	Change (Factor)	Prior MEI Risk	Projected New MEI Risk	Reanalyze	Comment
Hanford CH	Pu-238	78	9.4E-08 CH	7.0E-06		**Large change - reevaluate site**
	Pu-239	21		2.0E-06		
	Total alpha CH	15		1.4E-06	●	
RH	Pu-241	-1,630	1.3E-07 RH	< 1.3E-07		
	Total alpha RH	154		< 1.3E-07		
INEL CH	Am-241 CH	5.5	9.1E-07	5.0E-06		Draft WM PEIS and new projections exceed E-06, as annotated in Chapter 8.
	Total alpha	3.1		2.8E-06		
LANL CH	Am-241	-3.8	6.7E-05	2.5E-06		Risk is lower than in prior estimate; retain prior analysis
	Total alpha	-1.5		1.0E-05		
ORR RH	Cm-244	-4	1.4E-06	5.6E-07		Projected new risk is < 1.0E-06
	Total alpha	-7		9.8E-07		
RFETS CH	AM-241	3.7	1.5E-06	5.6E-06		Draft WM PEIS and new projections exceed E-06, as annotated in Chapter 8.
	Total alpha	3.3		5.0E-06		
SRS CH	Pu-238	-1,500	2.4E-05	3.8E-08	●	**Large decrease; site previously had largest risk - reevaluate risks**
	Total alpha	-100		2.4E-07		
WIPP CH	Pu-238	-4.7	6.7E-05	3.2E-06	●	**SRS decrease transfers to WIPP, which had elevated risk - reevaluate risks**
	Total alpha	-2.6		1.7E-05		

Notes: CH = contact-handled waste; RH = remote-handled waste.

[a] Radioactivity is for alpha-emitting radionuclides only. Tritium and other non-alpha emitting radionuclides are not included in this sum because of the small size of their dose conversion factor. Tritium and other nuclides are included separately in this table at sites where they contribute significantly to the potential health risk.

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Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

Volume V of V

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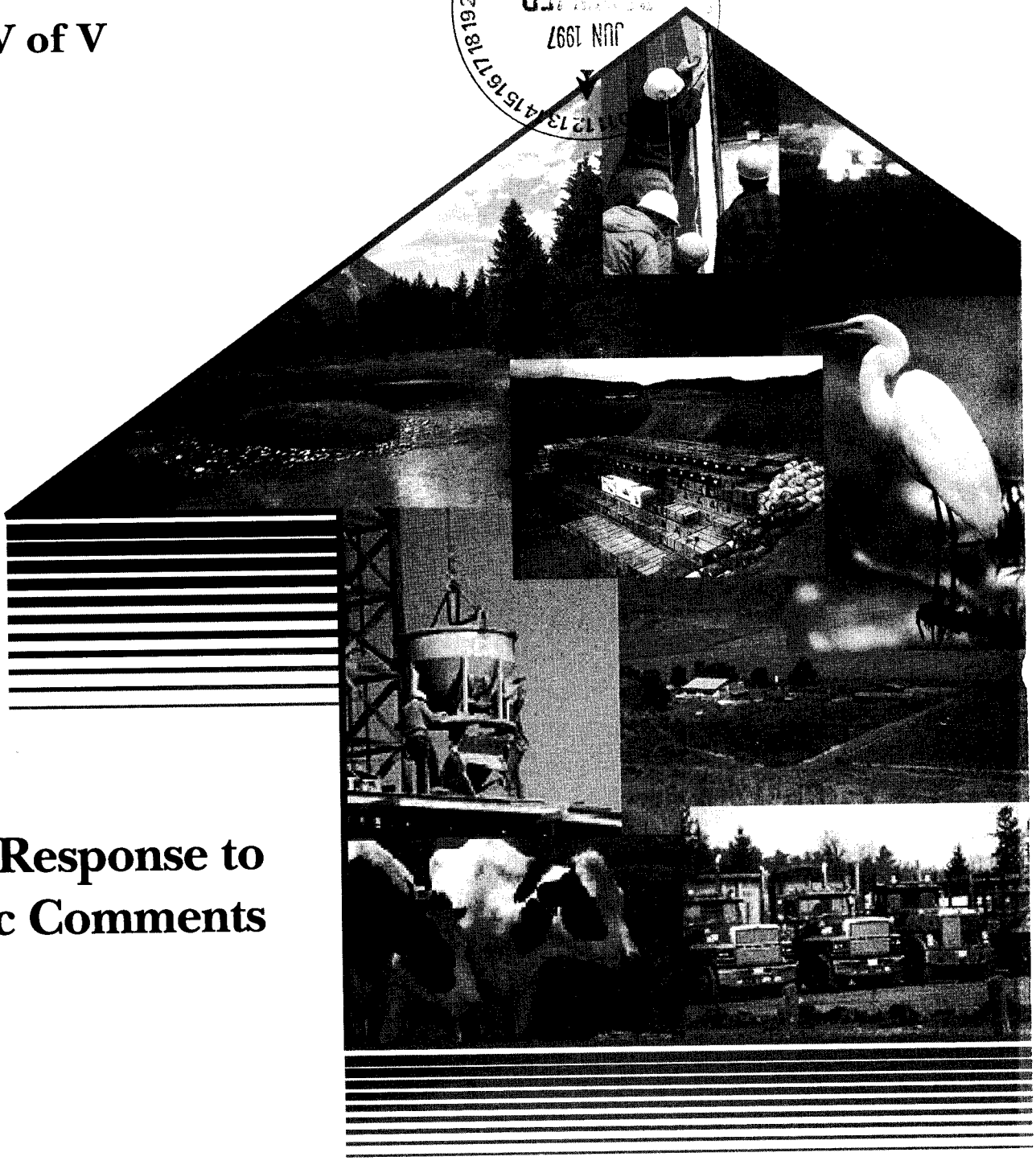

Response to Public Comments

DOE/EIS-0200-F

FINAL
WASTE MANAGEMENT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
for
Managing Treatment, Storage, and Disposal of
Radioactive and Hazardous Waste

Volume V of V

Response to Public Comments

U.S. Department of Energy
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COVER SHEET

RESPONSIBLE FEDERAL AGENCY: U.S. Department of Energy

TITLE: Final Waste Management Programmatic Environmental Impact Statement

CONTACT: For further information about this Environmental Impact Statement, contact:

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ABSTRACT: The Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) examines the potential environmental and cost impacts of strategic management alternatives for managing five types of radioactive and hazardous wastes that have resulted and will continue to result from nuclear energy research and the development, production, and testing of nuclear weapons at a variety of sites around the United States. The five waste types are low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. The WM PEIS provides information on the impacts of various siting alternatives, which the Department of Energy (DOE) will use to decide at which sites to locate additional treatment, storage, and disposal capacity for each waste type. This information includes the cumulative impacts of combining future siting configurations for the five waste types and the collective impacts of other past, present, and reasonably foreseeable future activities.

The selected waste management facilities being considered for these different waste types are treatment and disposal facilities for low-level mixed waste; treatment and disposal facilities for low-level waste; treatment and storage facilities for transuranic waste in the event that treatment is required before disposal; storage facilities for created (vitrified) high-level waste canisters; and treatment of nonwastewater hazardous waste by DOE and commercial vendors. In addition to the No Action Alternative, which includes only existing of approved waste management facilities, the alternatives for each of the waste-type configurations include Decentralized, Regionalized, and Centralized Alternatives for using existing and operating new waste management facilities. However, the siting, construction, and operations of any new facility at a selected site will not be decided until completion of a sitewide or project-specific environmental impact review.

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Guide to Comments and Responses

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Introduction

This volume of the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (WM PEIS) summarizes the comments on the Draft PEIS that the U.S. Department of Energy (DOE) received during the public comment period, and provides DOE responses to those comments.

The Draft WM PEIS was issued for public review and comment on September 22, 1995. In response to requests from the public, DOE extended the original 90-day comment period (September 22 to December 21, 1995) to February 19, 1996 (a total of 150 days).

During the 150-day public comment period, which included 13 public hearings in 18 cities across the United States, DOE received over 5,000 comments from more than 1,200 individuals, agencies, and organizations. Approximately 4,000 individuals cosigned letters or signed petitions.

How DOE Considered Public Comments in the NEPA Process

In compliance with the provisions of the National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*) and regulations of the President's Council on Environmental Quality (CEQ) (40 CFR 1500-1508), DOE assessed and considered public comments on the Draft WM PEIS, both individually and collectively. Some comments led to PEIS modifications; others resulted in a response to explain or communicate DOE policy, to clarify the scope of the WM PEIS, to explain the relationship of this PEIS to other related NEPA documentation, to refer commentors to information in the PEIS, to answer technical questions, to further explain technical issues, or to correct readers' misinterpretations.

Public input contributed to the development of decision factors and criteria, defined as desirable attributes or characteristics that measure the relative acceptability of alternatives, which were used to identify candidate preferred alternatives These factors and criteria include, but are not limited to, human health risk, environmental impacts, regulatory compliance, DOE and site waste management missions, technology development, transportation, cost, and mitigation. Volume I, Section 1.7.3, describes the factors and criteria DOE used to select preferred alternatives, which are identified or described in Volume I, Section 3.7, of the Final WM PEIS.

Public comments also provided valuable suggestions for improving the WM PEIS. A brief summary of public comments and resulting changes to the PEIS is provided in Volume I, Section 1.7.2. Responses to public comments given in this volume (Volume V) identify specific WM PEIS changes made as a result of the comments.

How to Find Individual Comments and Responses

The table at the back of this volume provides the guide to locating comments provided by individuals and organizations, as well as summaries of comments provided at public hearings. Individuals are listed first, alphabetically; organizations are listed second, alphabetically; and public hearings are listed last, alphabetically, by the city in which the hearing was held. To find each comment and DOE's response, locate the commentor's name (individual or organization) in the guide and turn to the index locations listed. The numbers in parentheses following the index numbers identify comments/responses. These are tracking numbers used in the WM PEIS comment/response computer database. In this comment/response volume, these numbers are in numerical order within each section, which permits commentors to locate their comments. The guide includes the entries "Anonymous" and "Illegible." Anonymous entries include comments provided in documents that did not identify the commentor or an organization. Illegible indicates names that were unreadable.

Comments that were the same or very similar to others were grouped and summarized and a single DOE response is provided. Thus, commentors might not read their exact words, but the essence of each comment is captured in the grouping. If an individual or organization is listed more than once in the guide, this indicates that DOE received more than one letter from the commentor, each containing different comments.

Public hearing participants who asked to have their comments specifically attributed to them are included in the list of individuals. Petitions are attributed to the first person who signed the petition or to the person who mailed the petition, if identified. The remaining petitioners are not listed individually. Be assured, however, that all petitions, written comments, and public hearing comments are accounted for and responded to in this volume. DOE also received a number of letters that did not contain comments (requests for copies of the PEIS, change of address notifications, etc.). These persons are not listed in the guide to comments and responses.

A "reverse index" to public comments is available in the DOE WM PEIS public reading rooms. The reverse index can be used by readers to identify the individual(s) attributed to each of the comments.

Supporting Documents and Technical References

Many of the responses to public comments in this volume refer to supporting technical reports, databases, DOE Orders, Federal laws and regulations, and other DOE EISs. DOE has not included these on the list of references provided at the back of this volume because they are listed and described in Volume I, Sections 1.4 and 1.8 cited as appropriate in Volumes I, II, III, and IV, and listed as references at the back of chapters and appendices. The Volume V list of references includes only references unique to Volume V.

List of Acronyms and Abbreviations

AED	Aerodynamic Equivalent Diameter
Ames	Ames Laboratory
ALARA	As Low as Reasonably Achievable
ANL-E	Argonne National Laboratory - East
AQCR	Air Quality Control Region
AQRV	Air Quality Related Values
ARAM	Automated Remedial Action Methodology
BACT	Best Available Control Technology
BEIR	Biological Effects of Ionizing Radiation
BEMR	Baseline Environmental Management Report
Bettis	Bettis Atomic Power Laboratory
BNL	Brookhaven National Laboratory
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH	Contact-handled
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CY	Calendar Year
D&D	Decontamination and Decommissioning
DARHT	Dual-Access Radiographic Hydrodynamic Test
DCF	Dose Conversion Factors
DNAPL	Dense, Nonaqueous-Phase Liquids
DNFSB	Defense Nuclear Facility Safety Board
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DUST	Disposal Unit Source Term
DWPF	Defense Waste Processing Facility
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ETEC	Energy Technology Engineering Center
FEMP	Fernald Environmental Management Project
Fermi	Fermi National Accelerator Laboratory
FFCAct	Federal Facility Compliance Act
FR	Federal Register
FTE	Full-time Equivalent
FY	Fiscal Year
GTCC	Greater-Than-Class C
Hanford	Hanford Site

List of Acronyms and Abbreviations

INEL	Idaho National Engineering Laboratory
IRIS	Integrated Risk Information System
K-25	Oak Ridge K-25 Site
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LLMW	Low-Level Mixed Waste
LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level Waste
MEI	Maximally Exposed Individual
MEPAS	Multimedia Environmental Pollutant Assessment System
Mound	Mound Plant
MWMF	Mixed Waste Management Facility
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
Norfolk	Norfolk Naval Shipyard
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PAEC	Potentially Adverse Effects Concentrations
Pantex	Pantex Plant
PEIS	Programmatic Environmental Impact Statement
PGDP	Paducah Gaseous Diffusion Plant
Pinellas	Pinellas Plant
PLC	Potentially Life-Threatening Concentration
PM_{10}	Particulate matter of aerodynamic diameter less than 10 micrometers
SEIS-I	WIPP Supplement Environmental Impact Statement
SEIS-II	WIPP Disposal Phase Supplemental Environmental Impact Statement
SNF	Spent Nuclear Fuel
SNL-CA	Sandia National Laboratories (California)
SNL-NM	Sandia National Laboratories (New Mexico)
SRS	Savannah River Site
STP	Site Treatment Plan
TLV	Threshold Limit Values
TRUW	Transuranic Waste
TSCA	Toxic Substances Control Act

List of Acronyms and Abbreviations

VOC	Volatile Organic Compound
WIPP	Waste Isolation Pilot Plant
WM PEIS	Waste Management Programmatic Environmental Impact Statement
WVDP	West Valley Demonstration Project
Y-12	Oak Ridge Y-12 Plant

List of Acronyms and Abbreviations

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1. Purpose and Need for Action

Comment (3036)
Protection of the environment should be an element of the WM PEIS purpose and need and should be reflected throughout the PEIS.

Response
Protecting the environment is an important goal of DOE's waste management activities. DOE revised Volume I, Section 2.2, of the WM PEIS to include enhanced protection of the environment, as well as protection of public health and safety, as part of the WM PEIS purpose and need statement. This goal is also reflected throughout the PEIS. For example, Volume I, Section 1.1, states that the PEIS will help DOE continue to protect workers, public health and safety, and the environment.

Each waste-type chapter in the PEIS (Chapters 6 through 10 in Volume I) discusses the health risks and environmental impacts specific to one of the five waste types considered in the WM PEIS. Chapter 12 identifies ways DOE could mitigate potential adverse impacts.

Comment (3331)
DOE intends to use this WM PEIS as a *tool* to help select sites for waste management activities, but the PEIS does not select any specific location. Isn't this the U.S. Department of Energy? Isn't this the agency responsible for managing 54 U.S. sites? Isn't this the agency that is supposed to be sure all sites are meeting the criteria today? Doesn't this document address the treatment, storage, and disposal of radioactive and hazardous waste? Isn't this the agency the American people empowered by Congressional Act? Then why was this document written?

Response
The WM PEIS evaluates the potential environmental consequences of alternative configurations of a nationwide program for managing radioactive and hazardous waste, as discussed in Volume I, Section 1.1. Based on the factors and criteria identified in Section 1.7.3 DOE has identified preferred alternatives and a configuration of sites for each of the five waste types considered in the document. The results of the WM PEIS will provide input on environmental topics which, combined with other considerations (e.g., budget constraints, national priorities, site agreements with States), will contribute to the final decision on a national waste management configuration to be identified in Records of Decision. The WM PEIS will also provide a general point of reference for site-specific NEPA documents prepared to support decisions and locating waste management facilities on particular sites (see Volume I, Section 1.8).

1. Purpose and Need for Action

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2. Proposed Action

Comment (3352)
The Draft WM PEIS states that DOE needs to improve the management of its current and anticipated volumes of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste in order to comply with all laws and to protect public health and safety. Implicit in this statement is that the current management system does not protect human health and the environment as well as it could and is possibly not in compliance with applicable laws. Yet, by DOE's own admission, the facilities that are going to *improve* this situation are not going to be in operation for at least 10 years, and probably longer. That means that the current situation of unacceptable release levels will continue a decade or more. Therefore, the situation for the next 10 to 20 years could have a significant impact on the environment. Yet this impact is not analyzed in the PEIS.

Response
DOE revised the text cited in the comment (Section 2.2) to clarify that DOE will manage its current and anticipated waste volumes in order to comply with all applicable Federal and State laws, to protect public health and safety, and to enhance protection of the environment.

DOE is committed to operating its hazardous and radioactive waste management activities in compliance with applicable regulations and in a way that protects human health and the environment. For purposes of the programmatic analysis the WM PEIS provides, DOE made the generalizing assumption that all waste management facilities necessary to implement a given alternative would be constructed in an initial 10-year period, followed by a 10-year operations period. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. The WM PEIS analysis is highly conceptual and DOE recognizes that construction of actual facilities could occur within a much shorter time period and that waste will begin to be processed at some facilities before construction at all facilities is completed. Nevertheless, DOE believes that the WM PEIS provides a reasonable and conservative estimate of environmental impacts sufficient to support programmatic decisionmaking.

As required by NEPA, the WM PEIS includes an analysis of the impacts of a No Action Alternative. In this PEIS, "no action" is defined as a continuation of current programs. As a part of current programs, some facility upgrades would be necessary to continue to comply with applicable regulations in an efficient, cost-effective manner. Continuing current programs would not result in chronic unacceptable releases because existing DOE waste management facilities routinely meet all regulatory requirements for releases to the environment and would continue to do so. Thus, DOE does not expect significant adverse impacts to the environment from ongoing activities during the period before new waste management facilities begin to operate.

Comment (3539)
The issues addressed in EISs should not be limited to potential problems for which there are practical near-term solutions. EISs "should not be used as tools to sell the development of a piece of property."

Response
The WM PEIS is a national study that examines the environmental impacts of managing DOE's radioactive and hazardous wastes. This strategy is expanding waste management horizons by developing new waste management options and analytical approaches to ensure safe and efficient

2. Proposed Action

management of DOE's radioactive and hazardous wastes, to comply with all applicable Federal and State laws, to protect public health and safety, and to protect the environment.

The PEIS expands existing options and looks into the future to find long-term management solutions for the waste types considered in the document, especially in light of the long-term hazards posed by certain waste materials. The PEIS analyzes candidate DOE sites for the management of its radioactive and hazardous wastes, but is not intended to be used as tools to "sell the development of a piece of property."

3. Waste Management Alternatives

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(No comments were received for this section)

3.1 General Comments, Not Waste-Type Specific

Comment (13)
What will actually be done with DOE wastes?

Response
DOE will manage its wastes by some combination of treatment, storage, and disposal, depending on the waste type. DOE has made no final decisions about how and where to treat, store, and dispose of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. Rather, DOE is developing a Department-wide strategy for managing these wastes. This WM PEIS evaluates the environmental impacts and costs of management at alternative DOE sites, for the five types of waste. It will be part of the basis for decisions about how and where to manage the waste. Decisions will be announced in Records of Decision (RODs) to be published in the *Federal Register* following publication of the Final PEIS.

Comment (36)
Why would DOE build more storage facilities under the No Action Alternative?

Response
The No Action Alternative represents the status quo of DOE waste management operations, and includes existing or planned waste management facilities. For low-level mixed waste and transuranic waste, current practice is to store waste until treatment and disposal capability is available. The PEIS continues this practice, adding storage capacity at each site to accommodate the additional waste generated during the next 20 years. Impacts for construction and operation of the additional storage are evaluated. For low-level waste, waste is shipped for disposal at one of six currently operating disposal sites. Thus, there is no requirement for additional storage. For high-level waste, additional storage is approved for SRS and Hanford; this was evaluated as planned facilities under the No Action Alternative. No additional storage was assumed for hazardous waste.

Comment (197)
Allow DOE sites to manage and monitor all the Nation's wastes and to be continually scrutinized by the public and government agencies.

Response
DOE is responsible for managing its wastes in accordance with all applicable laws and regulations. The management of non-DOE wastes (e.g., from commercial reactors) is outside the scope of the WM PEIS.

DOE strongly believes that its programs benefit from open exchange and coordination with the public, and with other government agencies. DOE welcomes public input to further improve its waste management activities.

Comment (220)
DOE should factor into the WM PEIS analysis the possibility that it will have an additional waste burden from failed commercial facilities. The analysis should factor in any change in "economy of scale" from DOE-generated waste processing to waste generated elsewhere.

Response
DOE is not responsible for radioactive waste from commercial facilities. Therefore, such waste is beyond the scope of the WM PEIS. The U.S. Nuclear Regulatory Commission (NRC) or a State delegated by NRC to manage radioactive waste (NRC Agreement State) is responsible for regulating commercial facilities.

Comment (391)
DOE needs to examine waste management issues across the complex to gain a national "big picture."

Response
DOE believes that the WM PEIS provides the national "big picture" that will help with long-term planning efforts and be part of the basis for future decisions concerning the configuration of DOE's waste treatment, storage, and disposal complex.

Comment (487)
If a waste program is not safe it should not be in anyone's backyard.

Response
The purpose of this WM PEIS is to enhance, on a national level, the management of DOE's current and anticipated volumes of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste in order to ensure safe and efficient management of these wastes, to comply with applicable laws and regulations, and to protect public health and safety and the environment. This study provides information on the impacts to alternative DOE sites. DOE will use this information in deciding where to locate additional treatment, storage, and disposal facilities for each waste type.

The WM PEIS analyzes impacts to human health and the environment for the proposed waste management alternatives. It also considers the cumulative impacts when the waste management actions are added to other past, present, and reasonably foreseeable future actions. If a particular site is chosen for a new waste management operation as a result of the PEIS analysis, additional sitewide or project-level NEPA documentation would be prepared.

Comment (542)
The project [Department-wide waste management as described in the WM PEIS] is consistent with the goals and objectives of the State of South Carolina, Grant Services Unit.

Response
Thank you for your comment.

Comment (1147)
We prefer alternatives that minimize transportation of these waste products as much as practicable.

Response
WM PEIS decision criteria and factors, which DOE used to select preferred alternatives, include favoring selection of alternatives and sites to minimize adverse environmental impacts and balancing the number of shipments with potential environmental risks, safety consequences, public concerns, mission needs, and costs. These criteria and factors are described in Volume I, Section 1.7.3.

3.1 General Comments, Not Waste-Type Specific

The PEIS includes a detailed assessment of risks associated with accidents from both rail and truck transportation, including low probability/high consequence and high probability/low consequence accidents. DOE found that risks from transportation accidents would be low under all alternatives. The Decentralized Alternative, however, would minimize transportation, while the Regionalized and Centralized Alternatives involve increased transportation.

Section 3.7 in Volume I of the WM PEIS provides DOE's preferred alternatives and the reasons they are preferred.

Comment (1288)
The impact of importing wastes to Livermore is an issue within the community.

Response
Lawrence Livermore National Laboratory (LLNL) is included in some of the proposed waste management alternatives evaluated in the WM PEIS for low-level mixed, low-level, and transuranic wastes, as described in Sections 6.3, 7.3, and 8.3 in Volume I, respectively. DOE analyzed the potential human health risks and environmental impacts associated with management activities at LLNL for each of these waste types and found that under all the alternatives risks and impacts would be small.

Comment (1570)
The WM PEIS only addresses the alternative of waste storage in perpetuity; it should address the alternative of storage predicated on total elimination of the wastes.

Response
The WM PEIS evaluates storage, treatment, and disposal of low-level mixed waste and low-level waste; treatment and storage of transuranic waste; and treatment of hazardous waste. However, because of DOE's large waste inventories and the wastes generated by ongoing operations, complete elimination of radioactive and hazardous waste does not appear feasible, even under the most effective pollution prevention plans. Volume IV, Appendix G, of the WM PEIS describes DOE's Pollution Prevention Program, DOE's waste reduction goals, and how waste management activities could be affected by pollution prevention efforts.

Comment (1638)
DOE's waste management system should reflect that the environmental management mission is dynamic and changing with time; hybrid and/or evolving configurations of management systems might be required.

Response
DOE is not constrained to select the specific configurations analyzed in the alternatives in the WM PEIS. It can select hybrid configurations as long as the impacts of alternatives analyzed in the WM PEIS include the impacts of the hybrid alternative. DOE has revised the text in Volume I, Section 3.4, of the WM PEIS to clarify how a hybrid alternative approach might be used. DOE's preferred waste management alternatives, and the reasons they are preferred, are identified in Section 3.7 in Volume I of the Final PEIS.

3.1 General Comments, Not Waste-Type Specific

Comment (1762)
All waste types and waste volumes should be on the table for the public to strategize about. Transuranic waste and low-level mixed waste are pulled out of the decisionmaking process because of WIPP and the Federal Facility Compliance Act.

Response
The PEIS addresses the management of five waste types: low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. For transuranic waste, the PEIS analyzes potential locations for treatment and storage. DOE is analyzing the level of treatment for disposal and whether to dispose of transuranic waste at WIPP in the WIPP SEIS-II. For low-level mixed waste, the PEIS analyzes treatment and disposal decisions, but not storage because DOE assumes that it will store low-level mixed waste on the sites where it is generated until treatment and disposal. The low-level mixed waste alternatives were developed in parallel with the Federal Facility Compliance Act Site Treatment Plans. DOE's preferred alternatives for managing the five waste types and the reasons they are preferred are discussed in Section 3.7 in Volume I.

Comment (1937)
Clarify if ANL-E waste would be shipped to Idaho National Engineering Laboratory (INEL).

Response
None of the 36 alternatives analyzed in the WM PEIS include wastes generated at ANL-E being shipped to INEL. Chapters 6 through 10 in Volume I of the PEIS provide more detail on the alternatives analyzed.

Comment (2113)
None of the proposed alternatives are acceptable; rather, a moral change in DOE is required.

Response
Thank you for your comment.

Comment (2148)
Store the waste in an aboveground, monitorable facility.

Response
DOE assessed waste storage under the WM PEIS No Action Alternative. Most of this waste is stored in aboveground monitored facilities. As a matter of policy, DOE views waste storage as a temporary solution that would only defer a decision on disposal.

Comment (2306)
Assume that there will be onsite treatment. That is part of minimizing transportation.

Response
As identified in Volume I, Section 2.1, of the Final WM PEIS, DOE's proposal includes improving treatment of low-level mixed waste, low-level waste, transuranic waste preparatory to geologic disposal, and nonwastewater hazardous waste.

3.1 General Comments, Not Waste-Type Specific

Alternatives evaluated in the WM PEIS generally incorporate some type of onsite treatment. This treatment varies from the minimum treatment required to transport the waste, to treatment to meet Resource Conservation and Recovery Act (RCRA) land disposal restrictions for low-level mixed waste, for example. In general, transportation of waste offsite for treatment would be least under the Decentralized Alternatives. Note, however, that some types of treatment (e.g., solidification) actually increase the volume of waste that would need to be transported. This is because a solidifying agent such as cement might be added to the waste. U.S. Department of Transportation regulations require that some types of waste be solidified before they are transported.

DOE will consider transportation requirements in its WM PEIS evaluations (see Volume I, Sections 6.4.2, 7.4.2, 8.4.2, 9.4.2, and 10.4.2, and Volume IV, Appendix E). DOE will need to balance the number of shipments with potential environmental risks, safety consequences, public concerns, mission needs, and costs.

Comment (2317)
DOE should store nuclear waste as safely as possible near where it is generated and stop creating nuclear wastes.

Response
One of the four broad categories of alternatives analyzed in the WM PEIS is the Decentralized Alternative. Under this alternative, wastes would be managed as close to their point of origin as possible.

Radioactive and hazardous wastes were and are generated by DOE during national security and energy research facility, decontamination and decommissioning, and environmental restoration. However, DOE is strongly committed to pollution prevention. Appendix G (Volume IV) of the WM PEIS describes DOE's Pollution Prevention Program, waste reduction goals, and the implications of these activities for DOE's waste management strategy.

Comment (2416)
The various waste management alternatives for the different waste types do not, in some cases, cover a reasonable range of alternatives. A review of the list of choices, the preferred alternatives, and the tables showing treatment, storage, and disposal locations suggest that the real range of alternatives that makes sense is much narrower than the total range of alternatives analyzed.

Response
As discussed in Volume I, Section 3.2, the CEQ regulations implementing NEPA require Federal agencies to include a discussion of reasonable alternatives and provide sufficient information for each alternative so that reviewers can evaluate the comparative merits of those alternatives. Sections 1.7.3 and 3.5 in Volume I discuss the methodology for identifying alternatives. The WM PEIS analyzes four broad categories of alternatives that represent reasonable alternatives where DOE can manage its waste. These are No Action, Decentralized, Regionalized, and Centralized. CEQ regulations require that the No Action Alternative be analyzed. The sites identified in alternative configurations were chosen for evaluation based on the volume of waste they currently have in inventory, the amount of waste they expect to generate over the next 20 years, the waste's origin and treatment requirements, the waste treatment facilities at each site, and the requirements for transportation. DOE believes that application of this methodology produced a set of reasonable alternatives of the broadest range.

3.1 General Comments, Not Waste-Type Specific

Comment (2655)
Has the possibility of returning the majority of the waste back to the original mining sites been evaluated, since they are already radioactive?

Response
The CEQ regulations implementing NEPA require an EIS to evaluate all reasonable alternative actions or, where there are potentially a very large number of alternatives, a reasonable number of examples covering the full spectrum of alternatives. In general, mining sites are not necessarily located where existing geologic factors would help to contain wastes onsite. Furthermore, the characteristics of wastes are vastly different from those of the original materials that were extracted from the mines and might often be mixed with hazardous substances. Placing low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste in mining sites is not a reasonable alternative for these reasons.

Comment (3268)
The WM PEIS should not base alternatives on the viability of facilities that might or might not ever be available, and for which the future safety and effectiveness are questionable. Rather, DOE should base alternatives on long-term, monitored, and retrievable storage options. Such storage options should allow for upgrades or replacements. Disposal cannot realistically be considered as an alternative when adequate technology for disposal does not exist.

Response
DOE does not agree that the alternatives analyzed in the WM PEIS should be limited to long-term, monitored and retrievable storage options. Waste storage is considered to be a temporary solution and DOE believes decisions on disposal need to be made. The WM PEIS analysis considered the impacts of four categories of alternatives. With the exception of the No Action alternatives, the analysis considered the risk, impacts, and cost associated with the construction of treatment, storage, and disposal facilities suitable to meet the capacity requirements at each proposed site. These facilities would be constructed to meet EPA and DOE requirements, assuming best available technologies. Data for these technologies are generally based on actual operating experience; thus, adequate technology is considered to be available. Technologies and treatment processes are discussed for each waste type, other than high-level wastes, in Sections 6.2.2, 7.2.2, 8.2.2, and 10.2.2. The high-level waste analysis only considers storage of high-level waste that has already been treated. Under the No Action alternatives, minimal construction was assumed necessary. This allows for comparison of the other alternatives to the No Action, which helps to serve as a baseline.

Comment (3332)
None of the alternatives presented in the WM PEIS are good enough. Recycling is the only good alternative. DOE, you will not reprocess and reclaim plutonium. It wastes our tax dollars and creates huge quantities of "ominous" wastewater.

Response
The DOE Pollution Prevention Program encompasses those activities that involve source reduction and recycling of all waste and pollutants. Volume IV, Appendix G, of the WM PEIS provides a description of DOE's Pollution Prevention Program and a discussion of how DOE's pollution prevention efforts and practices could affect the waste volume that waste management facilities receive and, consequently, the need for such facilities.

3.1 General Comments, Not Waste-Type Specific

The processing or reclamation of plutonium is not part of the scope of this PEIS. DOE will make decisions on plutonium based on other EISs including the Fissile Materials PEIS, the Stockpile Stewardship and Management PEIS, the Pantex Sitewide EIS, the Plutonium Vault EIS, and the Plutonium Residues EIS.

Comment (3338)
While one alternative seems in the abstract to show benefits in one area (e.g., the economy), it shows increased risk in another (e.g., transportation risks or potential impacts to groundwater). For example, the Decentralized Alternatives put more groundwater at risk, while lessening transportation risks. Clean, healthy water is essential to survival on the planet, and since this is all the water we have, keeping it safe is paramount.

Response
As pointed out by the commentor, the selection of different alternatives would result in different impacts. For example, the magnitude of the transportation-related activities varies with each alternative, ranging from minimized transportation of waste for Decentralized Alternatives to significant transportation of waste for some Centralized Alternatives.

To the extent possible, the WM PEIS analyzes groundwater resources impacts as well as transportation risks. DOE considered these and other impacts in its identification of preferred alternatives for each waste type. Actual programmatic decisions will be documented in Records of Decision published in the *Federal Register*. When selecting locations for waste management facilities on selected sites, DOE will consider the results of existing relevant and required new sitewide or project-level NEPA reviews.

Comment (3349)
NEPA requires an EIS to present the impacts of the proposal, alternatives to the proposal, and preferred alternatives. DOE did not identify a preferred alternative for low-level waste treatment or disposal, transuranic waste treatment, or low-level mixed waste disposal. It is impossible to accurately comment on the proposals if we do not know exactly what is being proposed.

Response
The CEQ regulations that implement NEPA require that preferred alternatives be identified in Final EISs. Preferred alternatives need only be identified in draft EISs if the agency has a preference at the time the draft is prepared.

DOE's proposed action is the improved management of five types of waste. In the Draft WM PEIS, DOE outlined four broad categories of alternatives for managing these waste types, and identified preferred alternatives for low-level mixed waste, high-level waste, and hazardous waste. DOE sought public comments on the alternatives and also invited members of the public to identify their preferences for waste management alternatives and provide input on decision criteria to assist DOE in selecting preferred alternatives. DOE's preferred alternatives for all waste types and the reasons they are preferred are identified in Section 3.7 in Volume I of the Final WM PEIS.

3.1 General Comments, Not Waste-Type Specific

Comment (3350)
Commentors are concerned that DOE will present "hybrid" alternatives in the Final WM PEIS that were not proposed in the draft. This would violate NEPA and would deprive commentors of the opportunity to be fully informed concerning the proposals.

Response
NEPA requires DOE to analyze reasonable alternatives. The WM PEIS alternatives were developed and defined to incorporate all possible actions of DOE concerning waste management. As described in Volume I, Section 3.4, of the WM PEIS, the waste management configuration that DOE ultimately selects for a particular waste type is not necessarily limited to one of the alternatives presented. A hybrid alternative could be developed that would incorporate components from one or more of the alternatives analyzed. For example, DOE may choose to treat a particular waste type on a regionalized basis and dispose of it at a centralized location. Another example would be to select a disposal site analyzed under a centralized alternative and additionally select a second disposal site analyzed under a regionalized alternative.

The preferred alternatives are identified in Volume I, Section 3.7, of the Final WM PEIS. The waste-type chapters provide the impacts for the preferred alternatives. (See Volume I, Sections 6.16, 7.16, 8.16, 9.16, and 10.16, of the Final WM PEIS.)

Comment (3351)
All of the WM PEIS alternatives are limited to treating, storing, or disposing of waste. This organization of the PEIS is questionable. All alternatives basically propose to do the same thing, but in different places. The PEIS should present the environmental impacts of the proposal and the alternatives in comparative form, and sharply define the issues and provide a clear basis for choosing among options. By lumping all of the potential activities under three broad terms, DOE robs the public of information about the sharp differences in all of the reasonable alternatives of what can be done with the waste. For example, what about the alternative of detoxification? Is this a reasonable alternative? If detoxification is not a reasonable alternative, then DOE should explain why.

Response
DOE designed the WM PEIS to assist in the formulation of a broad national waste management strategy, including the future configuration of the DOE waste management complex. Although the configuration is analyzed on the basis of impacts related to treatment, storage, and disposal operations using generic technologies, the study does not focus on specific technologies or technology selection (e.g., detoxification). Appendix H in Volume IV of the WM PEIS describes several technologies that might be used to properly manage these wastes once the sites and configuration are selected. Hazardous waste and low-level mixed waste could contain toxic constituents. These types of waste are treated and disposed of in accordance with RCRA requirements.

Comment (3552)
The WM PEIS analyzes too many alternatives. The decision to develop multiple options unique to each waste type results in an unmanageable number of alternatives. It is not clear how the different alternatives represent a range of environmental, cultural, human health, and socioeconomic impacts.

3.1 General Comments, Not Waste-Type Specific

Response
The four broad categories of alternatives considered in the WM PEIS are the No Action, Decentralized, Regionalized, and Centralized Alternatives. However, the number of possible alternatives under these broad categories is vast, because five waste types, three management activities (treatment, storage, and disposal), and 17 major sites are evaluated. Thus, there are many possible combinations for the numbers and locations of DOE sites for treatment, storage, and disposal facilities. To narrow these combinations to a level that would permit meaningful analysis, DOE selected representative alternatives for analysis under each category.

DOE developed and defined the alternatives based on waste origin, and character; current and projected volumes and locations within the DOE complex; existing facilities and capabilities; and specialized treatment and disposal requirements. Evaluation of each alternative included impacts from the alternatives, such as human health risks; environmental, cultural, transportation and socioeconomic impacts; and costs associated with the range of waste treatment, storage, and disposal activities available to DOE.

Comment (4053)
The weapons and nuclear fuel complexes continue to produce tons of liquid and solid radioactive wastes that require temporary storage at the sites where they are generated. After a few years, these sites will inevitably evolve into permanent waste storage facilities that will be used to take in wastes from other facilities or civilian generators, whether local communities accept this outcome or not. The WM PEIS does not offer the public genuine alternatives to the continued environmental destruction of this country by further weapons research, development, and testing.

Response
This WM PEIS is a nationwide examination of the potential environmental impacts of managing five types of radioactive and hazardous wastes that result primarily from nuclear defense activities--the development, production, and testing of nuclear weapons at a variety of sites located around the United States. DOE needs to enhance its capability for managing its current and anticipated volumes of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste in order to ensure continued safe and efficient management of these wastes, to comply with all applicable Federal and State laws, and to protect public health and safety and the environment. For each waste type, facilities are needed to treat, store, and dispose of the waste. For the first time, DOE has attempted not only to examine in an integrated fashion the impacts of Department-wide waste management decisions for each waste type, but also the cumulative impacts for all the waste facilities at a given site.

Comment (4442)
The WM PEIS Summary document should explain why Regionalized and Centralized Alternatives involving sites that do not have the largest volumes of waste were eliminated. This could involve quantitative sensitivity analyses of the tradeoffs between transportation risks (assuming maximum use of trains for waste transportation) and any differences in the risk to the maximally exposed individual (and to the population for the general public versus workers), if a given amount of waste is treated at one site versus another. The Draft WM PEIS did not provide definitive analysis showing that siting alternatives involving sites with the largest volumes of waste correspond to those that minimize impacts on the general public and the environment. This issue should be evaluated.

3.1 General Comments, Not Waste-Type Specific

Response
Section 3.5 in Volume I of the WM PEIS states that in order to determine reasonable proposed sites for waste management facilities, DOE determined where the largest waste volumes are located and where transportation requirements would be minimized. However, waste volume was not the sole criterion used to identify sites for analysis. The character of the waste, specialized treatment requirements, and existing facilities were also taken into account. For example, some wastes that require special treatment, such as remote-handled low-level mixed waste (LLMW), alpha-contaminated low-level waste, and remote-handled transuranic waste, were analyzed separately, and treatment sites were chosen for analysis based on the volumes requiring special treatment, rather than on total volumes. In some cases, treatment facilities could be used for more than one waste type. Therefore, some sites were evaluated as candidate sites even where the volume of a particular waste type was not among the largest.

An advantage of regionalizing or centralizing waste management at the sites with the largest waste volumes is that these are generally larger sites with large buffer zones between the waste management facilities and the site boundaries. However, the Final PEIS now includes the results of a collective offsite population impacts analysis based on hydrology and site size/population density factors (Section 5.4.1.2.3 in Volume 1). This analysis indicates that sites like Hanford, NTS, INEL, LANL, and Pantex might be better suited for disposal than other sites.

3.2 General Comments, Waste-Type Specific

Comment (2870)
Why is there no preferred alternative for transuranic waste, since most of the transuranic waste is mixed waste and subject to the Site Treatment Plans, as is the low-level mixed waste? Note also, low-level mixed waste and transuranic waste alternatives should reflect the recent court decision, and DOE commitment to build a mixed waste processing facility at INEL.

Response
Approximately 60% of transuranic waste is mixed waste. However, for purposes of the WM PEIS analysis, all transuranic waste was considered to be mixed waste. The uncertainties associated with the treatment of transuranic waste and the WIPP facility at the time the Draft WM PEIS was developed did not allow for selection of a transuranic waste preferred alternative. While the Draft WM PEIS did not provide a preferred alternative for transuranic waste, the Final WM PEIS, consistent with the requirements of NEPA, identifies the preferred alternative for transuranic waste treatment and storage in Volume I, Section 3.7.

NEPA requires DOE to analyze all reasonable alternatives, even those that may not necessarily reflect" court decisions. Low-level mixed waste treatment at INEL was considered in the alternatives analyzed. DOE assumes the court decision referred to in the comment is the Consent Order based on the settlement agreement of October 1995 that resolved litigation between the State of Idaho and DOE and the Department of the Navy. DOE issued an amended Record of Decision for the SNF/INEL EIS to reflect the provisions of this Consent Order, which includes the requirements for DOE to commence building and operating a mixed waste treatment facility at INEL.

3.2.1 Low-Level Mixed Waste

Comment (2436)
There is essentially no range of alternatives for the treatment and disposal of remote-handled low-level mixed waste. In all alternatives, this waste is treated and disposed of at Hanford, INEL, ORR, and SRS.

Response
Remote-handled wastes often require specific technologies for safe treatment and disposal that are not routinely available at all sites. Because of concern for public health and safety and because transporting remote-handled waste is very costly, DOE is also committed to reducing the amount of remote-handled wastes transported between facilities. The WM PEIS analyzed remote-handled low-level mixed waste at the four sites where the waste currently exists--Hanford, INEL, ORR, and SRS. Because such wastes often require specific technologies for safe treatment and disposal, it would be unreasonable to consider transporting remote-handled wastes to other sites that have little, if any, experience with these wastes.

Comment (3017)
DOE should evaluate the low-level mixed waste alternative that replicates the Federal Facility Compliance Act (FFCAct) activities that the sites and states have committed to in consent agreements.

Response
To ensure that any possible configurations in the Site Treatment Plans are included in the WM PEIS analysis, DOE evaluated seven broad alternatives for management of low-level mixed waste (see Volume I, Chapter 6). Volume I, Section 3.7, of the Final WM PEIS provides the preferred alternative for low-level mixed waste management, along with the supporting rationale.

3.2.2 Low-Level Waste

Comment (1672)
For the Hanford Site and NTS, costs are similar for the centralized disposal of all low-level waste without treatment when rail or truck transportation is used. The next most cost-competitive option is $2 billion more expensive. The most cost-effective Regionalized Alternative would probably be disposal facilities at NTS and Hanford, but this alternative was not included.

Response
To the extent possible, the Regionalized Alternatives were selected to include sites that were centrally located in the regions analyzed. Therefore, the two-site Regionalized Alternatives incorporated an eastern site and a western site. This logic is supported by the waste volumes. According to Volume I, Figure 7.1-1, 981,300 cubic meters of low-level waste are located in the east and 345,100 cubic meters are located in the west.

As described in Section 7.14, the total costs of low-level waste Regionalized Alternative 7 (disposal at SRS and NTS) would be $13.9 billion--$2.8 billion more than the $11.1 billion Centralized Alternative 2 (disposal at NTS). Truck transport costs for Regionalized Alternative 7 would be $0.67 billion; for Centralized Alternative 2 they would be $2.25 billion. Assuming that approximately 60% of the $1.56 billion difference in truck transportation costs is due to shipping the eastern sites' wastes to a western site (NTS), similar shipping charges would result, regardless of whether wastes were shipped to NTS or Hanford. Therefore, an alternative that regionalizes disposal at NTS and Hanford is likely to cost more than an alternative that allows regionalized disposal at SRS and NTS or Hanford. Of course, if the geographic distribution of waste volumes changed substantially, these relationships could also change.

Comment (2048)
A commentor at the Brookhaven National Laboratory (BNL) public hearing stated that the Low-Level Radioactive Waste Siting Commission has prohibited the siting of disposal sites for radioactive wastes over a sole-source aquifer.

Response
DOE will comply with all applicable Federal and State regulations when siting waste management facilities. The WM PEIS identifies the lower aquifer system (Magothy and Raritan Formations) and the Pleistocene Upper Glacial Aquifer as sole-source aquifers and as part of the affected environment for BNL. The existence of these sole-source aquifers is, therefore, considered in the WM PEIS analysis.

Comment (2867)
In Volume I, Chapter 7, the alternatives listed do not analyze the impacts of the importation, treatment, and disposal of an intermediate amount of low-level waste to INEL. In the footnotes for all low-level waste alternatives except No Action, alpha low-level waste would be treated and disposed of at the closest of five sites. The alpha low-level waste stored at INEL is considered to be low-level mixed waste and will be treated along with the transuranic waste stored there, and both disposed of in the WIPP facility. In addition, the low-level waste waste acceptance criteria for the current disposal facility prohibits the disposal of low-level waste containing more than 10 nanocuries per gram of transuranic radionuclides.

3.2.2 Low-Level Waste

Response
DOE used standard definitions for each of the waste types addressed in the WM PEIS that do not reflect the subtleties of site-specific definitions or waste characteristics. Additionally, the programmatic nature of the WM PEIS did not allow for the inclusion of site-specific waste acceptance criteria.

3.2.3 Transuranic Waste

Comment (39)
It does not seem reasonable to ship transuranic waste (TRUW) from INEL to the Hanford Site or to the Oak Ridge Reservation (ORR) for treatment and then to ship it back to New Mexico for storage, when INEL is one of the four sites with the largest volume of transuranic waste.

Response
Under the Decentralized Alternative and all Regionalized Alternatives, INEL would treat its own contact-handled TRUW and then transport the treated waste to WIPP for disposal. INEL has more contact-handled TRUW than any other DOE site. However, the Hanford Site is estimated to have approximately 10 times more remote-handled TRUW than INEL; thus, the Regionalized Alternatives assume that INEL would transport its remote-handled TRUW to the Hanford Site for treatment prior to disposal at WIPP. Different facilities are used for treatment of remote-handled TRUW and contact-handled TRUW, and the consolidation of treatment of remote-handled TRUW at the site with the greatest quantity of that waste type (Hanford) is a reasonable alternative. Under none of the TRUW alternatives described in Volume I, Section 8.3, does INEL ship TRUW to ORR for treatment.

Comment (190)
DOE should modify the transuranic waste No Action Alternative to (1) include storing plutonium-238 onsite until radioactive decay decreases the high exposure potential during treatment and handling and (2) include transporting plutonium-239 directly to WIPP, the designated repository for transuranic waste, thereby reducing treatment and handling costs.

Response
The WM PEIS alternatives include a No Action Alternative under which transuranic waste would be stored onsite under the assumption that WIPP will not be available during the 20-year period of analysis. Shipment of plutonium-contaminated transuranic waste would not be consistent with the definition of the No Action Alternative. Storage of plutonium-contaminated transuranic waste is consistent and was evaluated under the No Action Alternative for the 20-year period of analysis. The impacts of storage beyond 20 years are analyzed as part of the No Action Alternatives in the WIPP SEIS-II. Other alternatives consider the impacts of treating transuranic waste to various treatment levels and at various sites prior to shipment to WIPP for final disposal. Finally, under the Centralized Alternative, DOE evaluated the impacts of shipping all of the contact-handled transuranic waste to WIPP for both treatment and disposal. Some level of treatment was assumed at each site for all alternatives involving transportation, to ensure safe shipment of the transuranic waste and to meet regulatory requirements for transportation, as well as to meet acceptance criteria at WIPP. Therefore, for example, some treatment of plutonium-238 is assumed in every alternative with transportation. DOE did not single out individual radionuclides for separate management at each site; this level of complexity was beyond scope of this analysis for purposes of the programmatic decisions being considered. However, such management decisions would be appropriate for each site, and the WM PEIS notes that plutonium-238 would require special mitigation measures beyond those considered in the WM PEIS.

Comment (915)
DOE's preference for transuranic waste treatment and storage sites is not clear.

3.2.3 Transuranic Waste

Response
The Draft WM PEIS did not identify a preferred alternative for transuranic waste. NEPA and CEQ regulations only require the agency to identify a preferred alternative in a draft EIS if the agency has a preference at the time the draft is released for a public review. However, the agency must identify a preferred alternative in its final EIS. DOE identifies its preferred alternative for transuranic waste treatment and storage and the reasons it was designated the preferred alternative can be found in Volume I, Section 3.7, of the Final PEIS.

Comment (1564)
A commentor is concerned that the Centralized Alternative for transuranic waste treatment at WIPP was not previously evaluated.

Response
The PEIS includes a Centralized Alternative for transuranic waste, under which contact-handled transuranic waste would be treated at the location of final disposition. DOE assumed this would be WIPP. DOE identifies its preferred alternative for transuranic waste treatment and the reasons it was designated the preferred alternative can be found in Volume I, Section 3.7, of the Final PEIS. Selection of the Centralized Alternative for transuranic waste would necessitate a project-level NEPA review for the treatment facility.

Comment (2385)
DOE should analyze more fully the treatment options considered [e.g., as presented for the transuranic waste (TRUW) Centralized Alternative]. The WM PEIS fails to address the feasibility of safe shipments of untreated plutonium-238 combustible wastes from the Savannah River Site (SRS) and Los Alamos National Laboratory (LANL) to an offsite facility.

Response
Volume I, Section 8.3.4, describes the TRUW Centralized Alternative. Under this alternative, SRS would ship all of its TRUW to WIPP for treatment to meet land disposal restrictions and for disposal. No onsite treatment of TRUW is assumed at SRS under this alternative. LANL would ship its contact-handled TRUW to WIPP for treatment to meet land disposal restrictions and for disposal. LANL would ship its remote-handled TRUW to Hanford for treatment and then to WIPP for disposal. Treatment to meet land disposal restrictions would include thermal treatment of combustibles.

As described in Volume I, Section 8.2.3, DOE assumed that facilities would be made available at sites requiring retrieval, characterization, treatment, repackaging, and shipment of TRUW to meet U.S. Department of Transportation or RCRA transportation regulations, and to meet State shipping and receiving requirements. Therefore, DOE assumed that plutonium-238 combustible wastes would be treated, if necessary, and, therefore, would meet all shipping requirements and be safe to ship.

Comment (2405)
Section 6.2 of the WM PEIS Summary document states that SRS would receive transuranic waste from other sites under some alternatives. Please describe what SRS will be asked to take and from where.

Response
Volume I, Section 8.3, of the WM PEIS presents details of the transuranic waste alternatives evaluated, including the Regionalized Alternatives that involve shipment of waste from other sites to SRS for

3.2.3 Transuranic Waste

treatment. Under the Regionalized Alternatives, SRS would treat contact-handled transuranic waste from six other sites: ANL-E, the Mound Plant, ORR, Paducah Gaseous Diffusion Plant (PGDP), the University of Missouri, and West Valley Demonstration Project (WVDP). The contact-handled transuranic waste from these sites would comprise about 17% of the transuranic waste to be treated at SRS under these alternatives. Under the No Action, Decentralized, and Centralized Alternatives, no transuranic waste would be shipped to SRS.

Comment (3146)
The WM PEIS does not provide an adequate basis for proceeding with WIPP, nor does it consider the range of reasonable alternatives to WIPP. Although the number of fatalities and costs suggest implementing the No Action Alternative for transuranic waste (TRUW), DOE is still committed to begin emplacement of wastes at WIPP, reasoning that extended storage under the No Action Alternative is not in compliance with RCRA. The WM PEIS must analyze alternatives for storage that would comply with RCRA.

Response
DOE believes that the WM PEIS includes reasonable alternatives sufficient to support programmatic decisions on TRUW treatment and storage. The No Action Alternative does evaluate, for the period of analysis (20 years), the impacts if there is a delay in the receipt of TRUW at WIPP and waste continues to be stored at the generating sites. As described in Volume I, Section 1.1, the WM PEIS analyzes alternatives for treating and storing TRUW preparatory to proposed disposal at WIPP. The WM PEIS does not study the repository itself, nor will it be used to support decisions on TRUW disposal at WIPP.

The decision of whether to store TRUW or treat TRUW for disposal is contingent on the DOE disposal decision for WIPP, not on whether continued TRUW storage would comply with RCRA. The disposal impacts from operating WIPP as a TRUW repository are addressed in the WIPP SEIS-II, which analyzes the potential environmental impacts associated with the operation of WIPP and the minimum level of TRUW treatment needed. The WIPP SEIS-II No Action Alternatives, in part, evaluate the continued management of TRUW at the generator and/or treatment sites, and decommissioning of the WIPP facility, if TRUW were not disposed of at WIPP. A discussion of the relationship between the WM PEIS and the WIPP SEIS-II is provided in Volume I, Section 1.8.1.

Comment (3148)
The WM PEIS contains no discussion of storage and disposal alternatives for the volumes of retrievably stored transuranic wastes that do not meet the WIPP waste acceptance criteria or for other reasons could not be sent to WIPP.

Response
For purposes of analysis, the WM PEIS assumes that all transuranic waste shipped to WIPP for disposal will meet the WIPP waste acceptance criteria. Once the waste acceptance criteria are finalized, this could mean that certain transuranic waste would have to be treated to meet these criteria. Only the wastes that meet final WIPP waste acceptance criteria will be accepted for disposal at WIPP, if WIPP becomes operational as a transuranic waste repository.

3.2.3 Transuranic Waste

Comment (3150)
The WM PEIS does not include a reasonable Centralized Alternative for transuranic waste, because the Centralized Alternative considered assumes that TRUW would be treated at WIPP, even though the WIPP Land Withdrawal Act does not authorize such an activity.

Response
Under the Centralized Alternative, DOE would not ship all transuranic waste to WIPP for treatment. DOE would ship all contact-handled transuranic waste to WIPP for treatment to meet land disposal restrictions and for disposal and remote-handled transuranic waste would be shipped to the Hanford Site and ORR for treatment to meet land disposal restrictions prior to disposal at WIPP. Consolidation of remote-handled transuranic waste at one site for treatment was not considered because a large number of trips would be required, and most remote-handled transuranic waste requires extensive treatment (but not necessarily to meet land disposal restrictions) before it can be shipped.

Agencies are required under NEPA to analyze reasonable alternatives, even if the alternatives are not within the agency's jurisdiction (e.g., in conflict with current law). While the WIPP Land Withdrawal Act does not make provision for treatment activities at WIPP, for purposes of analysis and compliance with NEPA, DOE considered WIPP to be a reasonable WM PEIS siting alternative. Consideration as a siting alternative in the WM PEIS does not mean a site will be selected to perform waste management activities.

Comment (3212)
The WM PEIS does not analyze options to WIPP as the national repository for transuranic waste. WIPP might not open, and even if it does, it will not hold all of the transuranic waste in the DOE complex (this includes transuranic waste that is currently buried, plus waste that will be generated from remediation efforts). DOE should analyze all options for transuranic waste, including other disposal sites, extended monitored retrievable storage at the point of generation, regionalized and centralized storage, and the adequacy of current treatment standards (WIPP waste acceptance criteria) for such storage. The impacts of transporting waste to WIPP, and other options, should be analyzed in the WM PEIS.

Response
DOE believes that the WM PEIS includes reasonable alternatives to support programmatic decisions on national transuranic waste treatment and storage configurations. The WM PEIS does not however, analyze the environmental impacts of disposal at WIPP or alternative locations for a geologic repository. For purposes of analysis, DOE assumed that WIPP will become operational. Although the WM PEIS does not evaluate WIPP or its suitability for disposal, the No Action Alternative does evaluate for the period of analysis (20 years) the impacts if there is a delay in the receipt of transuranic waste at WIPP and waste continues to be stored at the generating sites.

DOE is analyzing impacts of disposal and continued storage of transuranic waste in the WIPP SEIS-II and will make both disposal and transuranic waste treatment decisions based on the WIPP SEIS-II analysis. The WIPP SEIS-II No Action Alternatives evaluate the continued management of transuranic waste at the generator and/or treatment sites, and decommissioning of the WIPP facility. These alternatives analyze environmental impacts if transuranic waste were not disposed of at WIPP. The WM PEIS will provide a basis for decisions on where any transuranic waste treatment and storage facilities would be sited.

3.2.3 Transuranic Waste

It is true that during the 35-year planned operational life of WIPP, the amount of transuranic waste projected to be available for disposal could exceed the statutory capacity of WIPP. DOE is in the early planning stages of evaluating options for disposal of this excess transuranic waste.

Comment (3609)
Legally, can WIPP be used as the central treatment location? Can liquids go to WIPP? Even if they are grouted? Can soils go to WIPP? Even if they are grouted or organically solidified?

Response
Agencies are required under NEPA to analyze reasonable alternatives, even if the alternatives are not within the agency's jurisdiction (e.g., in conflict with current law). While the WIPP Land Withdrawal Act does not provide for treatment activities at WIPP, for purposes of analysis and compliance with NEPA, DOE considered WIPP to be a reasonable WM PEIS siting alternative. Consideration as a siting alternative in the WM PEIS does not mean a site will be selected to perform waste management activities.

Current planning basis WIPP waste acceptance criteria would limit liquid waste forms at WIPP to less than 1% per container. Grouted or organically solidified transuranic waste forms would be acceptable at WIPP if they met the other requirements of the waste acceptance criteria. The WIPP SEIS-II evaluates what types of transuranic waste, if any, would be disposed of at WIPP and what type of treatment would be required for disposal of waste at WIPP.

Comment (3620)
If the repackaging of transuranic waste has or will commence under the No Action Alternative, then we find the characterization of the No Action Alternative unsatisfactory as well as an abuse and violation of NEPA requirements. Repackaging is in itself a major action that could significantly effect the environment. Also, if repackaging of transuranic waste has or will commence under the No Action Alternative, then the only difference between the No Action Alternative and the other alternatives is simply transportation of the wastes.

Response
As described in Section 8.3.1, the No Action Alternative evaluates treatment to WIPP-WAC only for future transuranic waste and does not assess the impacts of removing transuranic waste from retrievable storage. However, as stated in WM PEIS Section 8.14, under the No Action Alternative, DOE would only treat waste that required urgent repackaging to prevent leakage at the site. The packaging would not be sufficient to allow transportation to other sites.

Comment (3633)
In Section 8.3.5, why not calculate the cross-country trips for remote-handled transuranic waste shipments for extensive treatment to be able to compare with the other alternatives. This is another example of DOE's selective calculations to show only what outcome DOE wants.

Response
DOE did not calculate cross-country trips for remote-handled transuranic waste shipments because a single-site Centralized Alternative for remote-handled transuranic waste treatment was not considered to be a reasonable alternative for detailed analysis in the WM PEIS. Because so much remote-handled transuranic waste would have to be shipped across the country under such an alternative, an

3.2.3 Transuranic Waste

unreasonable amount of pretreatment cost would have to be incurred to ensure acceptable transportation risks. Much lower costs and limited transportation risks were expected to accrue in the consolidation alternative that is analyzed, under which DOE would treat remote-handled transuranic waste at the two sites - the Hanford Site and ORR - where approximately 90% of current and projected inventory is located.

3.2.4 High-Level Waste

Comment (2256)
I do not believe that this is a document that can lead to waste management decisions, particularly in the case of the high-level radioactive waste. It is based on privatization plans that might be able to get underway, that might be able to build a facility, that might be able to vitrify. It is premature to include in this PEIS information about how the vitrified waste will be stored.

Response
DOE believes that the WM PEIS will be a useful tool in the waste management decisionmaking process. Treatment of high-level waste is not analyzed in the WM PEIS, but is analyzed in other sitewide or project-level NEPA documents. Disposal of high-level waste will be analyzed in the Geologic Repository EIS. The WM PEIS, thus, looks only at the impacts of storing vitrified high-level waste.

The PEIS has been modified (see Volume I, Section 1.7.4) to acknowledge the potential use of privatized facilities for the management of the five waste types considered, including high-level waste. The WM PEIS does not preclude the use of waste management facilities constructed and operated by private entities on DOE sites at DOE's direction. Proposals to use commercial or privatized facilities for waste management decisions would be analyzed in sitewide or project-specific NEPA documents.

Both the Defense Waste Processing Facility at SRS and the West Valley Demonstration Project began vitrifying high-level waste in 1996. Vitrification at these facilities is supported by existing site-specific NEPA documentation. DOE will store the canisters containing the vitrified waste until a geologic repository is ready to accept them for final disposal.

Comment (2407)
The scheduled date of 2015 for availability of the high-level waste geologic repository seems early. Include a few sentences on selection of this date for the WM PEIS and what contingency planning is available if a later date is needed and what contingency planning exists for the lack of a repository. The WM PEIS should include analysis of the impacts of a delayed date for the repository (for example, 2035 or 2050) due to the uncertainties associated with the opening date.

Response
As stated in Volume I, Section 9.2.2, of the WM PEIS, although a geologic repository for the permanent disposal of high-level waste is scheduled to begin accepting DOE-managed high-level waste in 2015, for purposes of the WM PEIS analysis, DOE also analyzed high-level waste canister storage requirements should the opening of the repository occur after 2015. For example, Table 9.4-4 presents risk results for the scenario of an opening after 2015 as incremental annual storage risks.

3.2.5 Hazardous Waste

Comment (41)
Referencing the Draft PEIS Summary document, Section 8.2.2, the commentor asked, "Why start incineration of hazardous wastes at LANL, ORR, and SRS and stop at INEL? LANL currently does no onsite treatment. The discussion states a preference for expansion of current treatment sites versus building new ones. Also, the PEIS generally states that it is cheaper to transport wastes than to build new facilities.

Response
For the Decentralized Alternative, DOE assumed thermal treatment at three sites with existing or planned incinerators--LANL, ORR, and SRS. To account for the decision to retire the Controlled Air Incinerator at LANL and the decision to continue operation of the Waste Experimental Reduction Facility at INEL, DOE has revised the WM PEIS (see Section 8.2.2 of the Summary document and Section 10.3.2 in Volume I) to replace LANL with INEL as a candidate for onsite treatment of hazardous waste under the Decentralized Alternative.

Comment (2034)
The WM PEIS hazardous waste analysis is based on the estimate that 90% of the total hazardous waste in a given year is generated by 11 or fewer DOE sites (Volume I, Section 10.1.2). However, the WM PEIS also states that the 11 sites are not always the same every year. Because of the variability, is the selection of the 11 sites from one particular year appropriate for the analysis of impacts, rather than the sites that have contributed 90% of the waste for the entire time period of data accumulation?

Response
The objective of the WM PEIS hazardous waste evaluation was to determine impacts for a policy of greater onsite treatment versus continued reliance on commercial vendors. This evaluation used representative sites and treatment technologies. Based on a review of RCRA uniform hazardous waste shipping manifests, facility reports, and hazardous waste generation and disposal information dating back to 1984, 11 sites typically account for 90% of DOE hazardous waste, but the sites differ from year to year. Thus, DOE selected the 11 sites for the WM PEIS analysis based on 1991 and 1992 data, which were the most current data when the PEIS analysis began. DOE believes that recent waste generation rates are more likely to reflect future trends than rates from the 1980s. Thus, DOE believes that its selection of 11 hazardous waste sites based on the 1991 and 1992 waste generation rates is adequate for the programmatic decisions it must make.

Comment (2036)
Under the No Action Alternative, 3% of the hazardous waste would be treated at two DOE sites and the remainder would be treated at commercial facilities. Under the Decentralized Alternative, 11% would be treated at three DOE sites, and the remainder sent offsite. The differences in the two options are so small that they were discussed together. We do not believe there is enough difference in the two alternatives to justify calling the Decentralized Alternative a meaningful option.

Response
The WM PEIS hazardous waste analysis is designed to evaluate the impacts from onsite treatment of waste, with emphasis on organic wastes requiring thermal destruction. The alternatives were selected to provide representative results for the range of onsite options. For the Final PEIS analysis, the alternatives evaluate treatment onsite of 3%, 9%, 50%, and 90%, respectively, of the DOE RCRA waste (excluding wastewater). The Decentralized Alternative uses three sites that have exciting or

3.2.5 Hazardous Waste

planned thermal treatment facilities. DOE recognizes that the differences in hazardous waste volumes between the No Action and Decentralized Alternatives are small. However, evaluating both alternatives is consistent with the overall framework of the four broad categories of alternatives. DOE added text to Volume I, Section 10.3, to better explain the alternatives.

Comment (2039)
Under Regionalized Alternative 1, clarify how DOE determined the assumption that two-thirds of the hazardous waste would be sent to the regional hubs and the other one-third sent to commercial incinerators.

Response
Section 10.3.3 in Volume I describes Regionalized Alternative 1 for hazardous waste treatment. Under this alternative, hazardous waste (other than wastewater) generated by 11 major DOE sites that could be treated through organic removal/recovery technologies (such as incineration) would be sent to five regional centers--Hanford, INEL, LANL, ORR, and SRS--for treatment.

The regional centers would treat two-thirds of the received hazardous waste and send the other one-third to a commercial facility. The two-thirds/one-third split in waste treatment discussed above is an analytic assumption used to mathematically achieve the 50% onsite treatment for Regionalized Alternative 1. Approximately 75% of the waste being treated (excluding wastewater) is incinerable; thus, to achieve a 50% onsite treatment rate for both incinerable and non-incinerable waste, two-thirds of the incinerable waste must be treated onsite.

Comment (2040)
A centralized alternative was not explored because the current policy is the use of decentralized or regionalized commercial facilities. The decision was, therefore, not to use an alternative that could not be compared to current practice. Considering that Regionalized Alternative 2 uses only two DOE facilities to treat 90% of the hazardous waste, going to one centralized site does not appear to be a major difference. DOE's current practice should not preclude it from exploring a centralized option.

Response
Section 10.3.4 in Volume I of the WM PEIS states that a Centralized Alternative for hazardous waste management was not considered because for hazardous waste the decision of concern is whether DOE should continue to use commercial treatment facilities or construct its own. Since the hazardous waste analysis is designed to evaluate the level of onsite DOE versus offsite commercial treatment, only alternatives representative of various onsite treatment capacities were needed. DOE selected four representative alternatives to account for both the effects of site consolidation and a range of waste volumes (3%, 9%, 50%, and 90%, respectively, of non-wastewater treated onsite). These representative alternatives were considered adequate to evaluate the policy option of increased onsite treatment. DOE has added text to Volume I, Section 10.3.4, to better explain why the Centralized Alternative was not evaluated.

Comment (2860)
Volume I, footnote b to Tables 4-1 and 4-2, states that other sites also manage hazardous waste but were not analyzed in the WM PEIS. On what arbitrary basis can other hazardous waste generators be excluded? If any site manages any quantity of hazardous waste it should be included and noted in the WM PEIS. Furthermore, the WM PEIS must state the preferred alternative for handling hazardous

wastes from those sites currently excluded from the analysis, particularly BNL. In addition, the WM PEIS should state that any quantity of hazardous waste generated by BNL shall be transported offsite.

Response

DOE estimates that more than 90% of the total hazardous waste in a given year is generated by 11 sites. DOE focused its hazardous waste analysis on the 11 largest DOE generator sites, which are listed in Table 10.1-1 in Volume I of the WM PEIS. The 90% cutoff is appropriate to support programmatic decisions on hazardous waste, which would apply to BNL as well as the other generator sites. Because BNL is not one of those 11 largest generator sites, the PEIS does not specifically analyze hazardous waste at BNL, but the PEIS analysis is representative of DOE sites in general. DOE's preferred alternative for managing nonwastewater hazardous waste and the reason it is preferred is identified in Volume I, Section 3.7 of the WM PEIS.

3.3 Public Preferences for or Opposition to Management Alternatives

Comment (141)
A very small percentage (less than 4%) of the WM PEIS public comments expressed a preference for or opposition to a specific waste management alternative. Of those, about one-third were preferences for the Decentralized Alternative and about one-fifth were preferences for the No Action Alternative. The remaining expressions of preference or opposition were spread among the alternatives or combinations of alternatives.

Most of these commentors gave reasons for their support or opposition, some did not. Some commentors viewed and commented on the alternatives in a programmatic sense, without reference to a specific site. Most often, however, commentors expressed support for or opposition to an alternative from a site-specific perspective. That is, commentors were most expressive about alternatives in terms of what the alternatives would mean for their site, and not for the Nation as a whole. A few commentors identified preferences for alternatives to manage specific waste types; most did not. Public preferences for or opposition to specific waste management alternatives are summarized below. Note that public comments opposing the siting of new waste management facilities and activities at specific sites are addressed in Sections 3.5.1 through 3.5.17 in this volume.

No Action Alternative

Commentors who expressed a preference for the No Action Alternative, in general or for their site, gave one or more of the following reasons: It would "keep things the way they are;" waste would not be added to sites by bringing it from other sites; therefore sites and the general public would not be subjected to the potential for additional risks associated with transporting and receiving additional wastes. It would cost less than other alternatives. Additional wastes would not be brought to sites in seismically active areas, or areas subject to severe weather or flooding. Under other alternatives, leaks could impact drinking water, agriculture, and other resources. Moving wastes away from some sites might cause people to lose their jobs. The waste is "OK" where it is. "Nothing has happened yet"; if DOE tries to change the way it is currently managing waste, it "might mess up." "More bad than good" would come out of doing anything else. Sites already have enough wastes and communities do not want them to have more. Incineration is dangerous. There is not enough information in the PEIS to proceed with any other alternative.

Some commentors prefer the No Action Alternative specifically for management of high-level, transuranic, and hazardous waste types. Some commentors prefer the No Action Alternative for BNL because the site would continue treatment of wastewater and ship other wastes offsite.

Of the few commentors who oppose the No Action Alternative, some stated that they want change or they are concerned that waste will continue to accumulate, making the problem harder to solve.

Decentralize Alternative

Commentors who expressed a preference for the Decentralized Alternative, in general or for their site, gave one or more of the following reasons: It would reduce the risks and costs of large-scale transportation of wastes. It would be safer than other alternatives. It would present fewer risks to the environment. It would not involve any additional lands. Wastes would be managed where they are generated and additional wastes would not be taken away from or brought to sites. It would avoid increased risks that would result from bringing additional wastes to some sites. It would create jobs at

some sites, improve local economies, and bring additional revenues to local governments. Additional wastes would not be brought to sites in areas that are subject to earthquakes, severe weather (e.g., tornadoes), or other dangerous events (e.g., floods). Waste would not "pile up" in one place. It might cause sites to be more careful about what wastes they generate and concentrate on minimizing or eliminating the generation of waste. It would cause fewer negative impacts to local communities.

Many of the commentors who prefer the Decentralized Alternative stated that they do not want PGDP to be a decentralized site. One commentor prefers Decentralized or Regionalized Alternatives for treatment of low-level mixed waste and low-level waste at PGDP because it would increase benefits with minimal or no additional risks, and the experienced workforce at PGDP would be available to support treatment of these wastes.

A few commentors prefer the Decentralized Alternative specifically for the management of transuranic waste. One commentor prefers either the Decentralized or Regionalized Alternative for low-level waste because they appear to be the best compromise between cost and environmental protection.

Some commentors oppose the Decentralized Alternative for PGDP because it would cost too much and incineration would cause air pollution and health impacts. Some commentors oppose the Decentralized Alternative for ANL-E because it would cost too much; it would increase the risk of more accidents and leakage; more than 2,000 residents around ANL-E have signed a petition opposing this alternative, and this item should be put to a voter referendum in November. Some commentors oppose Decentralized Alternatives specifically for management of low-level mixed waste and low-level waste at BNL because of ongoing restoration efforts to remediate groundwater resources contaminated from past disposal of radioactive wastes.

Regionalized Alternatives

Several commentors prefer the Regionalized Alternatives, but not for PGDP. Reasons given for the preference were that regionalization "only hurts a few spots in the country;" PGDP already has enough nuclear waste; and waste should be removed from PGDP because of the potential impacts of an earthquake. One commentor suggested regionalizing the waste and distributing it evenly among the 37 locations, with a few exceptions (e.g., PGDP and LLNL) because of the potential for earthquakes. Conversely, some commentors prefer a Regionalized Alternative for PGDP because it would create jobs, put money into the local economy, and the site should be responsible for the waste it generates.

Some commentors prefer a Regionalized Alternative for ANL-E because it makes more sense from a cost perspective and a safety issue. Some commentors prefer a Regionalized Alternative because it would manage wastes at sites that have the largest volumes. Some commentors prefer Regionalized Alternatives specifically for management of low-level mixed waste and/or low-level waste (some specified because it would result in low fatalities and low estimated life-cycle costs). Some commentors prefer Regionalized Alternatives specifically for management of transuranic waste. Some commentors prefer the Regionalized and Centralized Alternatives for BNL because radioactive wastes should be stored in areas remote from biological habitats, highly populated areas, or a sole-source aquifer. One commentor prefers Regionalized or Centralized Alternatives at BNL specifically for management of low-level mixed waste, low-level waste, and hazardous waste.

3.3 Public Preferences for or Opposition to Management Alternatives

Commentors who expressed opposition to the Regionalized Alternatives, in general or for their site, gave one or more of the following reasons: There would greater danger from emissions from a leak. There would be risks from earthquakes at some sites; there are too many people living, working, going to school, etc., around some of the sites. Transportation risks are too great. Sites already have enough waste. People at some sites would lose their jobs. Regionalizing waste management would harm more places. If there are already impacts at a site, a Regionalized Alternative would add more impacts.

Centralized Alternatives

Some commentors prefer the Centralized Alternative. Most commentors who preferred the Centralized Alternative specified that they do not want waste to be centralized at their site or that they want waste removed from their site. One commentor supports centralization, but not at locations around water sources or near active fault lines. Another recommended that under the Centralized Alternative, separate sites be designated for management of low-level and high-level wastes. Those who prefer the Centralized Alternative gave one or more of the following reasons for the preference: There would be security advantages. Centralizing at one or two sites reduces the number of populated areas that could be affected by a spill. It would reduce the number of people exposed to radiation. It would be easier to monitor and control the waste if it is centralized. It would be easier to control a spill if waste is centralized. It would reduce the risk of an accident. Existing risks (human health risks, environmental contamination, etc.) associated with waste located at multiple sites would be eliminated. Some sites are in seismically active areas; removing wastes from these sites would eliminate the concern over radioactive releases that could be caused by earthquakes. Much of the waste is already concentrated at a few sites. It is worth the risk of a transportation accident to get the waste moved from multiple sites to one or two sites.

Commentors who expressed opposition to the Centralized Alternative, in general or for their site, gave one or more of the following reasons: transportation of wastes would present substantial risks to workers, the public, and the environment; a centralized site might become "overstocked" with wastes; and there could be impacts to those living near sites where waste is centralized.

One commentor stated that the Centralized Alternative is the least likely to work because attempts over the last 20 years to centralize wastes have failed. One commentor opposed the Centralized Alternative specifically for management of transuranic waste.

Response

DOE appreciates the public's response to its request for comments on the WM PEIS alternatives. Although DOE does not respond specifically to each point offered in these comments, DOE did consider these comments, and many other factors, in its selection of preferred alternatives to manage the five types of waste considered in the WM PEIS. The decision criteria and factors used in the selection of preferred alternatives are described in Volume I, Section 1.7.3 of the WM PEIS. DOE's preferred alternatives and the reasons they are preferred are described in Volume I, Section 3.7, and in the Summary document.

DOE's final decisions will be based on this PEIS and other considerations such as regulatory compliance, budget constraints, schedules, compliance with site agreements with States, national priorities, and other DOE studies. Decisions will be announced in Records of Decision to be published

in the *Federal Register*. If DOE selects a site for a waste management operation that prompts the need for new or expanded facilities, DOE would consider the results of relevant existing or required new sitewide or project-level NEPA reviews which examine potential environmental impacts in more detail.

Comment (530)
One commentor pointed out that many of the alternatives considered in the WM PEIS proposed shipment of offsite wastes to INEL. Such waste movement must be consistent with State of Idaho offsite waste principles as established in the Federal Facility Compliance Act (FFCAct) Site Treatment Plan (STP) Consent Order and with requirements mutually agreed upon in the Spent Nuclear Fuel Court Order of October 1995. Another commentor stated that the management of low-level mixed waste at INEL is effectively ruled out by those documents. Another commentor stated that DOE should know that the proposals within the WM PEIS and the Agreement with the State of Idaho are good, and that it is appropriate to handle spent nuclear fuel separately from other wastes at INEL.

Response
NEPA requires DOE to analyze reasonable alternatives. The mixed waste treatment alternatives described in the Draft WM PEIS are broad enough to envelop the potential environmental impacts of the configuration that results from the FFCAct process. The WM PEIS and the FFCAct STPs were developed in parallel, ensuring consistency and integration. The PEIS, which broadly analyzes DOE's waste management activities, provides the analysis of potential environmental impacts of the STPs developed for site-level mixed waste treatment decisions.

DOE revised Section 1.4 in Volume I of the WM PEIS to clarify that its compliance with applicable laws and regulations would necessarily include compliance with applicable site-specific plans, agreements and consent orders.

DOE considered these comments, along with many other comments and decision criteria and factors, in its selection of preferred alternatives to manage the five WM PEIS waste types. Section 3.7 in Volume I identifies DOE's preferred alternatives and the reasons they are preferred. However, these are not final decisions. Final decisions will be based on this PEIS and other considerations such as budgets, schedules, national priorities, and other DOE studies. Decisions will be documented in Records of Decision published in the *Federal Register*.

Comment (1760)
Until DOE develops a comprehensive national strategy, all wastes should be stored at the point of generation.

Response
Although the WM PEIS does not make actual programmatic waste management decisions, it analyzes and identifies preferred programmatic alternatives to manage wastes across the DOE complex, including the storage of wastes at the point of generation. Current DOE waste management activities are not confined to storage activities. DOE is pursuing other activities such as treatment and disposal.

DOE considered this and other public comments in its selection of WM PEIS preferred alternatives (see Volume I, Section 3.7).

3.3 Public Preferences for or Opposition to Management Alternatives

Comment (1899)
Onsite disposal may be cheapest in the long run because most sites are already large enough and meet government standards.

Response
The selection of the Decentralized Alternative, as advocated in this comment, would result in DOE management of waste where it is or where it will be generated, treated, or disposed of in the future. For low-level mixed waste and low-level waste disposal, the Decentralized Alternative is evaluated for the siting, construction, and operation of disposal facilities at 16 sites, including 10 sites that do not currently have low-level mixed waste or low-level waste disposal. The evaluation results indicate that costs are greatest for this alternative and decrease as the number of disposal sites decreases through the efficiencies realized from economies of scale. The Decentralized Alternative would require less transportation of wastes than the other alternatives, however, facility costs are greater than transportation costs. Low-level mixed waste costs are presented in Section 6.14 and low-level waste costs are presented in Section 7.14 in Volume I of the WM PEIS. An approach such as Decentralization might offer other particular economic benefits, such as jobs and income at many sites, but DOE must base its final decision on diverse environmental, economic, and regulatory issues.

Comment (2258)
We must not accept no action. Nuclear waste must be dealt with. DOE should have a comprehensive strategic plan that identifies all EISs and the decisions that will result. There has to be a cooperative approach.

Response
NEPA requires an EIS to include a discussion of a No Action Alternative. While such a "status quo" alternative could result in non-compliance with applicable laws and regulations, analysis of the No Action Alternative provides an environmental baseline against which the impacts of other alternatives can be compared. As evidenced by this PEIS, DOE is placing a high priority on "dealing" with its radioactive and hazardous wastes through a Department-wide strategy for safe and efficient management of these wastes.

The WM PEIS preferred alternatives and the reasons they are preferred are identified in Section 3.7 in Volume I of the Final PEIS. Actual programmatic waste management decisions will be announced in Records of Decision published in the *Federal Register*.

The decisions to be made subsequent to the Final WM PEIS will result in a comprehensive strategic plan for the management of the five waste types analyzed. DOE has coordinated the preparation of the WM PEIS with other EISs being prepared on similar proposals for strategic management of nuclear materials within DOE Section 1.8.1, Waste Management PEIS Relationship to Other Actions and Programs, has been updated to reflect the relationship and status of these other studies. To the extent the information was available for incorporation, Chapter 11 in Volume I of the PEIS addresses cumulative impacts resulting from other programs.

Comment (2328)
Incineration of low-level mixed waste at ORR under a Regionalized alternative, if properly carried out, is not an objectionable method. The destruction of nonradioactive organic contaminants is particularly

attractive, in contrast to burying them in landfills from which they might eventually leak into the environment.

Response
DOE agrees. Properly designed and operated incinerators are as or more effective than other treatment technologies, and DOE does not preclude their use at any site. EPA's combustion strategy states, "If properly designed and operated in compliance with regulatory standards, combustion is a technology that provides sound management of hazardous waste." Fact sheets on radioactive and mixed waste incineration published jointly by EPA and DOE (EPA 402-F-95-004 through 007, January 1996) recognize the effectiveness of incineration as part of the DOE Waste Management Program.

Comment (2345)
I prefer the No Action Alternative for hazardous waste rather than have DOE incinerate hazardous waste because of the vapors and secondary chemicals produced in the process. Has DOE considered their effects?

Response
Thank you for expressing this preference. NEPA requires DOE to analyze reasonable alternatives. DOE identifies its preferred waste management alternatives in Volume I, Section 3.7, of the WM PEIS.

DOE did evaluate the effects of the incineration emissions from treatment of hazardous waste, including combustion products. See Volume I, Chapter 10.

Comment (3201)
Please explain why the WM PEIS does not select a preferred alternative for the low-level waste. In selecting the preferred alternative from the alternatives proposed in the WM PEIS, DOE should select the alternative that minimizes the number of fatalities, including transportation fatalities.

Response
DOE did not have a preferred alternative for treatment and disposal of low-level waste when the Draft WM PEIS was issued in September 1995. NEPA does not require the identification of a preferred alternative in a draft environmental impact statement if such an alternative is not known at that point in time. In accordance with the requirements of NEPA, after consideration of the analyses presented in the WM PEIS, the decision criteria in Volume I, Section 1.7.3, and all public comments in the Draft WM PEIS, DOE has identified preferred alternatives for each waste type, including low-level waste, in Volume I, Section 3.7, of the Final WM PEIS. As described in Volume I, Section 1.7.3, DOE favors alternatives which reduce human health risk, including the number of vehicle accidents expected to occur during transportation of waste.

Comment (3556)
One commentor prefers the Decentralized Alternative for low-level mixed waste because LANL and Sandia National Laboratories-New Mexico (SNL-NM) would treat and dispose of their own low-level mixed waste and none would be brought to New Mexico from other sites. If SNL-NM is unable to site a protective disposal unit, the commentor's second choice for low-level mixed waste is Regionalized Alternative 1 because LANL would receive waste only from SNL-NM. If LANL is unable to site additional protective disposal units, the commentor's third choice is Regionalized Alternative 3, under which all low-level mixed waste and low-level waste would be disposed of at NTS.

3.3 Public Preferences for or Opposition to Management Alternatives

Response
DOE considered this, and many other comments and factors, in its selection of preferred alternatives to manage the five types of waste considered in the WM PEIS. The decision criteria and factors used in the selection of preferred alternatives are described in Volume I, Section 1.7.3, of the WM PEIS. DOE's preferred alternatives and the reasons they are preferred are described in Volume I, Section 3.7, and in the Summary document.

The preferred alternatives are not final decisions. Final decisions will be based on this PEIS and other considerations such as regulatory compliance, budget constraints, schedules, compliance with site agreements with States, national priorities, and other DOE studies. Decisions will be announced in Records of Decision published in the *Federal Register*. If DOE selects a site for a waste management operation that prompts the need for new or expanded facilities, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA reviews which examine potential environmental impacts in more detail.

Comment (3557)
A commentor prefers the Decentralized Alternative for treatment and disposal of low-level waste because LANL and SNL-NM would treat and dispose of their own low-level waste, and none would be brought to New Mexico from other sites. If SNL-NM is unable to site a protective disposal unit, the commentor prefers as a second choice Regionalized Alternative 2 because LANL would dispose of low-level waste only from SNL-NM. This commentor believes that the preferred alternative should be the same for low-level mixed waste and low-level waste because both wastes could be disposed of together once the hazardous component of low-level mixed waste is treated. The commentor does not understand why the No Action and Decentralized Alternatives for low-level mixed waste differ from those for low-level waste.

Response
The alternatives differ for low-level mixed waste and low-level waste because RCRA land disposal restrictions still apply to low-level mixed waste even after its hazardous components have been treated. Treated low-level mixed waste must be disposed of in a RCRA-permitted disposal facility. Since these restrictions do not apply to low-level waste, other or different alternatives are reasonable to be analyzed in the EIS.

DOE considered this, and many other comments and factors in its selection of preferred alternatives to manage the five types of waste considered in the WM PEIS. The decision criteria and factors used in the selection of preferred alternatives are described in Volume I, Section 1.7.3 of the WM PEIS. DOE's preferred alternatives and the reasons they are preferred are described in Volume I, Section 3.7, and in the Summary document.

The preferred alternatives are not final decisions. Final decisions will be based on this PEIS and other considerations such as regulatory compliance, budget constraints, schedules, compliance with site agreements with States, national priorities, and other DOE studies. Decisions will be announced in Records of Decision published in the *Federal Register*. If DOE selects a site for a waste management operation that prompts the need for new or expanded facilities, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA reviews which examine potential environmental impacts in more detail.

3.3 Public Preferences for or Opposition to Management Alternatives

Comment (3559)
For transuranic waste, a commentor prefers a modified Decentralized Alternative, under which SNL-NM would treat and store contact-handled transuranic waste and LANL would treat and store contact-handled and remote-handled transuranic waste; thus, SNL-NM would be added as an additional storage site.

Response
As shown in WM PEIS Volume I, Tables 8.3-1 and 8.3-2, SNL-NM is considered as a transuranic waste storage site under the No Action Alternative and a transuranic waste treatment site under the Decentralized Alternative.

DOE considered this, and many other comments and factors, in its selection of preferred alternatives to manage the five types of waste considered in the WM PEIS. The decision criteria and factors used in the selection of preferred alternatives are described in Volume I, Section 1.7.3, of the WM PEIS. DOE's preferred alternatives and the reasons they are preferred are described in Volume I, Section 3.7, and in the Summary document.

Final decisions will be based on this PEIS and other considerations such as regulatory compliance, budge constraints, schedules, compliance with site agreements with States, national priorities, and other DOE studies. Decisions will be announced in Records of Decision published in the *Federal Register*. If DOE selects a site for a waste management operation that prompts the need for new or expanded facilities, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA reviews that examine potential environmental impacts in more detail.

Comment (3958)
A commentor prefers the No Action Alternative for treatment, storage, and disposal of hazardous waste. Although not mentioned in the Draft WM PEIS, both LANL and SNL-NM are permitted under RCRA to treat hazardous waste.

Response
DOE considered this, and many other comments and factors, in its selection of preferred alternatives to manage the five types of waste considered in the WM PEIS. DOE's preferred alternatives and the reasons they are preferred are described in Volume I, Section 3.7, and in the Summary document. The decision criteria and factors used in the selection of preferred alternatives are described in Volume I, Section 1.7.3, of the WM PEIS. As identified by the commentor, LANL and SNL-NM are permitted for hazardous waste treatment. However, neither is currently incinerating hazardous waste, the generic treatment technology used in the WM PEIS.

3.4 Waste Management Sites

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(No comments were received for this section)

3.4.1 General Comments

Comment (30)
DOE's draft preferred alternatives will not have adverse environmental impacts for the Hampton Roads region.

Response
Thank you for your comment. DOE has identified preferred alternatives, and the reasons they are preferred, for all waste types in Volume I, Section 3.7, of the Final WM PEIS.

Comment (31)
Do not store, treat, or dispose of wastes in metropolitan areas, such as the Hampton Roads region, or in environmentally sensitive areas.

Response
None of the 17 "major" sites evaluated for waste management activities are located in the Hampton Roads region, although the Decentralized Alternative for management of low-level mixed waste would result in treatment and storage at Norfolk Naval Shipyard.

DOE appreciates the public's response to its request for comments on the WM PEIS alternatives. DOE considered this, and many other comments and factors, in its selection of preferred alternatives to manage the five types of waste considered in the WM PEIS. The decision criteria and factors used in the selection of preferred alternatives are described in Volume I, Section 1.7.3, of the WM PEIS. DOE's preferred alternatives and the reasons they are preferred are described in Volume I, Section 3.7, and in the Summary document.

Comment (71)
Commentors suggested that DOE locate waste treatment, storage, and disposal activities in sparsely populated or unpopulated areas, or in areas that are remote and isolated. Many suggested desert areas; others suggested ocean or space disposal.

Response
DOE prefers to avoid introduction of radioactive waste at DOE and other Federal sites where none exists. In turn, the proximity of a waste management site to populated areas is only one factor in evaluating alternatives. DOE must consider and balance other factors to achieve its objective of safe and efficient treatment, safe and secure storage, and ultimate disposal of each waste type. For example, DOE must consider waste transportation requirements. Although selecting sites for waste management activities in less-densely populated or remote areas could reduce the potential for some impacts, the risks of transporting wastes over longer distances to reach remote sites would increase the potential for other impacts. Section 1.7.3 in Volume I lists and describes examples of the factors DOE will consider in the decisionmaking process.

NEPA requires DOE to analyze reasonable alternatives. Neither ocean nor deep space disposal are considered feasible. Because of ongoing concerns over polluting the marine environment, and in accordance with U.S. law and international agreements (the London Dumping Convention of 1975, as amended), EPA no longer issues permits for ocean dumping or disposal of radioactive materials. As for launching the material into space, the costs and accident risks associated with such an approach would likely be significantly higher than those associated with the alternatives evaluated in the WM PEIS.

3.4.1 General Comments

Comment (528)
The public needs to be aware that INEL operations are generally safe; DOE should get on with making its decisions with the use of care and good science.

Response
DOE intends to proceed, as it has done to date, using care and good science in making waste management decisions across the Department and on a site-specific or project-level basis. The WM PEIS, which is a national decisionmaking tool, has been prepared to help DOE enhance the management of its current and anticipated volumes of radioactive and hazardous wastes in order to ensure safe and efficient management of these wastes, to comply with all applicable Federal and State laws, and to protect public health and safety and the environment.

Comment (917)
A commentor supports the DOE preference to store high-level waste at INEL, the Hanford Site, and SRS until disposal in a geologic repository becomes a reality.

Response
Thank you for your comment.

Comment (1650)
DOE has not done too bad a job at NTS, despite mistakes, and deserves full support.

Response
Thank you for your comment.

Comment (1826)
It is possible that the inflated waste generation data are part of a misdirected, yet intentional effort to maintain Argonne National Laboratory (ANL-E) on a national list of potential disposal sites. The PEIS does not sufficiently reflect reasonable present and future conditions to allow one to draw conclusions about the impacts of the proposed actions at ANL-E.

Response
The waste volumes identified in the Draft WM PEIS were based on the best data available at the time the analysis was performed. The Draft WM PEIS presented a "snapshot in time" of the waste volumes and projections. Since the Draft PEIS was published, DOE has updated information on several types of waste. Appendix I of the Final WM EIS addresses how newly available data on low-level waste, low-level mixed waste, and transuranic waste might affect the analyses of alternatives in the PEIS.

Section 1.6.1 in Volume I of the WM PEIS explains how DOE identified sites for analysis. Identification as a "major site" does not mean the site will be selected for waste management activities. The concept of the major site is intended to facilitate the WM PEIS analysis in terms of alternatives considered and to allow for meaningful comparison of programmatic waste management options.

As described in Section 4.4.1 in Volume I of the WM PEIS, the information on current conditions in terms of the affected environment at ANL-E was obtained largely from reports prepared in 1990 through 1994. More detail is provided in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS.

3.4.1 General Comments

The characterization of the affected environment establishes the baseline conditions from which the impacts of the various WM PEIS alternatives can be assessed.

Comment (1869)
DOE should investigate the feasibility of using other agencies' sites (e.g., the U.S. Department of Agriculture research facility in Clay Center, Nebraska) for disposal.

Response
Volume I, Section 3.10, of the WM PEIS explains that DOE does not consider the use of other Federal agencies' sites for waste management activities to be reasonable. However, the WM PEIS does consider, at a conceptual level, the use of commercial and privatized waste management facilities, including those at sites that might be purchased or leased from other Federal agencies. Although DOE committed during the scoping process to avoid introduction of radioactive waste at DOE and other Federal sites where none exists, this does not preclude the use of privatized or non-DOE-owned facilities for management of DOE waste, as discussed in Section 1.7.4.

Comment (1926)
There are not enough safeguards to give communities a sense of security. The potential impacts of a waste disposal facility at ANL-E were not shown to the surrounding communities.

Response
Only the Decentralized Alternatives for low-level waste and low-level mixed waste would involve *disposal* actions at ANL-E. The potential impacts of such disposal actions (as well as from possible waste treatment and storage) are provided in Chapters 6 and 7 in Volume I. To supplement the quantitative estimates of individual disposal risks presented in Sections 6.4.1.6 and 7.4.1.7 of the WM PEIS, DOE also performed semi-quantitative analyses of the *potential* for offsite population risk. ANL-E was determined to be intermediate among the 16 proposed disposal sites in its potential vulnerability to offsite population risks from disposal. Additional detail on potential impacts at ANL-E is provided in Section 2 in Volume II of the WM PEIS. Furthermore, Site Summaries for each of the 17 major sites analyzed in the WM PEIS (including ANL-E) have been added to the back of the PEIS Summary document.

Comment (1986)
The WM PEIS states that low-level mixed waste will be stored on the sites where it is generated until treatment and disposal. This does not take into consideration the Naval Nuclear Propulsion program sites that were required to complete Mixed Waste Site Treatment Plans in accordance with the Federal Facility Compliance Act of 1992. Mixed waste from Naval Nuclear Propulsion Program sites undergoing base closure will be stored at projected treatment sites. This should be reflected in the Final WM PEIS.

Response
Because this is a programmatic analysis, DOE made broad assumptions applicable to all sites, including the assumption that low-level mixed waste would be stored where it is generated until treatment and disposal. This assumption was not meant to restrict site-specific operations and exceptions where they would not prejudice programmatic analysis or decisions. DOE added this clarification to Volume I, Section 1.6.

3.4.1 General Comments

All of the Naval Nuclear Propulsion Program sites listed in Volume I, Table 6.1-1, have relatively small inventories and projected generation of low-level mixed waste. None of the sites are evaluated in detail. The Final WM PEIS considers updated waste inventory data, including low-level mixed waste inventories at Naval Nuclear Propulsion Program sites undergoing base closure in Volume IV, Section I.2. DOE concluded that pretreatment storage at different sites would not significantly affect decisions stemming from the WM PEIS.

Comment (2105)
BNL is a good neighbor and should continue to do world-class research. BNL's mission has always been primarily research oriented and has not included waste disposal. Identifying waste disposal sites across the country will erode DOE's credibility and impact funding for BNL and DOE.

Response
Potential waste management activities would not alter BNL's mission as an important research facility within DOE's configuration of sites.

NEPA requires DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at BNL is a reasonable programmatic waste management alternative. BNL is one of 17 reasonable candidate sites ("major sites") for programmatic waste management activities. Note that BNL would manage only its own low-level mixed waste and low-level waste and could take advantage of private-sector waste management resources. BNL would dispose of low-level mixed waste and low-level waste only under the Decentralized Alternative. BNL would not dispose of any offsite wastes. The newest low-level mixed waste and low-level waste volumes for BNL are provided for in Volume IV, Appendix I, of the WM PEIS.

Comment (2193)
The commentor stated that he was quoting from page 34 of the final Site Treatment Plan. "...Battelle has decided to withdraw its application for the Part B permit, as a recommendation under a corporate cost reduction program." In order to save $250,000 for a private entity you have decided to rip up all the advisory board's advice, and the multi-site principles, and ship it to Hanford for disposal. Well, our values are not being factored in here and we are not going to let you do that.

Response
DOE assumes that the commentor was referring to the Battelle Columbus Site Treatment Plan. The commentor infers that Hanford has agreed to disposal of Battelle waste to save Battelle Columbus the expense of obtaining a RCRA Part B permit. This inference is not true on several counts. Battelle Columbus is not a "private entity," but a DOE-funded facility and the waste is DOE waste. The waste codes which result from decontamination and decommissioning activities at Battelle Columbus were never included in the permit application to begin with; nor was onsite treatment ever part of the permit request. Hanford was chosen as a primary site for treatment and storage of Battelle's radioactive waste based on historical ties. The impacts of using Hanford were assessed in an Environmental Assessment, which was shared with the State of Washington.

Battelle Columbus withdrew its RCRA Part B permit after meeting with EPA, the State of Ohio, and local stakeholders. Battelle made a decision to act as a 90-day waste generator, which means that waste can only be stored onsite for a maximum of 90 days. The decision to withdraw the RCRA Part B permit application did save money and also allows Battelle to meet all regulatory requirements.

3.4.1 General Comments

The Battelle Site is sending low-level mixed waste to the Hanford Site for treatment only. After treatment at the Hanford Site, the low-level mixed waste will be shipped offsite for disposal. The agreement to treat one of Battelle's waste streams at Hanford was negotiated between Battelle Columbus, the Ohio EPA, the State of Washington Department of Ecology, DOE-Headquarters, and the Richland Office, in accordance with the Federal Facility Compliance Act.

Comment (2417)
The WM PEIS portrays waste management taking place at "greenfields," but does not recognize that most of the proposed locations have significant problems with environmental contamination. Because of the severity of some of these problems, it is not necessarily appropriate to correlate inventory with preferability for a particular alternative.

Response
DOE is committed to managing its wastes in an environmentally acceptable manner. New treatment and disposal facilities would be subject to project-level NEPA reviews that would address potential environmental impacts from those projects. DOE's preferred alternative for a project would not necessarily correlate with the inventory location of the waste to be managed, although inventory location would clearly be an important factor in the facility location decision.

DOE recognizes that other activities on DOE sites have environmental impacts and that these other activities should be accounted for. Volume I, Chapter 11, of the WM PEIS discusses the combined impacts of waste management alternatives for the five types of waste analyzed in the WM PEIS for each of the 17 major sites. Chapter 11 then presents these combined impacts, added to the impacts of other past, present, and reasonably foreseeable future actions external to the WM PEIS in (cumulative impacts). CEQ and DOE regulations require consideration of cumulative impacts.

Comment (2847)
Volume I, Section 6.3.5, states that Knolls Atomic Power Laboratory was eliminated because it is a Navy site. Yet a similar site, Bettis, was eliminated because of terrain and geology. According to Section 4.5, both sites have the same mission and ownership and are jointly managed by DOE and the Navy. It is not clear why the Navy site status should eliminate one or the other. Descriptions of these sites in Section 4.5 should be clarified to explain who has direct responsibility and authority (ownership) for these sites.

Response
DOE revised Section 6.3.5 to state that Bettis was eliminated because of sloping terrain and unstable geology, and because it is a Navy site. In addition, DOE revised Chapter 4 in Volume I to clearly indicate the affiliations of the sites.

Comment (2949)
ORR is considered for treatment and disposal of low-level mixed waste. Where on the site would DOE dispose of these wastes?

Response
ORR is considered as a candidate site for treatment and disposal of low-level mixed waste under several alternatives in the WM PEIS, which DOE has prepared as part of its effort to develop an overall national strategy on which to base waste management decisions. However, the WM PEIS does

3.4.1 General Comments

not propose locations within site boundaries for facilities. Facility locations will be determined after DOE announces WM PEIS decisions and considers the results of existing or new sitewide or project-level NEPA reviews.

Comment (3782)
The public needs to understand the specific reasons why populated areas are being considered for waste management facilities, rather than the desert southwest and plains where it is least likely to harm people.

Response
To identify reasonable proposed sites for waste management facilities, DOE determined where the largest volumes of waste are and where transportation requirements would be minimized. Other site-selection criteria included the characteristics of the waste, specialized treatment requirements, and existing facilities.

Sites that are less densely populated were considered for waste treatment, storage, and disposal. Although storage and disposal in less populated regions may lessen some impacts, the risks from transporting waste to these remote areas would increase. These trade-offs are described in the WM PEIS and are important factors that will be considered in the decision process. The remoteness and low population density of a location for a waste management site constitutes only one factor in evaluating alternatives. Other criteria include the construction or modification of facilities and increased transportation requirements.

Comment (4394)
A commentor suggested that DOE consider the Savanna Army Depot, located approximately 130 miles west of ANL-E in the northwest corner of Illinois for the following reasons as the site for a government waste storage facility: (1) the government already owns the property and it has already been used as a storage site for similarly hazardous materials, (2) it is located within only a few hours of not only Argonne, but also Fermi National Accelerator Laboratory and Ames Laboratories, (3) it is a rural site with very little nearby population, (4) the citizens of the communities around the depot would be receptive to the idea of having this facility nearby because of the positive effect it would have on the local economy, and (5) it is in the same State as two of the three proposed waste generators and so would avoid any potential problems with transporting waste across State lines. Another commentor stated that there are large tracts of Federal lands, Federal facilities, commercial facilities, and possibly Indian Reservations where DOE could store, treat, and/or dispose of its waste.

Response
As stated in the WM PEIS, Volume I, Section 1.6, DOE limited its scope to the 54 sites for which DOE has some management responsibility. Of those 54, 40 contained one or more of the waste types considered in the PEIS, and only 17 contain the bulk of those wastes. DOE limited the scope of the WM PEIS to these 54 sites, focusing most specifically on the major 17 sites identified in Table 1.6-2. However, Section 1.7.4 in Volume I discusses the concept of using commercial facilities.

3.4.2 Identification of 17 Major Sites

Comment (520)
The WM PEIS discusses 17 "major" sites associated with transuranic and other wastes. Other public documentation lists 27 sites. The PEIS should discuss the other 10 sites and explain why they were not included in the analysis. Taxpayers are concerned about the total picture.

Response
For purposes of the programmatic level of analysis in the WM PEIS, DOE identified 17 "major" sites because they contain the bulk of the five waste types, have the capability for the future disposal of low-level mixed waste and low-level waste, or have existing or planned major waste management facilities. These 17 sites are the focus of this PEIS because they are candidates to either receive wastes generated at other sites, to host disposal facilities, to manage high-level waste, or were included to be consistent with the Federal Facility Compliance Act process. DOE revised Section 1.6.1 in Volume I to expand the explanation of how these 17 sites were identified as candidates for waste management activities.

The 10 additional sites referred to in the comment have waste volumes compared to the volumes at the 17 major sites. DOE did not expect those small waste volumes to measurably affect the programmatic alternatives evaluated in the WM PEIS. Therefore, the sites were not included in the impacts analysis. The additional sites would principally package and ship wastes, rather than support major waste treatment or disposal facilities; therefore, waste management impacts at these sites are expected to be small.

Comment (1665)
Screening criteria used for selection of disposal sites are "woefully inadequate." DOE should expand its screening criteria to consider (1) the exclusion of sites that are located in large region of influence population areas, and (2) transportation impacts, as well as issues of distance to where most of the wastes to be disposed of are currently located.

Response
As described in Volume I, Section 6.3.5, 16 candidate low-level mixed waste disposal sites were selected for evaluation in the WM PEIS based on screening performed by DOE in coordination with the States under the Federal Facility Compliance Act (FFCAct). For consistency, the same 16 sites were also evaluated for low-level waste disposal. The screening process determined which DOE sites could be eliminated from consideration for disposal without further evaluation.

In the WM PEIS risk analyses, DOE did not attempt to predict risks to current or future offsite populations from the disposal of low-level waste and low-level mixed waste. Estimating these risks requires knowing the exact location of disposal facilities on a site with respect to existing aquifers and the populations that might use them. Since the PEIS does not attempt to make decisions about locations of disposal facilities on sites, quantitative estimates of collective dose and risk are not attempted.

However, to supplement the quantitative estimates of maximally exposed individual disposal risks presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I, DOE performed semi-quantitative analyses of the potential for offsite population risk in Section 5.4.1.2.3 of the Final PEIS. These analyses produced estimates of relative population vulnerability of the sites, rather than quantitative estimates of person-rem doses and cancer fatalities. For these analyses, DOE used simple statistical methods and information about site characteristics known or expected to be associated with the potential for offsite population disposal risk to develop "risk vulnerability" groupings of the sites. ROI population was one

3.4.2 Identification of 17 Major Sites

of the factors used in the analysis. The sites within each of the three vulnerability groups developed in this analysis have similar potential for offsite population health risk from disposal.

DOE used minimization of waste transportation as a criterion in developing alternatives. The WM PEIS analyzes transportation impacts. Detailed analyses are presented in the waste type and cumulative impacts chapters of Volume I of the WM PEIS. In addition, Appendix E in Volume IV of the WM PEIS is dedicated to transportation.

Comment (1744)
Provide a list of the 16 sites selected as disposal sites and explain how and why the WM PEIS differs from the *Performance Evaluation of the Capabilities of DOE Sites for Disposal of Mixed Low Level Waste*.

Response
Section 6.3.5 in Volume I of the WM PEIS lists and describes how DOE identified the 16 sites evaluated for potential disposal of low-level waste and low-level mixed waste (i.e., ANL-E, BNL, FEMP, Hanford, INEL, LANL, LLNL, NTS, ORR, PGDP, Pantex, Portsmouth, RFETS, SNL-NM, SRS, and WVDP) were identified. In addition, Section 1.8.2 discusses the relationship of the WM PEIS with the efforts of the DOE Disposal Workgroup.

Although the Federal Facility Compliance Act does not specifically address disposal of treated mixed wastes, both DOE and the States have recognized that disposal issues are an integral part of treatment discussions. A process was established by the DOE Disposal Workgroup in conjunction with State representatives and the National Governors Association to evaluate and discuss the issues related to the potential disposal of the residuals from the treatment of DOE low-level mixed waste at the sites subject to the Federal Facility Compliance Act. The results of this analysis are presented in the report entitled *Performance Evaluation of the Capabilities of DOE Sites for Disposal of Mixed Low Level Waste*.

The focus of this process has been to identify sites that are suitable for further evaluation of their potential as disposal sites from among the sites that currently store or are expected to generate mixed waste. The evaluation is intended to increase understanding of the strengths and weaknesses of a site's potential for disposal, but is not a site-selection process. Ultimately, the identification of sites that might receive low-level mixed waste for disposal will follow State and Federal regulations for siting and permitting, and will include appropriate public involvement.

The sites identified through the Disposal Workgroup process reflect the same set analyzed for low-level mixed waste disposal in the WM PEIS, except that the WM PEIS analysis includes BNL, which has been categorized by the DOE Disposal Workgroup as low in priority for a mixed waste disposal mission.

Comment (2240)
The WM PEIS alternatives are not adequate because they have been preselected and look at the West as a dumping ground.

Response
All alternatives except the Centralized Alternatives consider disposal facilities in the East as well as in the West. Volume I, Section 3.5, describes how DOE selected the alternatives. To identify reasonable

proposed sites for waste management facilities, DOE determined where the largest waste volumes are located and where transportation requirements would be minimized. Treatment, storage, or disposal facilities were analyzed at those sites.

However, total volumes of waste were not the sole criterion used to select sites. The character of the waste, specialized treatment requirements, and existing facilities were also taken into account. For example, some wastes that require special treatment were analyzed separately, and treatment sites were selected for analysis based on the volumes requiring special treatment rather than on total volumes. In some cases, treatment facilities could be used for more than one waste type. Therefore, some sites were evaluated as candidate sites even if the volume of a particular waste type at that site was not among the largest.

This process was not biased toward the West. In fact, 8 of the 16 sites considered for disposal of low-level mixed waste and low-level waste are east of the Mississippi River. For transuranic waste and high-level waste, the candidate repository sites at Carlsbad, New Mexico (WIPP), and NTS (Yucca Mountain) were used for transportation calculations; however, they were not evaluated for disposal, which is beyond the scope of the WM PEIS.

Comment (3243)
DOE's criteria for selecting candidate waste treatment and disposal sites should be reevaluated so as to question or dismiss sites with: (1) large region of influence (ROI) population densities, (2) high seismic risk, (3) transport routes connecting to waste generating sites that have the highest percentage of travel in urban areas (high population densities, traffic congestion and delays), and (4) sites where offsite contamination is already posing substantial environmental and health risks to the surrounding communities.

Response
The points specified by the commentor are addressed in the WM PEIS environmental impacts analysis in the waste-type and cumulative impacts chapters. The 17 "major" waste management sites contain the bulk of the five waste types, have the capability for future disposal of low-level mixed waste and low-level waste, or have existing or planned major waste management facilities. These 17 sites are the focus of this PEIS because they are candidates to receive wastes generated elsewhere, to host disposal facilities, to manage high-level waste, or were included to be consistent with the Federal Facility Compliance Act process. The PEIS refers to these sites as major sites, and considers in detail environmental impacts that could arise from treating, storing, and disposing of wastes at these sites.

Comment (3921)
DOE needs to explain why 37 of 54 sites were removed from the list. DOE is too limited in its site selections. For example, let's send the waste to Washington, D.C. Let the Government have it.

Response
Section 3.5 in Volume I of the WM PEIS describes how DOE selected the alternatives. Section 3.10 describes alternatives not evaluated in detail in the WM PEIS. Of the 54 DOE sites that generate or have in inventory identifiable quantities of radioactive or hazardous waste, 17 were considered "major" sites because they contain the bulk of the waste and are candidates to receive waste from other sites for treatment, storage, or disposal. The other 37 sites have relatively small amounts of waste and DOE

3.4.2 Identification of 17 Major Sites

eliminated them as candidate sites for receiving waste from other sites. Under various alternatives, these 37 sites are candidates for managing the wastes that are generated onsite.

3.5 Public Preferences for or Opposition to Siting Waste Management Activities/Facilities

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(No comments were received for this section)

3.5.1 Argonne National Laboratory-East

Comment (209)
Of those commentors opposing the siting of programmatic waste management activities at ANL-E, some gave no reason for their opposition and others expressed one or more of the reasons listed below:

- The overall risks to public health and safety, worker health and safety, and the quality of the environment from normal operations, operations accidents, and truck and rail transportation accidents;

- Specific Risks: Risks to surrounding residential communities and farmland; risks to sensitive habitat (such as Waterfall Glen Forest Preserve); risks due to possible earthquakes, tornadoes, and flooding; potential air, groundwater and drinking water contamination; potential negative impacts on the local economy, including decreased real estate values, business opportunities, and tax revenues; potential negative impacts to the overall quality of life in the area; safety risks in the event of a terrorist attack;

- Factors: The population density, including many children, around the site; the "higher-than-average" cancer rates in surrounding communities, especially among children, and potential dangers to future generations; existing contamination at the site; the longevity of the waste and the lack of long-term accountability and guarantees of safety in the future; the site's proximity to major highways; construction costs, and potential clean-up costs in the event of a release of radioactivity; potential evacuation problems in case of an accident; the potential for lawsuits and waste of tax dollars;

- Opinions: That there are more viable and cost-effective storage and disposal alternatives than ANL-E, which should only be used for research and development; that proposed waste management activities at ANL-E conflict with existing treatment plans and Federal Facility Compliance Act agreements; that construction and processing operations would contribute non-hazardous wastes to an already overburdened system; that wastes could be shipped to less-densely populated, remote or desert areas, and the cost would be minimal compared to the risk of contamination; that there is a lack of communication and adequate public input to waste management decisions; that there is a lack of confidence in DOE's ability to properly manage past, existing or future wastes, as well as its ability to prevent environmental damage; that DOE is proposing to use unproven thermal treatment technologies; and that ANL-E does not have adequate facilities and equipment to become a permanent waste facility.

Response
NEPA requires DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at ANL-E was analyzed as a reasonable option under some of the WM PEIS waste management alternatives. ANL-E is one of 17 "major" sites analyzed in the WM PEIS, which is a nationwide study to help DOE make programmatic, Department-wide decisions about how it will manage the five waste types considered in the PEIS. Major sites are those candidate locations that might either receive wastes generated offsite, manage high-level waste, host disposal facilities, or were included to be consistent with the Federal Facility Compliance Act process. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation as a major site does not mean the site will be selected for a programmatic waste management role. Under 3 of the 36 alternatives evaluated (Decentralized Alternatives for low-level mixed waste, low-level waste, and transuranic waste), DOE would construct new facilities to manage wastes at ANL-E. These facilities would manage wastes generated at ANL-E, a small quantity of low-level mixed waste generated at Ames Laboratory, and low-level waste generated at Ames and Fermi Laboratories. No transuranic wastes from off the site would be managed

3.5.1 Argonne National Laboratory-East

at ANL-E. Under the Regionalized and Centralized Alternatives, all ANL-E waste would be treated and disposed of at other DOE sites.

The WM PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10 for results; see Chapter 5 and Volume III, Appendix C, for analysis methods. The analysis considered potential impacts, including most of the impacts that concern commentors, from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives at all sites considered in the PEIS would be minimal. For those impacts that would not be minimal, DOE would incorporate mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. These are not final decisions. The subsequent Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from those provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies, will be considered in developing Records of Decision.

DOE used data from the 1990 U.S. Census to estimate that about 7,940,000 people live within 50 miles from the center of ANL-E. This population could possibly be exposed to emissions released to the atmosphere from waste treatment facilities. Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the PEIS (Volume I, Sections 6.4, 7.4, and 8.4). Offsite population human health risks and offsite maximally exposed individual health risks are also cumulative impact parameters addressed by the PEIS (see Volume I, Section 11.3). The health risk analyses suggest that adverse health effects to both adults and children from the operation of waste treatment facilities located at ANL-E would be negligible.

In response to requests from the residents of Lemont, Illinois, the Illinois Department of Public Health initiated a study of the cancer incidence among children in the Township. The Division of Epidemiologic Studies prepared a study based on hospital reports found in the Illinois State Cancer Registry for the years 1986 through 1993 (Illinois Department of Health, 1995). Seventeen cases of childhood cancer were observed in the study area, four cases more than the 13 that would be statistically expected. The most frequently reported childhood cancer type was leukemia, with six cases observed and three cases statistically expected. The report finds that those differences are not statistically significant. More details on the survey can be obtained from the study.

The WM PEIS evaluates the potential impacts of several types of accidents at treatment and storage facilities (e.g., fires, explosions, earthquakes, aircraft crashes). The PEIS also includes a detailed assessment of the risks of a complete range of credible transportation accidents for both rail and truck transportation. The analyses were designed to address the potential impacts of acts of terrorism or sabotage. DOE provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to quickly respond to an accident and assist local emergency response personnel, if requested by local agencies. Because health and safety consequences could possibly result from an accident involving radioactive or other hazardous material, DOE has allocated resources and

3.5.1 Argonne National Laboratory-East

has established emergency response training under the overall Federal Emergency Response Program to investigate the effects of such an accident.

DOE is concerned with health and safety and the need for emergency preparedness in and around its sites. Emergency response plans are required on sites and in the surrounding communities by Federal, State, and local authorities that deal with emergency situations such as earthquakes, floods, tornadoes, and other natural or man-made disasters. These plans are regularly updated and their review coordinated with DOE, the U.S. Department of Transportation, the Federal Emergency Management Agency, and State and local authorities.

Properly designed and operated thermal treatment technologies (incinerators), have been shown to be as or more effective than other proven treatment technologies and DOE will not preclude their use at any site. DOE compared impacts from incineration with non-thermal treatment technologies and identified little or no difference in treatment risks to human health; DOE documented these findings in a technical report. (M/B SR-03, September, 1995). DOE has an aggressive technology development program exploring alternatives to incineration. Alternatives would be tested and deployed depending on their potential to safely and effectively treat wastes.

As to the other specific risks cited by the commentors, refer to the following sections of the PEIS: air quality (Sections 6.5, 7.5, and 8.5); water resources (Sections 6.6, 7.6, and 8.6); and ecological resources (Sections 6.7, 7.7, and 8.7). Risks to local agriculture are not considered in the PEIS as a specific impact parameter; however, as environmental risks would be small, there is no reason to believe that there would be any negative impact to local agriculture. Further, site facilities are outside the probable 500-year maximum floodplain, and seismic analyses indicate there is little or no risk from earthquakes.

While implementing programmatic waste management decisions could entail construction of new and/or modification of existing facilities, the WM PEIS does not propose locations on sites for actual waste management facilities. If ANL-E is selected for a waste management role, DOE would consider site-specific conditions analyzed in existing or new sitewide or project-level NEPA reviews. DOE is aware of the sensitive ecological resources associated with ANL-E and would locate any new waste management facilities to minimize or avoid impacts to nearby wetlands and other sensitive habitats.

A major focus of the WM PEIS is to help DOE establish a Department-wide program to safely and efficiently manage radioactive and hazardous wastes. However, issues regarding existing pollution, a site's waste management record, and actual site cleanup efforts are more appropriately evaluated in sitewide or project-level studies. Impacts of existing actions and other missions related to radiological and hazardous waste are included in the cumulative impacts chapter of the WM PEIS, Volume I, Chapter 11.

The WM PEIS and the Federal Facility Compliance Act Site Treatment Plans were developed in parallel, ensuring consistency and integration. The PEIS provides the analysis of environmental impacts to support the Site Treatment Plans developed for site-level mixed waste treatment decisions. Pre-existing site-specific plans and agreements will be considered by decisionmakers to the extent possible; however, it is possible that some site-specific NEPA decisions might need to be revisited as a result of decisions made based on the WM PEIS.

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DOE recognizes that the siting of waste management activities may be perceived negatively by some persons. DOE is committed to protecting human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The WM PEIS will help DOE make sound waste management decisions.

The proximity of a waste management site to populated areas is only one of many factors in evaluating alternatives. DOE must consider and balance other factors to achieve its objective of safe and efficient treatment, safe and secure storage, and ultimate disposal of each waste type. For example, DOE must consider waste transportation requirements, and the PEIS presents alternatives that would minimize waste transportation (Decentralized Alternatives) or that would maximize waste transportation (Centralized Alternatives). Although siting waste management activities in less-densely populated or remote areas could reduce the potential for some impacts, the risks of transporting wastes over longer distances to reach remote sites would increase the potential for other impacts. Actual decisionmaking will consider a range of decision criteria and factors, including viability and cost-effectiveness. Section 1.7.3 in Volume I lists and describes examples of the factors and criteria DOE will consider in the decisionmaking process.

DOE must comply with all applicable laws and regulations. DOE believes that the WM PEIS meets the requirements of NEPA and CEQ regulations. The Final WM PEIS incorporates corrections to errors that affected the final analysis, which were identified in the Draft WM PEIS by public commentors, DOE, and its contractors. DOE believes the Final WM PEIS is technically sufficient to make programmatic waste management decisions. By carefully studying and planning long-term waste management strategies at the national and site levels, DOE hopes to correct past waste management practices to ensure protection of the public, workers, and the environment in the future.

DOE welcomes the level of interest in its waste management decisions, and has considered all comments offered during the public comment period. A well-informed and involved citizenry can provide valuable insight into what the public feels DOE should consider in its decisionmaking. However, DOE must, by law, actually make decisions, and is held accountable by the public and its regulators for safely implementing those decisions.

Comment (458)
The State of Illinois prefers a combination of alternatives not listed in the WM PEIS charts and considers a Regionalized Alternative that designates ANL-E as a treatment site for low-level waste but not a disposal site as the most preferable scenario. Since such an alternative is not presented in the WM PEIS, the State requests that DOE reevaluate the alternatives under consideration, and rewrite the WM PEIS and associated alternatives to incorporate this input.

Response
DOE assumes that the State of Illinois is referring to low-level mixed waste and not low-level waste due to the low-level mixed waste Site Treatment Plan for ANL-E that proposes to treat low-level mixed waste onsite, but dispose of residues offsite.

The WM PEIS analyzes 36 alternatives under four broad categories. In accordance with NEPA and CEQ regulations, these alternatives include the impacts that might be envisioned. Under the WM PEIS

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analysis, low-level mixed waste treatment and disposal at ANL-E is considered only under the Decentralized Alternative.

Section 3.7 in Volume I of the WM PEIS identifies the preferred configuration alternative for low-level mixed waste treatment and disposal and the reason it is preferred. The preferred treatment and disposal site(s) will be identified at a later date with appropriate public notification before a decision is made. The preferred alternatives identified in the WM PEIS will provide input into the Records of Decision process, which will culminate in programmatic waste management decisions. In this context, NEPA allows combining specific configurations analyzed in the WM PEIS, as suggested in the comment, when selecting a "DOE preferred alternative." Further, NEPA allows DOE, in making its decisions, to consider partial alternatives or combinations of alternatives, as long as they fall within the bounds of the alternatives considered in the EIS. (See Volume I, Section 3.4.) An alternative encompassing treatment at ANL-E without disposal could be selected without further analysis. DOE will explain in the Records of Decision how and why it made its decisions, and how the decisions relate to the alternatives analyzed in the Final EIS.

Comment (465)
Decisions for the siting, construction, and operation of a waste disposal facility at ANL-E should not be made until site-specific characteristics and potential impacts are evaluated. Also, DOE should outline how it will handle waste at the proposed disposal facility for ANL-E once that facility is filled; whether ANL-E will continue to receive waste; whether the disposal facility will be expanded; and whether another facility will be sited and started at ANL-E.

Response
The environmental impacts from construction and operation of generic waste disposal facilities are identified in the WM PEIS to provide relative comparisons to aid in decisionmaking. However, the WM PEIS did consider many site-specific characteristics at ANL-E, including population, weather, and geology and water resources. Even more detailed site characteristics would be considered in sitewide or project-level NEPA reviews.

DOE believes that it would be speculative to consider the disposition of wastes beyond the 30-year projected life of the new waste management facilities being considered in the PEIS. Therefore, these activities are outside the scope of the WM PEIS, but could be considered in future NEPA documentation.

Comment (471)
DOE should clarify whether ANL-E will be designated a regional site.

Response
DOE does not consider ANL-E a candidate site for a regional disposal facility for any of the five waste types addressed in the WM PEIS. DOE will announce the site's role in the final waste management configuration in Records of Decision published in the *Federal Register* following the publication of the Final WM PEIS.

Comment (1066)
ANL should not be considered as a future waste disposal site for radioactive materials because the community has already suffered enough. When DOE dropped the research on shortening the

radioactive life and reuse of radioactive materials, it lead to major employment cutbacks. The best place to store this material is in Washington, D.C.

Response
DOE evaluated 36 alternatives in the WM PEIS. DOE did not consider Washington, D.C., as a management site because it does not meet the criteria for a major site given in Section 1.6.1 in Volume I. Only under three alternatives (Decentralized Alternatives for low-level mixed waste, low-level waste, and transuranic waste) would new facilities be constructed to manage wastes at ANL-E. These facilities would manage wastes generated at ANL-E and a small quantity of low-level mixed waste generated at Ames Laboratory and low-level waste generated at Ames and Fermi Laboratories. Under the Regionalized and Centralized Alternatives, all ANL-E wastes would be managed at other DOE sites. DOE recognizes that some commentors disagree with the reasonable alternatives being considered in this PEIS for management of radioactive waste. The WM PEIS human health risk assessment and ecological risk assessment examined potential Waste Management Program effects on humans and the environment near ANL-E. DOE found that impacts to public health and the environment would be small at ANL-E under all waste management alternatives.

DOE is committed to research and will defend its programs. However, budget levels for DOE, as well as implementation guidance, are established by Congress. Thus, some DOE programs are experiencing cutbacks, which does impact employment in some areas.

Comment (1295)
The communities do not want any more waste of any kind brought to Argonne because of (1) the high residential population; (2) the already existing cleanup problems; (3) the legacy of Site A and Plot M; (4) already contaminated French drains; (5) incidents with uranium working its way up to the top of the ground; (6) past closures of drinking wells due to ANL-E ground contamination; and (7) already enough bad experiences.

Response
DOE evaluated 36 alternatives in the WM PEIS. Only under three alternatives (Decentralized Alternatives for low-level mixed waste, low-level waste, and transuranic waste) would new facilities be constructed to manage wastes at ANL-E. These facilities would manage wastes generated at ANL-E and a small quantity of low-level mixed waste generated at Ames Laboratory and low-level waste generated at Ames and Fermi Laboratories. Under the Regionalized and Centralized Alternatives, all ANL-E wastes would be managed at other DOE sites.

The WM PEIS human health risk assessment and ecological risk assessment examined potential Waste Management Program effects on humans and the environment near ANL-E. DOE found that impacts to public health and the environment would be small at ANL-E under all waste management alternatives.

Site A (which was decommissioned in 1956) and Plot M are not located on the ANL-E site. Moreover the drinking wells, also located offsite, were closed due to contamination at Site A. However, ANL-E continues a groundwater monitoring program at the site. The WM PEIS considered existing contamination at ANL-E and the region of influence surrounding the ANL-E Site as the baseline condition as discussed in Section 4.4.1 in Volume I and in the WM PEIS Affected Environment Technical Report. The need for additional remedial action at Site A and Plot M (a small parcel of land

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used for radioactive waste disposal) will be determined when the characterization activity has been completed. All such remedial action is part of the Environmental Restoration Program and therefore is beyond the scope of the WM PEIS analysis.

DOE's environmental restoration activities are governed, to a large extent, by the Comprehensive Environmental Response, Compensation, and Liability Act, and the Resource Conservation and Recovery Act. The objective of these laws is to provide for response to and remediation of past environmental contamination. DOE encourages the citizens to be proactive and report issues of environmental contamination to Federal, State, and local authorities.

Comment (1831)
There are important combinations of alternatives that were not evaluated in the WM PEIS. Specifically, DOE did not evaluate ANL-E for a treatment site under the low-level mixed waste Regionalized Alternatives.

Response
DOE analyzed 36 alternatives in four broad categories in the WM PEIS. These alternatives encompass the reasonable combinations of options that might be envisioned. In designing these alternatives, DOE used the principle of minimizing waste transportation to select the sites to host treatment and disposal facilities. Accordingly, in going from decentralized treatment to centralized treatment, the sites with the smallest amount of waste were the first to be eliminated as treatment centers. Of all the sites that would treat waste under the Decentralized Alternative, ANL-E was among the first six sites to be eliminated because it was among the six sites with the smallest volume of low-level mixed waste inventory plus 20 years of projected generation.

Under all alternatives, sites were assumed to treat their own wastewaters. Furthermore, sites not treating their waste to its final form would need to treat their wastes sufficiently to meet transportation requirements.

Comment (1833)
ANL-E is clearly not a major site. By WM PEIS definition, a major site is a candidate to receive wastes generated offsite, to host disposal facilities, or to manage high-level radioactive wastes. There is no technical basis for including ANL-E in this study. We are also not aware that ANL is scheduled to play a significant role in the management of DOE's high-level radioactive waste. If there are additional reasons for ANL-E being classified as a major site, such as projected waste volumes, make them clear in the PEIS.

Response
Volume I, Section 1.6.1, describes DOE's basis for selecting candidate sites for waste management activities and explains the designation "major site." Major sites are candidates to receive wastes generated at other sites, to host disposal facilities, or to manage high-level waste, or they are sites that were included in the study to be consistent with the Federal Facility Compliance Act process.

Within the alternatives evaluated in the WM PEIS, ANL-E is not considered for management of high-level waste. It is a candidate to receive wastes generated at other sites and to host low-level waste or low-level mixed waste disposal facilities.

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Comment (1835)
If DOE is seriously considering ANL-E as a prospective site for disposal of low-level mixed waste, it should discontinue that approach for lack of an adequate technical basis. Factors such as demographics, local geology, groundwater resources, and ANL-E's waste volume, if properly considered, will prevent DOE from concluding that ANL-E is a suitable disposal location site.

Response
DOE's preferred alternative for low-level mixed waste treatment is a combination of parts of the Decentralized and several Regionalized Alternatives (see Volume I, Section 3.7, for the rationale for this selection). DOE decisions about waste disposal will be based on all available information, including the WM PEIS analysis and current technical information (including up-to-date waste volume information). Section 1.7.3 identifies environmental impacts as a criterion DOE used to screen, evaluate, and narrow the number of alternatives and sites and to select preferred alternatives.

Comment (1838)
Consideration of ANL-E for disposal of waste is a proposed action that we will continue to oppose. Its significance could easily influence the finalization of the agreement between the State of Illinois and DOE under the Federal Facility Compliance Act.

Response
The fact that ANL-E is analyzed as a major site in the WM PEIS does not automatically entail selection of that site for a given waste management role. Rather, it means that potential impacts from conceptual waste management activities were analyzed. DOE evaluated 36 alternatives in the WM PEIS. Only under two alternatives (Decentralized Alternatives for low-level mixed waste and low-level waste) would facilities be constructed to dispose of wastes at ANL-E. These facilities would dispose of wastes generated at ANL-E and small quantities of low-level mixed waste generated at Ames and low-level waste generated at Ames and Fermi. Under the Regionalized and Centralized Alternatives, all ANL-E wastes would be managed at other DOE sites.

Section 1.8.3 in Volume I of the WM PEIS discusses the relationship of the document with other programs. The Federal Facility Compliance Act directs DOE to address the treatment of mixed waste that DOE generates or stores by requiring the development of mixed waste Site Treatment Plans. These plans identify how DOE will provide the necessary mixed waste treatment capacity, including schedules for bringing new treatment facilities into operation. The WM PEIS and the Site Treatment Plans were developed in parallel, ensuring consistency and integration. The mixed waste treatment alternatives described in the WM PEIS are broad enough to envelope the potential environmental impacts of the configuration that results from the Federal Facility Compliance Act process.

Although the Act does not specifically address disposal of treated mixed wastes, both DOE and the States have recognized that disposal issues are an integral part of treatment discussions. A process was established by the DOE Disposal Workgroup in conjunction with State representatives and the National Governor's Association to evaluate and discuss the issues related to the potential disposal of the residuals from the treatment of DOE low-level mixed waste at the sites subject to the Act. The focus of this process has been to identify sites that are suitable for further evaluation of their potential as disposal sites from among the sites that currently store or are expected to generate mixed waste. The evaluation is intended to increase understanding of the strengths and weaknesses of a site's potential for disposal, but is not a site-selection process. Ultimately the identification of sites that might receive

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mixed waste for disposal will follow State and Federal regulations for siting and permitting, and will include appropriate public involvement.

Information obtained through the Disposal Workgroup will be considered with information contained in the WM PEIS during the development of Records of Decision. Following the publication of WM PEIS decisions, DOE may (1) initiate site-specific NEPA reviews for new proposed disposal facilities; (2) initiate performance assessment analyses for compliance with DOE Order 5820.2A; and (3) initiate processes for permitting disposal facilities. Coordination with the States and stakeholders will continue to ensure stakeholder input and to resolve concerns at the earliest possible stage.

Comment (1885)
Commentors strongly oppose the selection of ANL-E as a potential site for storage of radioactive waste, because it takes more than 15 years to clean up a contaminated site and the cost to do so is substantial, with no guarantee that the funds will be available when needed.

Response
The WM PEIS is intended to provide environmental information to help DOE determine at which sites it should modify existing waste management facilities or construct new facilities. DOE evaluated 36 alternatives in the PEIS. Only under three alternatives (Decentralized Alternatives for low-level mixed waste, low-level waste, and transuranic waste) would new facilities be constructed to manage wastes at ANL-E. These facilities would manage wastes generated at ANL-E and a small quantity of low-level mixed waste and low-level waste generated at Ames.

The Environmental Restoration Program has been established to clean up environmental contamination at the sites where research, development, test, and production of nuclear weapons took place. Environmental cleanup is not within the scope of the WM PEIS, DOE's programmatic waste management study, because of the site-specific nature of environmental restoration decisions.

DOE receives funds through Congressional appropriations. Thus, environmental restoration, as well as waste management and other programs, are subject to prevailing budget policies.

Comment (1934)
A commentor opposes "another nuclear waste dump" at ANL-E and suggested cleaning up "the mess at Red Gate Woods" before planning a new facility.

Response
No uncontrolled dumping is permitted by current waste disposal regulations. If ANL-E were selected to host a disposal facility, the facility would be designed, constructed, operated, and maintained in compliance with all applicable regulations. This facility would be an engineered waste disposal facility with comprehensive waste acceptance criteria to ensure that performance objectives would be attained.

Site A and Red Gate Woods are environmental restoration sites that are being addressed by site-specific remedial actions and, therefore, are outside the scope of the WM PEIS. Stakeholder meetings are being planned for later this year to update constituents about the decisions on future environmental restoration actions for Site A and Red Gate Woods. DOE has searched the National Archives extensively looking for records detailing the wastes buried at Plot M, which is in the forest preserves outside the ANL-E boundaries. To date, DOE has been unable to find any records on what was put

into Plot M between May 1944 and its closure in July 1949. DOE is continuing to look for any records on what was disposed of in this area. The comment has been forwarded to the Argonne Group Office.

Comment (2650)
The region is already at risk from ANL-E experiments and potential problems at nuclear generating stations of Commonwealth Edison.

Response
Section 11.3 in Volume I of the WM PEIS identifies cumulative impacts for ANL-E and the existing baseline risk. These impacts and risks are generally minor. However, risks associated with activities outside of DOE's control, such as those from commercial nuclear generating stations, are not within the scope of the WM PEIS.

The WM PEIS decision process will not result in the selection of specific locations for waste management facilities on DOE sites. Before DOE selects locations for facilities on sites, it will consider the results of relevant existing or required new NEPA analyses, which would include detailed site-specific cumulative impacts.

Comment (2654)
Shipping methods must consider the safety of the community. Waste should not be transported by any means to ANL-E.

Response
The WM PEIS provides an analysis that allows for relative comparison of the possible risks due to waste transportation, which could be mitigated through careful planning and safety measures. DOE has always maintained that the risks of transporting its waste are very low, but no form of transportation is without some risk. The WM PEIS analysis is based on overall traffic statistics, which do account for the special measures DOE takes when transporting waste.

Because health and safety consequences could possibly result from an accident involving radioactive or other hazardous material, DOE has allocated resources and has established training on emergency response under the overall Federal Emergency Response Program to investigate the effects of such an accident. The mitigating measures that DOE takes include careful choice of the route used, the packaging and transportation methods used, and other considerations.

No one has ever been killed or seriously injured in an accident involving radioactive materials because of the nature of the cargo. In a 23-year observation period, 307 highway and 20 rail accidents occurred. Radioactive materials that could have serious consequences if released are packaged to withstand hypothetical accident conditions during shipping. Accidents involving these packages have resulted in no release of radioactive materials.

Shipping radiological and other hazardous material to interstate highways or rail terminals is described for each site in the WM PEIS Affected Environment Technical Report, which is referenced in the WM PEIS and is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the WM PEIS. In addition, transportation-related impacts are presented in Sections 6.4.2, 7.4.2, 8.4.2, 9.4.2, and 10.4.2 in Volume I, and Appendix E in Volume IV.

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In the transportation technical reports supporting the WM PEIS, which are available in the DOE public reading rooms listed in Section 1.9 in Volume I, estimates of shipments by truck and rail are given. It is estimated that Ames would send two truck shipments or one rail shipment of low-level waste; Fermilab would send 43 truck shipments or one rail shipment of low-level waste; and Ames would send one rail and one truck shipment of low-level mixed waste. Truck shipments would use Interstate 55 to minimize risks to the community. Thus, there would be less than one shipment a week for alternatives calling for shipments of waste to ANL-E.

Comment (2760)
Keep the neighborhood around ANL-E safe; remove the waste stored there illegally.

Response
DOE policy is to conduct its operations to protect the environment and ensure the safety and health of onsite workers and offsite residents. DOE will continue to comply with all applicable environmental and safety statutes and regulations with regard to its waste management activities at ANL-E and other DOE sites.

Comment (3752)
As a person living about one mile from the site, I drink the water from a well nearby. I am a cancer survivor and have greatly benefited by the diagnostic results of ANL. As an ANL employee, I have tried to maintain my objectivity about the WM PEIS, however, I oppose the permanent placement of the LLW and LLMW for a few reasons. (1) This is a densely populated (over 7 million people) area; thousands live just a few miles from the site. (2) As per President Clinton's speech [the commentor claims that President Clinton said in the State of the Union Address given on January 23, 1996, it was his objective to not store nuclear waste near densely populated areas with children], why are we considering it here? (3) I am concerned about drinking water. (4) I am concerned about accidental releases and radiation exposures.

Response
The proximity of a waste management site to populated areas is only one factor in evaluating alternatives. DOE must consider and balance other factors to achieve its objective of safe and efficient treatment, safe and secure storage, and ultimate disposal of each waste type. For example, DOE must consider waste transportation requirements. Although siting waste management activities in less-densely populated or remote areas could reduce the potential for some impacts, the risks of transporting wastes over longer distances to reach remote sites would increase the potential for other impacts. Section 1.7.3 in Volume I of the WM PEIS lists and describes a range of decision criteria and factors that DOE will consider in its programmatic waste management decisions. Minimization of risks to public health, and public preferences, will continue to play a crucial role in this process.

In his State of the Union Address of January 23, 1996, President Clinton identified the challenge "to leave our environment safe and clean for the next generation," given that "10 million children under 12 will live within four miles of a waste dump," a "third of us breathe air that endangers our health," and "in too many communities the water is not safe to drink." The WM PEIS represents DOE's national planning tool to enhance the management of its radioactive and hazardous waste in order to ensure safe and efficient management of these wastes, to comply with all applicable laws, and to protect public health and safety and the environment.

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The WM PEIS analysis estimates that risks from drinking water impacts and accident (treatment and storage facilities, transportation) would be small under all PEIS alternatives. More detail is provided in Sections 6.6.2, 7.6.2, 8.6.2, 9.6.2, and 10.6.2 in Volume I of the PEIS (water quality), and Appendices E and F (transportation, including accidents; facility accidents) in Volume IV.

Comment (3915)
Discount most of the public meeting participants and what they have said. ANL-E has not been involved in nuclear weapons production. Public safety and air quality are monitored. The people in this area should be concerned with the refinery and the chlorine tankers on the railroads. Property values are exploding, not declining.

Response
Thank you for your comment. It is DOE's policy to consider and respond to public comments and to factor public input into its decisions.

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Comment (330)
When deciding whether to store waste at BNL or ship it to a safer location, DOE should compare the difficulties, expenses, and safety concerns (especially drinking water at BNL) associated with those alternatives.

Response
BNL is considered for the management of low-level mixed waste and low-level waste. The site is not considered a potential candidate to receive wastes from other sites, and under all the Regionalized and Centralized Alternatives, BNL would ship its waste offsite for proper treatment and disposal. Under the No Action and Decentralized Alternatives the impacts of storing, treating, and disposing of low-level mixed waste and low-level waste onsite were analyzed and are reported. Chapters 6 and 7 in Volume I of the WM PEIS provide details of the full impact analysis for managing low-level mixed waste and low-level waste across the DOE complex.

The environmental impacts of managing low-level waste and low-level mixed wastes at BNL will be considered in making any treatment, storage, and disposal decisions concerning the BNL wastes. Other factors in the decisions will be impacts on DOE's mission and costs. In arriving at its decisions, DOE attempts to balance its waste management activities supporting site and Department-wide cleanup and ongoing site operations with the desires of the communities within which it operates.

Comment (400)
The Federal Facility Compliance Act Brookhaven Mixed Waste Matrix, which creates separate streams for each waste category and has a limited number of disposal facilities, is the most responsible option.

Response
DOE's low-level mixed waste is subject to the Site Treatment Plans required under the Federal Facility Compliance Act. The Final WM PEIS preferred alternative for low-level mixed waste is a combination of parts of the Decentralized and Regionalized Alternatives, and is intended to be consistent with the configuration established through the Federal Facility Compliance Act. The preferred alternatives, and the reasons they are preferred, are described in Section 3.7 in Volume I of the WM PEIS.

Comment (541)
Commentors oppose the siting of programmatic waste management activities at BNL. Some commentors gave no reason for their opposition; others expressed one or more of the reasons listed below.

- The overall risks to public health and safety and the quality of the environment from proposed waste management activities

- Specific Risks: Risks to endangered species; risks to sensitive habitat (such as the Long Island Pine Barrens and coastal ponds); potential groundwater and drinking water contamination

- Factors: The population density around the site; the "high rate" of breast cancer on Long Island; the site's location over a sole-source aquifer; existing water and air pollution

- Opinions: That DOE could find a better site; that the sum of legal impediments and environmental factors makes BNL extremely inappropriate for disposal of mixed and/or low-level wastes; that the

land at BNL is unsuitable for disposal of wastes; that in light of BNL's successful waste source reduction program, DOE should continue to focus on cleaning up existing contamination rather than bringing in new wastes from other sites; and that there is no guarantee that onsite treatment of waste is less damaging to the environment than shipping the waste to another facility.

Response

BNL is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation as a major site does not mean the site will be selected for a programmatic waste management role. Under two of the 36 alternatives in the PEIS (Decentralized Alternatives for low-level mixed waste and low-level waste), DOE would construct new facilities for BNL to manage its own waste. BNL would not dispose of any offsite wastes. Under the remaining alternatives, BNL's low-level mixed waste and low-level waste would be disposed of at other DOE sites.

The WM PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10 for results; see Volume III, Section C.4.1.2.3, for analysis methods. The analysis considered potential impacts, including most of the impacts that concern commentors, from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives at all sites considered in the PEIS would be small. For those impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts, and where applicable, to comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at BNL would have a significant negative impact on public health and safety or the natural environment.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. These are not final decisions. Records of Decision published in the *Federal Register* will announce DOE's decisions and the reasons for the decisions if they differ from those provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies, will be considered in developing Records of Decisions.

The WM PEIS addresses water resources as site-specific impact parameters. Major surface-water features associated with BNL include the onsite Peconic River and its intermittent tributary. Onsite streams and the Peconic River receive treated wastewater. Discharge monitoring in 1991 showed that all concentrations were within applicable standards, except for trichloroethylene. The lower aquifer system (Magothy and Raritan Formations) and the Pleistocene Upper Glacial Aquifer, which are all considered sole-source aquifers, are the major groundwater units at BNL. Groundwater monitoring in 1991 showed that eight parameters exceeded New York State Drinking Water Standards. Some groundwater contamination has migrated offsite, and concentrations have been found to exceed drinking water standards. However, as described in Sections 6.6.2 and 7.6.2 in Volume I, the WM PEIS water quality analysis indicated that disposal of low-level mixed waste and low-level waste at BNL would not cause groundwater concentrations to exceed drinking water standards that were used as an indication of acceptable groundwater quality.

3.5.2 Brookhaven National Laboratory

BNL is located in the Central Pine Barrens and within the Peconic Estuary system. One Federally listed endangered species (the Peregrine Falcon) and several State-listed species have been observed on or near the site. DOE is aware of the sensitive ecological resources associated with BNL, and would locate new waste management facilities to avoid impacts to threatened and endangered species, nearby wetlands, and other sensitive habitats.

DOE used data from the 1990 U.S. Census to estimate that about 5,740,000 people live within 50 miles from the center of BNL. This population could possibly be exposed to emissions released to the atmosphere from waste treatment facilities. Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the PEIS (Volume I, Sections 6.4, 7.4, and 8.4). Offsite population human health risks and offsite maximally exposed individual health risks are also cumulative impact parameters addressed by the PEIS (see Volume I, Section 11.2). The health risk analyses suggest that adverse health effects from the operation of waste treatment facilities located at BNL would be small. Public health impacts from disposal would similarly be small after implementation of mitigation measures necessary to ensure that DOE would not exceed radionuclide- and/or chemical-specific limits. Further, waste management facilities are not expected to contribute to radiation exposure of the general public or result in radiation emissions to the environment.

A major focus of the WM PEIS is to help DOE establish a Department-wide program to safely and efficiently manage radioactive and hazardous wastes. However, issues regarding existing pollution, a site's waste management record, and actual site cleanup and pollution prevention efforts are more appropriately evaluated in sitewide or project-level studies.

While DOE understands and appreciates individual concerns, some alternative must be selected in light of the considerable amount of existing radioactive and hazardous wastes. Be assured that DOE is committed to managing its wastes to protect human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The WM PEIS will help DOE make sound waste management decisions.

The proximity of a waste management site to populated areas is only one of many factors in evaluating alternatives. DOE must consider and balance other factors to achieve its objective of safe and efficient treatment, safe and secure storage, and ultimate disposal of each waste type. For example, DOE must consider waste transportation requirements, and the PEIS presents alternatives that would minimize waste transportation (Decentralized Alternatives) and that would maximize waste transportation (Centralized Alternatives). Although siting waste management activities in less-densely populated or remote areas could reduce the potential for some impacts, the risks of transporting wastes over longer distances to reach remote sites would increase the potential for other impacts. Section 1.7.3 in Volume I lists and describes examples of the criteria and factors DOE will consider in the decisionmaking process.

DOE prepared the WM PEIS as a part of its effort to develop an overall national strategy on which to base waste management decisions. After DOE announces its decisions and before selecting specific locations for waste management facilities on sites, DOE will consider the results of existing relevant or required new NEPA reviews, which would include more detailed evaluations of the potential for environmental impacts based on site-specific conditions.

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Comment (2090)
BNL is located in the Long Island Nassau-Suffolk Aquifer System, and WVDP is located in the Cattaraugus Creek Aquifer System. These have been designated as sole-source aquifers pursuant to the Safe Drinking Water Act. The sensitivity and importance of these sole-source aquifers should be considered in the selection of the sites. Specifically, site-specific NEPA documentation should include a detailed assessment of the potential groundwater impacts. A copy of EPA's guidance for conducting groundwater analyses in sole-source aquifers is available upon request.

Response
Volume I, Chapter 4, and Volume III, Section C.4.3.5, of the WM PEIS identify DOE sites, including BNL and WVDP, that are located over EPA-designated sole-source aquifers. DOE decisionmakers will consider the locations of sites in relation to sole-source aquifers when determining future waste management configurations. The minimization of environmental impacts is a decision criterion. See Volume I, Section 1.7.3.

In addition, before selecting locations for facilities on sites, DOE will consider the results of existing relevant or required new NEPA reviews, which would include detailed assessments of potential groundwater impacts. DOE will follow applicable guidelines, including those from EPA, in conducting its groundwater analyses.

Comment (2109)
Siting multiple disposal sites around the country would be poor waste management strategy and would play into the hands of those who would close the lab [BNL] and DOE as the lab's major funder.

Response
NEPA and CEQ regulations require the action agency to include a discussion of reasonable alternatives to a proposed action in an EIS. The agency must provide sufficient information for each alternative so that reviewers can evaluate the comparative merits of those alternatives. Four broad categories of alternatives encompass the reasonable alternatives available to DOE for siting of facilities for the five waste types that are considered in the WM PEIS. The No Action Alternative, Decentralized Alternatives, Regionalized Alternatives, and Centralized Alternatives. However, under each category of alternatives, there are many possible combinations for the number and location of DOE waste management sites. To narrow these combinations to a level where meaningful analysis could occur, DOE selected representative alternatives for analysis under each category.

Implementation of the waste management programmatic strategy could entail consolidation, or downsizing, of waste management activities at some sites or upgrading in more regionalized or centralized approaches. The PEIS does not *make* those decisions; rather, it makes recommendations. Decisions will be based on this PEIS, regulatory compliance, budgets, schedules, compliance with site agreements with States, national priorities, and other DOE studies. Decisions will be announced in Records of Decision to be published in the *Federal Register*.

Comment (2813)
A commentor stated that BNL is inappropriate for hazardous wastewater treatment, and is concerned that DOE believes sewage or wastewater treatment processes are appropriate for liquid hazardous wastes at BNL. BNL received a permit from New York State in 1995 for a hazardous waste management facility. The permit was solely to allow BNL to store hazardous wastes onsite prior to

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shipment for appropriate disposal. However, [the commentor] "is shocked" to discover that DOE considers shipment of liquid hazardous wastes to be inappropriate and requested that DOE amend the WM PEIS concerning the generic treatment of hazardous wastes at DOE facilities to reflect a policy that is truly applicable complex-wide.

Response
The continued treatment of hazardous wastewater onsite at DOE facilities is one of the assumptions identified in Volume I, Section 10.2.3, of the WM PEIS. For purposes of analysis the WM PEIS considers hazardous waste at the 11 sites which collectively produce 90% of that waste type. Due to the programmatic nature of the document, the WM PEIS analysis is generic in character and based on assumptions to allow for meaningful comparison of programmatic management options. DOE believes conclusions would not change, programmatically, if all sites (including BNL) were specifically analyzed. All sites, however, will be subject to the decision made based on the WM PEIS.

Most DOE hazardous waste consists of wastewater that contains less than a 1% concentration of organic materials. DOE currently treats hazardous wastewater onsite and will continue to do so in the future because wastewater is not difficult to treat, but it is difficult and expensive to transport to an offsite treatment facility. DOE believes that hazardous wastewater can be treated onsite within regulatory limits. DOE complies with all applicable statutes and regulations in treating hazardous waste onsite at BNL. DOE does not treat nonwastewater liquid hazardous waste with its sewage.

The focus of the PEIS alternatives is on the RCRA-defined nonwastewater hazardous waste that is used for fuel burning onsite or shipped offsite for incineration. This nonwastewater hazardous waste, predominantly solvents and cleaning agents, is about 1% of the DOE hazardous waste.

DOE revised Section 1.5.6 in Volume I of the WM PEIS to explain that non-hazardous and nonradioactive sanitary waste, non-hazardous solid waste, and hazardous and low-level process wastewater are not included in the PEIS analysis. They raise site-specific issues and, therefore, not appropriately addressed in a programmatic EIS.

Comment (2815)
BNL has very little low-level mixed waste waste and no low-level waste. BNL should not receive any offsite wastes because it does not produce a significant quantity of its own.

Response
Table 6.1-1 in Volume I of the WM PEIS is based on the 1994 Mixed Waste Inventory Report, which indicates that BNL has 190 cubic meters of estimated inventory plus 20 years generation of low-level mixed waste. The 1992 Integrated Data Base, the source of LLW data for the Draft WM PEIS, did not provide LLW data for BNL. Thus, the evaluation in the Draft PEIS for BNL did not include impacts from management of LLW. However, Tables 1.6-2 and 7.1-1 in Volume I of the Final PEIS show that the inventory plus the 20-year projected LLW volume at BNL is 5,600 cubic meters. The updated data were obtained from the 1995 version of the Integrated Data Base. Consideration of updated LLW estimates for BNL are included in Appendix I in Volume IV of the Final PEIS. Appendix I addresses the issue of how updated waste projections affect PEIS conclusions.

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BNL would manage only its own low-level mixed waste and low-level waste, and would dispose of such wastes onsite only under the Decentralized Alternatives. BNL would not dispose of any offsite wastes.

Comment (2850)
BNL and its surrounding area are too environmentally sensitive for "indefinite storage." Materials should be shipped off this site even under the No Action Alternative.

Response
The No Action Alternative can be characterized as the status quo alternative. Wastes would continued to be treated, stored, and/or disposed of at each site using only existing or planned facilities. The No Action Alternative for BNL means the following: for low-level mixed waste, BNL would treat wastewater only and store BNL low-level mixed waste onsite; BNL would ship low-level waste to Hanford for disposal. Note that RCRA Subtitle C implementing regulations governing low-level mixed waste, prohibit "indefinite storage" of waste that requires treatment.

As to the environmental sensitivity of the BNL area, DOE found that the construction of waste management facilities would entail a limited loss of acreage. DOE should be able to locate new waste management facilities in a manner to minimize adverse impacts to sensitive ecological resources. Actual waste management facilities will be analyzed in future sitewide or project-level NEPA reviews.

Comment (2856)
The WM PEIS states that Regionalized Alternatives are preferred for low-level mixed waste. There are blank spaces in Table 3.4-1 for the Regionalized Alternatives under BNL. If this means that BNL would not become a regional treatment and disposal site for low-level mixed waste, that low-level mixed waste would be shipped from BNL off Long Island, and that no low-level mixed waste would be shipped from offsite locations to BNL, the commentor supports this preferred alternative.

Response
DOE's preferred alternative for treatment of low-level mixed waste is a combination of parts of the Decentralized and Regionalized Alternatives. At BNL, the preferred treatment alternative is regionalized treatment, under which DOE would ship its low-level mixed waste offsite for treatment; although, some low-level mixed waste could be treated onsite, consistent with the Site Treatment Plan. All BNL low-level mixed waste would be disposed of offsite under the preferred alternative. Note, however, that these are not final decisions. Decisions will be announced in Records of Decision published in the *Federal Register* following publication of the Final WM PEIS.

Comment (2869)
As BNL is not an appropriate site to consider for the disposal of hazardous and/or radioactive wastes, BNL should be deleted from all of the tables in Chapters 4, 6, and 7.

Response
NEPA requires DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, BNL was analyzed as a reasonable potential waste management site for its own low-level mixed waste and low-level waste. For this reason, BNL is listed in the tables in Chapters 4, 6, and 7 in Volume I of the WM PEIS.

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Comment (2965)
The No Action Alternative for hazardous and/or radioactive waste is completely inappropriate for BNL. Because BNL is in a very environmentally sensitive area, there should be no treatment or storage of low-level mixed waste at this site.

Response
NEPA requires Federal agencies to include a discussion of reasonable alternatives in an environmental impact statement. DOE must provide sufficient information for each alternative so that reviewers may evaluate the comparative merits of those alternatives.

Under the WM PEIS alternatives, BNL would manage only its own low-level mixed waste and low-level waste. BNL would dispose of such wastes onsite only under the Decentralized Alternative. It would not dispose of any offsite wastes.

Although the Final WM PEIS does identify preferred alternatives for each waste type, actual programmatic decisions will be announced in Records of Decision. Moreover, the WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules and national priorities, as well as other DOE studies, will be considered in moving to Records of Decision. The minimization of environmental impacts, e.g., on ecological resources, is a decision criterion.

3.5.3 Fernald Environmental Management Project

Comment (1761)
The WM PEIS lists the Fernald Environmental Management Project (FEMP) as a possible disposal facility for other sites' waste. However, DOE, EPA, and the State of Ohio have already accepted the citizens' recommendation explicitly rejecting the idea that any offsite wastes come to FEMP for disposal.

Response
As described in Chapters 6 and 7 in Volume I of the Final WM PEIS, the alternatives for low-level mixed waste and low-level waste (the waste types considered for management at FEMP) do not include disposal at FEMP of waste generated offsite. Table 7.3-4 in Volume I of the Draft WM PEIS was misleading in identifying waste from sites other than FEMP (Ames, ANL-E, Fermi, Mound) being disposed of at FEMP. This table has been corrected in the Final WM PEIS.

Comment (2339)
Regionalized Alternative 2 is a good choice for low-level waste because it includes FEMP in the process. However, this choice could be precluded because of the preexisting agreements between FEMP and NTS.

Response
Historically, FEMP's low-level radioactive waste has been shipped to NTS for shallow land burial. FEMP ships this waste to NTS in accord with direction from DOE Headquarters and Nevada Defense Waste Acceptance Criteria NVD-325. There are no binding agreements between FEMP and NTS that would preclude the Regionalized 2 Alternative.

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Comment (1148)
We prefer that high-level waste from WVDP be stored at the Hanford Site rather than at SRS.

Response
Thank you for commenting. DOE's preferred alternative for managing high-level waste, and the reason it is preferred, is identified in Section 3.7 in Volume I of the WM PEIS. Programmatic decisions will be announced in Records of Decision published in the *Federal Register*. Budgets, schedules and national priorities, as well as other DOE studies will be factored into the decisionmaking process.

Comment (1952)
Of those commentors opposing the siting of programmatic waste management activities at the Hanford Site, some commentors gave no reason for their opposition and others expressed one or more of the reasons listed below:

- The overall risks to public health and safety (including Native Americans) and the quality of the environment from normal operations, facility accidents, and transportation accidents; including the potential contamination of water from buried waste;

- Contamination of critical sage-brush habitat in violation of the Endangered Species Act;

- That waste should be kept where it is, and DOE should not be allowed to import to Hanford and bury mixed radioactive and hazardous wastes from other nuclear weapons plants at Hanford;

- That Hanford facilities be used to treat mixed waste or low-level waste from other nuclear weapons plants only if there is no impact to Hanford cleanup schedules and if the wastes are not stored at Hanford before or after treatment for prolonged periods (a few commentors also expressed the opposite view);

- Seismic activity at Hanford was not considered with regard to long-term impacts of the treatment and storage of high-level waste; such site-specific analyses must be conducted at Hanford before any irreversible or irretrievable commitment of resources;

- That Hanford is not suitable for receiving additional wastes, as it is a Superfund site and existing wastes are not being properly stored or dealt with; Hanford cleanup needs to happen, not more dumping; modifications to the Hanford Site Tri-Party Agreement would be opposed; all waste should be kept in aboveground monitored storage; DOE should not create any more nuclear waste; and that DOE needs to determine the real total costs of these actions.

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at the Hanford Site was analyzed as a reasonable option under some WM PEIS waste management alternatives. Hanford is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites.

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Radioactive and hazardous wastes are generated at DOE facilities from the development, production, testing, and disassembly of nuclear weapons; from basic and applied research; and from energy research activities. DOE will continue to perform these and other functions within its mission until directed otherwise by the President and Congress.

The Hanford Site is being analyzed in the PEIS as a candidate location for management of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste.

For low-level mixed waste, DOE evaluated seven separate alternatives. Under five of these alternatives, Hanford would serve as a disposal site for its own low-level mixed waste. Under the Decentralized Alternative and Regionalized Alternative 1, Hanford would also receive low-level waste from two small sites amounting to less than 1% of the total volume disposed of at Hanford. For Regionalized Alternatives 2 and 4, Hanford would receive small volumes of wastes from six other sites amounting to 7% of the total onsite disposal at Hanford. For Regionalized Alternative 3, all Hanford low-level mixed waste would be shipped to other sites for disposal. Only under the Centralized Alternative would the Hanford Site be responsible for disposing of a substantial quantity of waste other than its own (86% of the total volume disposed of would be received from other sites).

For low-level waste, DOE evaluated 14 separate alternatives, 12 of which considered Hanford as a potential site for disposal. Under No Action, Hanford would continue to treat and dispose of low-level waste generated onsite, as well as offsite wastes that would amount to 68% of the total volume disposed of at Hanford. For the Decentralized Alternative and Regionalized Alternatives 1, 2, and 3, Hanford would only dispose of the wastes generated on the site. For Regionalized Alternatives 4 and 5 and Centralized Alternatives 3 and 4, Hanford would dispose of its own waste, as well as offsite wastes amounting to 8% of the total volume disposed of. Hanford would dispose of a greater amount of wastes generated off the site under Regionalized Alternative 6 (80%) and Centralized Alternatives 1 and 5 (both 94%), in addition to disposing of its own waste.

Under the transuranic waste management alternatives, Hanford would treat transuranic waste, and up to 10% of the total volume that it treats would come from other sites. However, no transuranic waste disposal would take place at Hanford.

Hanford currently stores high-level waste on the site. Under each of the alternatives for managing this waste type, all of the existing and planned high-level waste being stored at Hanford would eventually be transported off the site. Under Regionalized Alternative 2, Hanford would also receive and temporarily store high-level waste from WVDP prior to its shipment to a permanent storage location.

Under three of the four alternatives proposed for hazardous waste management, the Hanford Site would continue to ship all hazardous waste off the site for treatment either at a commercial facility or at another DOE "hub" site (INEL). For the remaining alternative (Regionalized Alternative 1), Hanford would serve as a hub site managing its own waste and hazardous waste received from LLNL. Under this alternative, Hanford would treat some of the hazardous wastes onsite, with any remaining waste being shipped off the site for treatment at a commercial facility.

The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10 for results; see Volume III, Appendix C, for analysis methods. The analysis considered potential impacts, including

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most of the impacts that concern commentors, from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives for all sites considered in the PEIS would be small. For those impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts. Therefore, there is no reason to believe that waste management activities at Hanford would have a significant negative impact on the natural environment or public health and safety.

DOE used data from the 1990 U.S. Census to estimate that about 378,000 people live within a 50-mile radius of the existing 200-Areas waste management facilities at Hanford. This population could possibly be exposed to emissions released to the atmosphere from waste management activities. Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the PEIS (Volume I, Sections 6.4, 7.4, and 8.4). Offsite population human health risks and offsite maximally exposed individual health risks are also cumulative impact parameters addressed by the PEIS (see Volume I, Section 11.6). The health risk analyses indicate that there is a potential for increased adverse health effects from the operation of waste treatment or disposal facilities located at Hanford. However, if DOE decides to site a new waste management facility at Hanford, it would establish design and operational limitations to ensure that releases from the facility would be maintained below regulatory limits. Appendix D in Volume III describes in more detail waste management facility human health risk estimates.

The PEIS also includes a detailed assessment of risks associated with accidents from both rail and truck transportation, including low-probability/high-consequence and high-probability/low-consequence accidents. DOE found that risks from transportation accidents would be low under all alternatives. DOE provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to quickly respond to an accident and assist local emergency response personnel, if requested by local agencies.

Section 4.4.4 in Volume I of the WM PEIS states that the seismicity of the Columbia Plateau is relatively low, although shallow, low intensity earthquakes occur throughout the Hanford Site area, although quakes of greater magnitude have occurred in the plateau region. Section 2.2.1.1 of the WM PEIS Affected Environment Technical Report further discusses the existing known faults within the Hanford area and the seismic history of the Columbia Plateau. The technical report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS.

Groundwater monitoring at Hanford in 1992 showed that 14 parameters exceeded comparison criteria. Preliminary investigations have identified four major groundwater contaminant plumes, which have been found to enter the Columbia River in at least three locations. However, any future waste management facilities at Hanford would be appropriately designed and constructed to minimize the potential for leaks affecting groundwater.

The PEIS ecological risk assessment found that environmental risks from treatment would be low at Hanford under all waste management alternatives, and environmental risk from disposal would be low after implementation of radionuclide- and/or chemical-specific limits.

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Sections 6.14, 7.14, 8.14, 9.14, and 10.14 of the WM PEIS compare potential costs by alternative for each waste type. In addition, Volume II of the PEIS contains data tables that include cost information for each site.

As evidenced by this PEIS, DOE does not intend to "dump" waste in the ground. DOE intends to properly manage the wastes to protect human health and the environment. The opinion that waste should be managed where it is generated most closely matches the No Action and Decentralized Alternatives (see Volume I, Chapter 3), which are carefully evaluated in this PEIS. Further, no wastes would be shipped to Hanford for treatment until suitable treatment facilities become available.

Other sites are being analyzed to take large quantities of Hanford transuranic waste and high-level waste for disposal. When decisions are made based on the WM PEIS, Hanford could be asked to take some or all of the low-level waste and low-level mixed waste in the DOE complex. Decisions will be based on impacts evaluated in the WM PEIS, as well as other criteria. Certainly, public input and equity will be considered in the final decisions.

DOE recognizes that the siting of waste management facilities may be perceived negatively by some people. DOE is committed to protecting human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The PEIS will help DOE make sound waste management decisions.

The WM PEIS uses generic treatment and disposal technologies and a number of conservative assumptions to develop its programmatic evaluations of the relative impacts of different waste management alternatives. The results of these impact analyses are screening-level estimates; prior to implementing any decisions and committing resources, DOE would develop more precise estimates of potential impacts. Issues regarding existing pollution, a site's waste management record, and actual site cleanup efforts will be evaluated at the site level.

DOE prepared the PEIS as part of its effort to develop an overall national strategy on which to base waste management decisions. This strategy includes compliance with all laws that govern protection of the environment, including the Endangered Species Act. Based on projected land requirements, DOE considered the potential for proposed waste management activities to affect sensitive habitats and species. Because the land required for the construction of waste management facilities would be a small fraction of available nonsensitive lands, DOE would be able to avoid direct impacts to sensitive lands. Further, DOE would have enough flexibility to avoid indirect impacts, such as those that could result from building access roads. If DOE selects Hanford for a specific waste management role, it would consider in greater detail potential impacts to endangered species and natural resources.

Preexisting site-specific plans and agreements, such as the Tri-Party Agreement, will be considered by decisionmakers. However, it is possible that some compliance agreements might need to be revisited as a result of decisions made based on the WM PEIS.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. These are not final decisions. Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets,

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schedules, and national priorities, as well as other DOE studies will be considered in developing Records of Decision.

Comment (2181)
Washington State voters passed a law, by an 84% margin, stating that we are not going to be your high level nuclear dump, not for temporary storage, nor for an underground repository. The WM PEIS does not examine alternatives to Yucca Mountain. Since Yucca Mountain is not likely to open on time, or at all, or have enough room for DOE wastes, Hanford would become a permanent waste dump.

Response
While the WM PEIS analyzes impacts from the storage and transportation of canisters that contain vitrified high-level waste, high-level waste treatment and disposal are outside the scope of the PEIS. High-level waste treatment is addressed through sitewide or project-level NEPA reviews identified in Sections 9.1.2.1 through 9.1.2.4 in Volume I of the PEIS.

The Nuclear Waste Policy Act, as amended in 1987 (Public Law 100-23), designated that a repository for high-level waste and spent nuclear fuel be developed and that deep geologic disposal be at Yucca Mountain, the only option studied for the disposal of high-level waste. Although the law does not require that the repository be at Yucca Mountain in Nevada, it identifies only Yucca Mountain for the site characterization activities that would precede the selection of a repository location. Potential environmental consequences of constructing and operating a high-level waste repository at the site is being evaluated in the Yucca Mountain Repository EIS. If the high-level waste repository is not established at Yucca Mountain, DOE would have to reevaluate long-term plans for disposition of high-level waste.

As described in Section 9.3.5 in Volume I, the WM PEIS does examine the environmental impacts of long-term storage of high-level waste canisters at Hanford if the repository does not open on time. The impacts of long-term *storage* of vitrified high-level waste at Hanford would be small.

Comment (2238)
The WM PEIS should include Chapter 5 of the Hanford Remedial Action EIS, including the land-use-based and health-risk-based alternatives.

Response
The WM PEIS is a national and programmatic study to help DOE develop a strategy to manage the radioactive and hazardous wastes for which the Waste Management Program is responsible. The alternatives in the Hanford Remedial Action EIS deal primarily with environmental restoration, not waste management, activities at Hanford. Environmental restoration activities are not within the scope of the WM PEIS. However, the PEIS does evaluate how the comparison among waste management alternatives could be affected by estimated volumes of environmental restoration waste that could be transferred to Waste Management Program responsibility (see Volume III, Appendix B). In addition, Section 1.8 in Volume I describes the relationship of this PEIS to other actions and programs, including the Hanford Remedial Action EIS.

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Comment (2260)
The workforce at Hanford is demoralized by no action. We need to identify the opportunities that exist from the legacy of the past. We cannot tolerate delays. We will never have all the answers; we will have to make decisions on incomplete information.

Response
The WM PEIS does not qualitatively analyze environmental restoration wastes ("the legacy of the past"), nor does the scope of the WM PEIS include environmental restoration alternatives. Section 1.7.1 in Volume I of the PEIS explains the change in scope of the WM PEIS, which removed environmental restoration alternatives from the analysis, primarily because of the site-specific nature of environmental restoration activities and the uncertainty about the characteristics of environmental restoration waste at many DOE sites.

Section 1.8.1 in Volume I does include descriptions of other Hanford NEPA documents and their relationship to the WM PEIS. Among these documents is the Hanford Remedial Action Draft EIS, which analyzes the impacts of remediating past-practice waste sites that are DOE's responsibility. It will help establish future land-use objectives to assist DOE in developing a remediation strategy for the Columbia River, Central Plateau, and all other geographic areas of the Hanford Site.

Section 11.6.2 in Volume I of the WM PEIS notes that the impacts of actions addressed in the Hanford Remedial Action Draft EIS are included in the cumulative impacts analysis for Hanford.

Comment (3088)
Since the State of Nevada indicates it does not want the high-level waste, Hanford could become a permanent centralized storage site under the Centralized Alternative, which would affect and require a modification to the Tri-Party Agreement. All of WVDP's 300 canisters would be shipped to Hanford because WVDP would generate all of its canisters prior to 2015; if acceptance of the high-level waste at the geologic repository is delayed past 2015, all canisters from WVDP, SRS, and INEL could be shipped to Hanford for storage prior to shipping to Yucca Mountain. Nevada might never accept these canisters, leaving Hanford a permanent storage site.

Response
As described in Section 9.3.5 in Volume I, the WM PEIS examines the environmental impacts of long-term storage of high-level waste canisters at Hanford if the repository designated by the Nuclear Waste Policy Act, as amended in 1987 (Public Law 100-23), does not open on time. The impacts of long-term storage of vitrified high-level waste at Hanford would be small.

Comment (3166)
One commentor stated that the State of Washington and the U.S. EPA should not allow DOE or the U.S. Department of Defense to transfer to the Hanford Site any hazardous and radioactive waste unless the following criteria are met. Transport of offsite waste to Hanford for treatment will require careful planning of routes and consideration of weather emergencies to minimize the likelihood of an accident. Emergency preparedness for minimizing the impacts from an accident will require financial support from DOE to State, Tribal and local involvement, including adequate equipment and training. When materials are shipped, timely notification should be provided to transportation agencies.

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Response
Sections 4.3.10 in Volume I and E.9 in Volume IV of the WM PEIS describe the transportation planning and route selection processes used by DOE. Transportation planning includes considerations of emergency planning and shipment notification requirements.

DOE requirements for emergency response preparedness are contained in DOE Order 151.1, *Comprehensive Emergency Management Systems and Planning for Preparedness for Operational Emergencies*. Emergency preparedness for transport of radioactive wastes is a vital part of the transportation planning process.

As a shipper of radioactive materials, DOE is responsible for complying with the regulations applicable to the safety of its shipments. This includes assisting State, Tribal, and local emergency responders if an accident occurs. DOE's Transportation Emergency Preparedness Program includes initiatives on planning and training, exercises, and technical assistance to State, Tribal, and local governments. DOE further provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to quickly respond to an accident and assist local emergency response personnel, if requested. DOE's Radiological Assistance Program teams are administered by eight Regional Coordinating Officers.

Comment (3421)
DOE's low-level radioactive waste is not regulated. At Hanford, it is buried in unlined, unregulated trenches that do not meet commercial standards and lack appropriate monitoring. DOE now wants to bury in Hanford's unlined and unregulated low-level radioactive waste trenches waste that has been considered mixed toxic or carcinogenic dangerous waste under the Washington State Dangerous Waste Law. Quantities of these wastes and corresponding risks and impacts (e.g., health, water, wildlife, and air) of having these wastes in the same unlined, unregulated burial trenches as radioactive wastes are not disclosed in the WM PEIS.

Response
Assuming that the comment might refer to low-level mixed waste after treatment, it is important to note that the disposal facilities for treated low-level mixed waste would be designed to comply with the applicable Dangerous Waste Regulations of Washington State.

Quantities of low-level mixed wastes and hazardous waste, including those referred to by the commentor, and the corresponding impacts analyses are found in Chapters 6 and 10, respectively, in Volume I of the PEIS. Further information is provided in Appendix I in Volume IV of the PEIS, and in technical reports available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final PEIS.

Comment (3715)
Even without considering environmental restoration and decontamination wastes, the Centralized Alternative for low-level mixed waste and hazardous waste could cause adverse air quality impacts, pose health risks along transportation corridors, make Hanford a sacrifice zone, and impact air and water resources and transportation corridors by treating/incinerating mixed waste from other sites at privatized facilities now planned by Hanford. In addition, if DOE chooses the Centralized Alternative for disposal of all DOE low-level mixed waste at Hanford, Hanford would get 6.3 times more waste than it already has plans to dispose of.

3.5.4 Hanford Site

Site Treatment Plans for other weapons plants include plans to ship mixed waste to Hanford for long-term storage/disposal in violation of Hanford Advisory Board advice, Joint States' principles, and DOE's own promises. Why do we have to worry about DOE choosing the Centralized Alternative for disposing of all of the Nation's low-level mixed waste at Hanford? Because DOE's cost estimate for the Centralized Alternative is $5 billion less than for the Decentralized Alternative.

Response
DOE analyzed the Centralized Alternatives for low-level mixed and hazardous waste to compare reasonable alternatives, as required by the CEQ regulations for implementing NEPA. Potential impacts that were analyzed included air quality, health risks from transportation, ecological resources, and land requirements. Cost was only one item among many analyzed. As waste is consolidated at fewer sites, costs for waste management facilities decrease. DOE identifies its preferred waste management alternatives and the reasons they are preferred in Volume I, Section 3.7, of the Final PEIS.

The WM PEIS provides the NEPA basis for the Federal Facility Compliance Act low-level mixed waste treatment configuration. The initial Site Treatment Plans were based on discussions among States, EPA, Tribal Governments, and the public. The implementing Compliance Orders can be modified to reflect technical, schedule, and other additional inputs as the treatment configuration and needs evolve.

Comment (3743)
If DOE chooses the Centralized Alternative for disposal of all low-level waste at the Hanford Site, even without consideration of Hanford's own cleanup waste requirements, the site's total wastewater treatment capacity would be exceeded.

Response
As noted in Section 1.7.3 in Volume I, in accordance with NEPA, the Final WM PEIS identifies a preferred alternative for each waste type. As noted in Section 1.7.3 in Volume I, DOE selected these preferred alternatives based on factors and criteria that include public input; favoring strategies that further DOE mission objectives; ensuring alternatives are consistent with site capabilities and availability of technologies; etc. Preferred alternatives and the reasons they are preferred are discussed in Section 3.7 in Volume I. DOE will announce its decisions in Records of Decision to be published in the *Federal Register*. Before selecting locations for waste management facilities on sites, DOE will consider the results of existing relevant or required new NEPA reviews, which would address in more detail potential environmental impacts based on site- specific conditions, including wastewater treatment capacity. If an alternative selected by DOE would result in the Hanford Site's total wastewater treatment capacity being exceeded, expanded wastewater treatment capacity would be among the new facilities required by that alternative.

3.5.5 Idaho National Engineering Laboratory

Comment (537)
DOE needs to understand that the disposal of low-level waste over an aquifer will not be a preferred alternative for Idaho; this would be a non-preferred alternative.

Response
Low-level waste would be disposed of at INEL under the No Action, Decentralized, and Regionalized 1 through 5 Alternatives. The WM PEIS analysis of the impacts to water quality from disposal showed that low-level waste disposal at INEL would not cause groundwater concentrations to exceed or even approach relevant drinking water standards under any of the low-level waste alternatives. More detail on water quality impacts from low-level waste management is provided in Section 7.6.2 in Volume I of the WM PEIS. DOE would conduct disposal unit performance assessments before siting disposal facilities at INEL or any site. Siting of disposal facilities will not occur before DOE has considered the results of sitewide or project-level NEPA reviews.

Comment (2583)
The WM PEIS states that INEL was eliminated from consideration as a Regionalized Alternative site for high-level waste because it has no existing or approved storage facilities. In that case, why is INEL appropriate for other alternatives?

Response
Four DOE sites either store or manage high-level waste: the Hanford Site, INEL, SRS, and WVDP. The WM PEIS analyzes the impacts of stored vitrified high-level waste. However, high-level waste at INEL is not vitrified; rather, it is in liquid or calcined forms pending future processing to a final waste form, and no high-level waste canister storage facility exists or is approved for INEL.

Because the site is not authorized to treat high-level waste to a final waste form acceptable for disposal in the candidate repository, the No Action Alternative assumes no canister production at INEL. INEL is also assumed to have no canister storage facilities under the No Action Alternative.

For all alternatives other than No Action, an average annual production rate of 48 canisters per year is assumed for INEL. Under the Decentralized Alternative, storage capacity would be constructed at the site equal to the anticipated total production of high-level waste canisters at INEL.

The Regionalized Alternatives for high-level waste address transporting the relatively small number of WVDP high-level waste canisters to either the Hanford Site or SRS, both of which have existing or planned storage facilities that could accept these canisters in the near term. In contrast, INEL was eliminated from consideration as a storage site *for WVDP canisters* under the Regionalized Alternatives because it has no existing or approved storage facilities for high-level waste. However, adequate storage capacity would be constructed at INEL under the Regionalized Alternatives for managing high-level waste canisters produced onsite.

Comment (2881)
The State of Idaho supports those alternatives proposing to construct or operate waste treatment facilities on INEL consistent with requirements of the Spent Nuclear Fuel Court Order of 1995, the Federal Facility Compliance Act, and the INEL Site Treatment Plan. The State opposes any proposed alternative specifying the siting and operation of any waste disposal facility over the Snake River Plain

sole-source aquifer. Because of the State's dependence on the aquifer, it also opposes any alternatives under which large amounts of offsite waste would be brought to INEL for disposal.

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at INEL was analyzed as a reasonable option under some of the WM PEIS waste management alternatives. INEL is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites.

INEL is analyzed in the WM PEIS as a candidate location for management of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste.

For low-level mixed waste, DOE evaluated seven separate alternatives. Under four of these alternatives, INEL would serve as a disposal site for low-level mixed waste. Under the Decentralized Alternative, INEL would only dispose of its own low-level mixed waste. For Regionalized Alternatives 1 and 2, INEL would also receive wastes from other sites that would amount to 10% and 9%, respectively, of the total volume disposed of at INEL. Only under Regionalized Alternative 4 would INEL receive and dispose of a substantial amount of low-level mixed waste from other sites (76% of the total volume disposed of at INEL). Conversely, under Regionalized Alternative 3 and the Centralized Alternative, all INEL low-level mixed waste would be shipped off the site to another location for disposal.

For low-level waste, DOE evaluated 14 separate alternatives, 7 of which considered INEL as a potential site for disposal. For the No Action, Decentralized, and Regionalized 1, 2, 3, and 4 Alternatives, INEL would only dispose of its own waste. Under Regionalized Alternative 5, INEL would receive and dispose of low-level mixed waste from other sites (69% of the total volume disposed of at INEL). Under Regionalized Alternatives 6 and 7, and the five Centralized Alternatives, INEL low-level waste would be shipped off the site to another location for disposal.

Under several of the transuranic waste management alternatives, INEL would treat transuranic waste, and up to 31% of the total volume that it treats could come from other sites. However, no transuranic waste disposal would take place at INEL.

INEL currently stores high-level waste onsite. Under the alternatives for managing this waste type (with the exception of No Action), the existing and planned high-level waste stored at INEL would eventually be transported off the site to a permanent storage location. Under the No Action Alternative, current onsite storage and management practices for high-level waste would continue.

Four alternatives were analyzed for hazardous waste management. Under the Decentralized Alternative, all INEL hazardous wastes would be shipped off the site for commercial treatment. Under No Action and Regionalized Alternative 1, INEL would continue to treat some hazardous wastes produced on the site, with any remaining waste being shipped off the site for treatment at a commercial facility. For Regionalized Alternative 2, INEL would also serve as a "hub" location for receiving hazardous wastes from several western region sites prior to onsite or offsite treatment.

The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10 for results; see

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Volume III, Appendix C, for analysis methods. The affected environment at each major site was considered in the PEIS analysis. The analysis considered potential impacts from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives considered in the PEIS would be small. For those impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at INEL would have a significant negative impact on the natural environment or public health and safety.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. The Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies, will be considered in developing Records of Decision. Similarly, the position and comments from the State of Idaho will be considered by decisionmakers in selecting alternatives for implementation.

The PEIS addresses water resources as site-specific impact parameters. The major groundwater unit at INEL is the Snake River Plain Aquifer, which is considered a sole-source aquifer for area wells. Although groundwater monitoring for radioactive and nonradioactive parameters have shown elevated levels of some contaminants at onsite wells, no contaminants were found to exceed established EPA levels in offsite wells.

Actual design, siting, construction, and operation of disposal facilities will require additional analyses, such as performance assessments, and would be in compliance with all existing site-specific requirements, such as the INEL Land Use Plan. The Site Treatment Plans were developed in accordance with the Federal Facility Compliance Act for treatment of DOE low-level mixed waste. The DOE Disposal Workgroup and the National Governors Association have developed a process to identify sites subject to Site Treatment Plans that are suitable for further evaluation of their potential as disposal sites. Information obtained through this process will be considered in developing Records of Decision for the WM PEIS. Further information on this process is provided in Volume I, Section 1.8.2, of the PEIS.

DOE recognizes that the siting of waste management facilities may be perceived negatively by some people. DOE is committed to protecting human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The PEIS will help DOE make sound waste management decisions.

DOE prepared the PEIS as a part of its effort to develop an overall national strategy on which to base waste management decisions. Before selecting locations for waste management facilities or sites, DOE will consider the results of existing or require new sitewide or project-level NEPA reviews, which will evaluate in greater detail the potential for environmental impacts at sites selected for programmatic waste management activities.

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Comment (1488)
Do not bring wastes to LANL from other sites. It is not an appropriate site for waste treatment, storage, or disposal.

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate reasonable alternatives to a proposed action. In this case, the potential for siting some waste management activities at LANL is a reasonable option under some of the WM PEIS alternatives. LANL is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation of a major site does not mean the site will be selected for a programmatic waste management role.

LANL is analyzed in the WM PEIS as a candidate location for management of low-level mixed waste, low-level waste, transuranic waste, and hazardous waste.

The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10 for results; see Volume III, Appendix C, for analysis methods. The analysis considered potential impacts from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives at all sites considered in the PEIS would be small. For those impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate impacts and, where applicable, comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at LANL would have a significant negative impact on the natural environment or public health and safety.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. The Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies will be considered in developing Records of Decision.

DOE prepared the PEIS as part of its effort to develop an overall national strategy on which to base waste management decisions. Before selecting locations for waste management facilities on sites, DOE will consider the results of existing required new sitewide or project-level NEPA reviews, which will evaluate in greater detail the design of specific facilities and the potential for environmental impacts at sites selected for programmatic waste management activities.

Comment (1490)
Keep low-level waste onsite at LANL.

Response
DOE considered managing LANL's low-level waste onsite under the No Action, Decentralized, and Regionalized 1, 2, 3, and 4 Alternatives. Under the Regionalized 5, 6, and 7, and Centralized Alternatives, LANL would ship some or all of its low-level waste to other sites. The low-level waste alternatives are detailed in Section 7.3 in Volume I. DOE is required to evaluate reasonable

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alternatives. This allows decisionmakers to make meaningful comparisons of waste management alternatives. The preferred alternatives and the reasons they are preferred are described in Section 3.7 in Volume I of the WM PEIS. While the WM PEIS presents national strategy options, actual programmatic decisions will be announced in Records of Decision, which will be published in the *Federal Register*. Budgets, schedules and national priorities, as well as other DOE studies (e.g., Baseline Environmental Management Report, Risk Reports, Site Treatment Plans) will be factored into the decisionmaking process.

Comment (1566)
Bringing hazardous waste into the community for incineration is not a good idea. The controlled air incinerator planned for LANL just lost funding. DOE needs to consider other options for treatment. The Final WM PEIS needs to discuss incineration in more detail.

Response
For the Final WM PEIS, DOE modified the Decentralized Alternative for hazardous waste and eliminated LANL as a candidate for onsite treatment of such waste. LANL remains as a candidate site for onsite treatment under Regionalized Alternative 1 (see Section 10.3.3).

Also for this analysis, DOE used generic treatment technologies (incineration and fuel burning) to determine representative impacts. However, DOE will not use the PEIS to select technologies. Volume IV, Section H.3.2, of the PEIS discusses the technical issues, schedule, cost, and public acceptability associated with the incineration of DOE waste.

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Comment (123)
If those commentors opposing the siting of programmatic waste management activities at LLNL, some commentors gave no reason for their opposition and others expressed one or more of the reasons listed below:

- The overall risks to public health and safety and the quality of the environment from normal operations, facility accidents, and transportation accidents;

- Specific Risks: Seismic risks associated with the location of Site 300 on an earthquake fault; potential groundwater and drinking-water contamination; and the dangers of transporting wastes over congested freeways that have "millions of commuters and frequent accidents";

- Factors: The prevailing winds in the area; the population density around the site; the potential cancer rates associated with programmatic waste management activities; that Site 300 is located only a few miles from the California aqueduct; and consistency with land-use and growth-planning issues;

- Opinions: That the thermal treatment technology is unproven; that Site 300 is currently a Superfund site, and as such DOE should not "dump" more waste there; that waste should be sent to unpopulated areas; that siting waste management activities at LLNL would cause property values to decrease; and that more studies are needed on possible health, safety, environmental, and economic impacts.

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at LLNL is a reasonable option under some WM PEIS management alternatives. LLNL is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation as a major site does not mean the site will be selected for a programmatic waste management role.

DOE considered the management of low-level mixed waste, low-level waste and transuranic waste at LLNL. Under 5 of the 36 alternatives in the PEIS (the Decentralized Alternative and Regionalized Alternative 1 for low-level mixed waste; the Decentralized Alternative and Regionalized Alternatives 1 and 2 for low-level waste), would DOE construct new disposal facilities to manage wastes at LLNL. These facilities would manage wastes generated at LLNL and at as many as six other sites. LLNL would receive offsite low-level mixed waste that would amount to 11% of the total low-level mixed waste volume disposed of at LLNL; it would receive offsite low-level waste that would constitute 56% of the total low-level waste volume disposed of at LLNL. Under the Centralized Alternative, all LLNL wastes would be managed at other DOE sites. For transuranic waste, LLNL would treat and store its own waste under the No Action and Decentralized Alternatives. No transuranic waste disposal would take place at LLNL.

The WM PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10 for results; see Volume III, Appendix C for analysis methods. The affected environment at each major site, including existing land use (such as, for LLNL, the City of Tracy Comprehensive Plan) was considered in the

3.5.7 Lawrence Livermore National Laboratory

PEIS analysis. The analysis considered potential impacts, including most of the impacts that concern commentors, from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives at all sites considered in the PEIS would be small. For those impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at LLNL would have a significant negative impact on the natural environment, public health and safety, or property values.

DOE recognizes that LLNL is one of the sites with the highest potential for being impacted by seismic effects (see Volume I, Section 4.3.4). Nonetheless, LLNL was included as a candidate site because it passed all of the screening criteria, one of which was that candidate sites could not be within 200 feet of an active fault. Major faults in the area are the San Andreas, Hayward, Calaveras, and Greenville Faults. However, local faults have the greatest potential for damaging earthquakes (see Section 4.4.6). The potential effects of accidents initiated by earthquakes at treatment facilities were calculated in the PEIS, assuming generic facility characteristics, and were estimated to produce minimal risks.

As to the other specific risks cited by commentors, refer to the following sections of the PEIS: water resources (Sections 6.6, 7.6, and 8.6) and air quality (Sections 6.5, 7.5, and 8.5). The PEIS also includes a detailed assessment of risks associated with accidents from both rail and truck transportation, including low-probability/high-consequence and high-probability/low-consequence accidents (Volume IV, Appendix E). DOE found that risks from transportation accidents would be low under all alternatives. DOE provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to quickly respond to an accident and assist local emergency response personnel, if requested by local agencies.

DOE used data from the 1990 U.S. Census to estimate that about 6,325,000 people live within 50 miles from the center of LLNL. This population could possibly be exposed to emissions released to the atmosphere from waste treatment or disposal facilities.

Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the PEIS (Volume I, Sections 6.4, 7.4, and 8.4). Offsite population human health risks and offsite maximally exposed individual health risks are also cumulative impact parameters addressed by the PEIS (see Volume I, Section 11.8). The health risk analyses indicate that there is a potential for increased adverse health effects from the operation of waste treatment or disposal facilities located at LLNL. However, if DOE decides to site a new waste management facility at LLNL, it would establish design and operational limitations to ensure that releases from the facility would be maintained below regulatory limits. Appendix D in Volume III describes in more detail waste management facility human health risk estimates.

Properly designed and operated incinerators have been shown to be as or more effective than other proven treatment technologies and DOE does not preclude their use at any site. DOE compared impacts from incineration with non-thermal treatment technologies and identified little or no difference in treatment risks to human health, DOE documented these findings in a technical report (M/B SR-03, September, 1995). DOE has an aggressive technical development program exploring alternatives to

incineration. Alternatives will be tested and deployed depending on their potential to safely and effectively treat wastes.

As evidenced by the PEIS, DOE does not intend to "dump" waste in the ground. A major focus of the PEIS is to help DOE establish a Department-wide program to safely and efficiently manage radioactive and hazardous wastes. However, issues regarding existing pollution, a site's waste management record, and actual site cleanup efforts are more appropriately evaluated in sitewide or project-level studies.

DOE recognizes that the siting of waste management facilities might be perceived negatively by some. DOE is committed to protecting human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The PEIS will help DOE make sound waste management decisions.

The proximity of a waste management site to populated areas is only one of many factors in evaluating alternatives. DOE must consider and balance other factors to achieve its objective of safe and efficient treatment, safe and secure storage, and ultimate disposal of each waste type. For example, DOE must consider waste transportation requirements, and the PEIS presents alternatives that would minimize waste transportation (Decentralized Alternatives) or maximize waste transportation (Centralized Alternatives). Although siting waste management activities in less-densely populated or remote areas could reduce the potential for some impacts, the risks of transporting wastes over longer distances to reach remote sites would increase the potential for other impacts. Section 1.7.3 in Volume I lists and describes examples of the criteria and factors DOE will consider in the decisionmaking process.

DOE prepared the WM PEIS as a part of its effort to develop an overall national strategy on which to base waste management decisions. The development of this strategy took into consideration the actions addressed in related DOE NEPA documentation (see Volume I, Section 1.8.2), including the EIS for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories. Additional sitewide or project-level NEPA studies will evaluate in greater detail the potential for environmental impacts at sites selected for programmatic waste management activities and will provide a basis for selecting treatment and disposal technologies.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. These are not final decisions. Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies, will be considered in developing Records of Decision.

Comment (1597)
There are no alternative routes for commuters in the LLNL area and transporting waste through here would be a problem. DOE should consider other places for waste disposal that are not near heavily populated areas.

3.5.7 Lawrence Livermore National Laboratory

Response
The WM PEIS does consider and analyze sites other than LLNL as potential disposal sites. Criteria for selecting candidate sites included the characteristics of the waste, specialized treatment requirements, and existing facilities. The remoteness and lack of population density of a location for a waste management site constitutes only one factor in evaluating alternatives. Other criteria would include construction/modification of facilities, and increased transportation requirements.

The same roads are used whether DOE ships waste to or from a particular site. Should DOE decide to dispose of waste in less-densely populated areas (i.e., not LLNL), generally speaking, more waste would be transported from LLNL than would have been transported to LLNL. Specifically, more low-level mixed waste would be transported in the LLNL area if DOE decides not to dispose of waste at LLNL and about the same amount of low-level waste would be transported.

The PEIS includes a detailed assessment of risks associated with accidents from both rail and truck transportation, including low-probability/high-consequence and high-probability/low-consequence accidents. DOE provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to quickly respond to an accident and assist local emergency response personnel, if requested by local agencies.

Comment (1603)
The Draft WM PEIS states that for low-level mixed waste under the Regionalized Alternative, LLNL is the preferred option. DOE should explain where it will transport waste for disposal after it is brought to LLNL for treatment.

Response
As described in Section 6.3.3 in Volume I of the WM PEIS, the WM PEIS analyzes four regionalized alternatives for low-level mixed waste. Only under Regionalized Alternative 1 would LLNL serve as a regional treatment and disposal site. Under this alternative, low-level mixed waste treated at LLNL would be disposed of at LLNL or shipped to NTS. Section 3.7 in Volume I of the Final WM PEIS identifies DOE's preferred alternatives and the reasons they are preferred. The specific disposal location on a particular site will not be determined on the basis of the WM PEIS analysis, but rather, would be selected on the basis of subsequent NEPA analyses.

Comment (4048)
Based on the WM PEIS, DOE is considering plans to convert many of its facilities to what will, for many, become a permanent form of land use: nuclear waste dumps. LLNL is an example of this emerging pattern of conversion. LLNL has no permanent disposal options for the large quantities of mixed waste it generates. The WM PEIS forecasts within the preferred alternative that two regional waste management facilities at LLNL will be developed: (1) the Main Site will house a regional mixed waste management facility, which is now to begin construction without the benefit of a facility-specific EIS; and (2) Site 300, a more rural area adjacent to Tracy that generally has been used to conduct high-explosives tests, will become a low-level waste dump.

Response
The WM PEIS assumes generic treatment and disposal facilities to manage low-level and low-level mixed wastes. For purposes of analysis, the disposal units at LLNL were assumed to be located at Site 300. DOE has not proposed the locations for specific facilities on specific sites. DOE would make

those decisions only after considering the results of NEPA reviews that consider site-specific conditions in greater detail.

Note that DOE has canceled its plans for the Mixed Waste Management Facility at LLNL.

LLNL is considered in the WM PEIS for low-level mixed waste disposal facilities under the Decentralized Alternative and one of four Regionalized Alternatives. This site is also a candidate site for low-level waste disposal facilities under the Decentralized Alternative and two of seven Regionalized Alternatives. The combined and cumulative impacts of siting waste management facilities at LLNL are addressed in Section 11.8 in Volume I of the WM PEIS. DOE has identified its preferred alternatives, and the reasons they are preferred, for management of low-level mixed waste and low-level waste in Section 3.7 in Volume I of the WM PEIS. If DOE ultimately selected the alternatives involving LLNL in Records of Decision, actual siting and construction of waste management facilities at LLNL would not occur before completion of sitewide or project-level NEPA reviews.

Comment (4062)
Any efforts to develop the LLNL Main Site or Site 300 as regional waste management centers must include site-specific environmental review and analysis.

Response
The WM PEIS has been prepared to assist DOE decisionmaking on waste management at a broad, programmatic level. Should LLNL be selected for regional treatment, storage, or disposal, DOE will consider the results of sitewide and project-level NEPA reviews, which would include detailed analyses of potential environmental impacts based on site-specific conditions.

3.5.8 Nevada Test Site

Comment (109)
A commentor opposes transportation of radioactive waste through southern Utah to the Nevada Test Site.

Response
DOE believes the risks associated with transportation of radioactive waste through southern Utah to the NTS would be small, as indicated in tables with the total impact by alternative in Appendix E in Volume IV of the WM PEIS. The WM PEIS analysis enables a relative comparison of possible risks due to the transportation of waste among sites, which DOE could mitigate through careful planning and safety measures.

Comment (225)
Of those commentors opposing the siting of programmatic waste management activities at NTS, some commentors gave no reason for their opposition and others expressed one or more of the reasons listed below:

- The overall risks to public health and safety and the quality of the environment from potential waste management operations, considering "the known soil, surface water, and groundwater contamination" from past nuclear testing and related experiments;

- The State of Nevada does not produce any nuclear wastes, is rapidly growing, and should not be used as a nuclear waste "dump" for other sites;

- Sites outside Nevada, including in Canada and Mexico, should also be considered for managing this waste.

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at NTS was analyzed as a reasonable option under some WM PEIS waste management alternatives. NTS is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation as a major site does not mean the site will be selected for a programmatic waste management role. Foreign countries, such as Canada and Mexico, in light of the lack of U.S. Government jurisdiction and the criteria described in Section 4.2.1, do not presently appear to be reasonable siting alternatives for waste management activities.

NTS is analyzed in the WM PEIS as a candidate location for management of low-level mixed waste, low-level waste, and transuranic waste.

For low-level mixed waste, DOE evaluated seven separate alternatives. NTS would serve as a disposal site under five of these alternatives. Under Regionalized Alternatives 2 and 4, NTS would only dispose of the low-level mixed waste generated on the site. Under the Decentralized Alternative and Regionalized Alternatives 1 and 3, NTS would dispose of low-level mixed waste, nearly all of which would be generated off the site. Under the Centralized Alternative, all NTS low-level mixed waste would be shipped off the site to another location for disposal.

3.5.8 Nevada Test Site

For low-level waste, DOE evaluated 14 separate alternatives, 10 of which considered NTS as a potential site for disposal. For the Decentralized Alternative and Regionalized Alternatives 1 and 2, NTS would dispose of its own low-level waste. Under the No Action Alternative, Regionalized Alternatives 3, 4, 5, and 7, and Centralized Alternatives 2 and 4, NTS would receive wastes from several other sites that would constitute the majority of the total volume disposed of at NTS. Under the remaining four alternatives, all NTS low-level waste would be shipped off the site to another location for disposal.

Under the transuranic waste management alternatives, NTS would treat only its own transuranic waste, and would receive none from other sites. Similarly, no transuranic waste disposal would take place at NTS.

The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10 for results; see Volume III, Appendix C, for analysis methods. The analysis considered potential impacts, including most of the impacts that concern commentors, from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives at all sites considered in the PEIS would be small. For those impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at NTS would have a significant negative impact on the natural environment or public health and safety.

DOE used data from the 1990 U.S. Census to estimate that about 14,300 people live within a 50-mile radius of an existing waste disposal facility at NTS. This population could possibly be exposed to emissions released to the atmosphere from waste management activities. However, the risk analyses in the PEIS suggest that the adverse health effects, if any, from the operation of waste treatment facilities at NTS would be small (see Volume I, Sections 6.4, 7.4, and 8.4).

Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the PEIS. Offsite population human health risks and offsite maximally exposed individual health risks are cumulative impact parameters addressed by the PEIS (see Volume I, Section 11.10). The health risk analyses suggest that adverse health effects from the operation of waste treatment facilities located at NTS would be small. Public health impacts from disposal would similarly be small after implementation of mitigation measures necessary to ensure that DOE would not exceed radionuclide- and/or chemical-specific limits. Volume III, Appendix D, describes in more detail waste management facility human health risk estimates.

The NTS waste management sites are currently undergoing extensive investigation for the purpose of determining the sites' ability to isolate the wastes from the environment. Further studies are ongoing to determine the potential that disposal of wastes may have of commingling with any other contamination that might exist on the surface or underground. All indications at this point are that no commingling occurs. An evaluation of all the interacting source terms will also be conducted.

Groundwater monitoring at NTS in 1991 showed that eight parameters exceeded comparison criteria at onsite wells. However, any future waste management facilities would be appropriately designed and constructed to minimize the potential for leaks affecting groundwater.

3.5.8 Nevada Test Site

DOE is committed to protecting human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The PEIS will help DOE make sound waste management decision.

DOE intends to properly manage the wastes to protect human health and the environment. DOE considered equity in selecting the PEIS preferred alternatives, and DOE decisionmakers will consider equity issues when developing Records of Decision. As indicated in Section 1.7.3, DOE favors alternatives that distribute waste management facilities in ways that are equitable. Although storage and disposal in less populated regions may lessen some impacts, the risks from transporting waste to these remote areas would increase. These trade-offs are described in the WM PEIS and are important factors that will be considered in the decision process.

A major focus of the PEIS is to help DOE establish a Department-wide program to efficiently and safely manage radioactive and hazardous wastes. However, issues regarding existing pollution, a site's waste management record, and actual site cleanup efforts are more appropriately evaluated in sitewide or project-level studies. The potential disposal of wastes in a geologic repository at Yucca Mountain is not within the scope of the WM PEIS. Possible environmental impacts from the construction, operation, and eventual closure of a potential repository for spent nuclear fuel and high-level radioactive waste at Yucca Mountain will be addressed in a separate EIS.

DOE prepared the WM PEIS as part of its effort to develop an overall national strategy on which to base waste management decisions. Before selecting locations for waste management facilities on sites, DOE will consider the results of sitewide or project-level NEPA analyses, which would evaluate in greater detail the design of specific facilities and the potential for environmental impacts at sites selected for programmatic waste management activities.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. These are not final decisions. The Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies, will be considered in developing Records of Decision.

Comment (1551)
People who work at NTS consider it a great national resource, and it should be used more.

Response
Thank you for your comment. While certain WM PEIS Centralized or Regionalized Alternatives might offer particular benefits to a local community or region over another approach, DOE must base its waste management strategy on the diverse national needs and issues that affect many sites and regions.

DOE has prepared a sitewide EIS for NTS that addresses the environmental impacts of alternatives for the continued operations of NTS and other DOE activities in the State of Nevada. DOE proposes to continue managing NTS and its resources in a manner that meets evolving DOE missions and responds to stakeholder concerns, as well as those of affected and interested individuals and agencies. The NTS sitewide EIS examines existing and potential impacts to the environment that have resulted, or could

result, from current and future DOE operations in southern Nevada. The EIS analyzes the impacts from DOE programs at NTS, the Tonopah Test Range, portions of the Nellis Air Force Range Complex, the Central Nevada Test Area, and the Project Shoal Area. These programs include ongoing activities for the stewardship of the Nation's nuclear weapons stockpile, management of radioactive waste, nondefense research and development, work for others, and environmental restoration. The EIS also examines newer programs such as the proposed Solar Enterprise Zone sites at NTS, Dry Lake Valley, Eldorado Valley, and Coyote Spring Valley, in accordance with the NTS mission of demonstrating the capability to provide alternative energy sources, including solar energy, to meet power needs for the southwestern United States. A copy of the Final NTS EIS, which was published in November 1996, can be reviewed at the DOE Nevada Operations Office public reading room located at 2621 Losee Road, Building B-3, Las Vegas, Nevada.

Comment (1588)
Apart from being considered for waste disposal actions, NTS should also be considered for treatment facilities because the latter bring the benefits of research and development, as well as employment.

Response
NTS is considered a candidate site for treatment of low-level mixed waste and transuranic waste. For low-level waste, all sites, including NTS would do "minimum treatment," which consists of solidification of liquids and powdered materials, packaging, and shipment. NTS is not considered in the WM PEIS as a candidate site for additional low-level waste treatment activities (e.g., thermal organic destruction, size reduction, and compaction followed by solidification) because it has a small volume of low-level waste compared to other DOE sites and has no existing treatment facilities.

Comment (1627)
Yucca Mountain as a permanent geologic repository has been studied for a long time without any answers. Nevada does not need aboveground storage of wastes at NTS that could last forever.

Response
The potential disposal of high-level wastes in a geologic repository at Yucca Mountain is not within the scope of the WM PEIS. DOE is preparing a Yucca Mountain Repository EIS and has established a tentative date of 2000 for the Record of Decision.

Under five alternatives, the WM PEIS analyzes the impacts of high-level waste canister storage options pending disposal. DOE analyzes five alternatives (No Action, Decentralized, Regionalized, and Centralized). For each alternative, DOE assumed that a geologic repository would begin accepting DOE-managed high-level waste in 2015 at the rate of 800 canisters per year. For purposes of analysis, DOE also evaluated a scenario that assumed that there would be a delay in acceptance of DOE-managed high-level waste at a repository until after 2015, but at the same rate of acceptance of 800 canisters per year. Under no alternative would NTS store vitrified high-level waste.

Comment (1759)
The WM PEIS does not include an adequate discussion for a national strategy for waste management.

Response
The WM PEIS is a nationwide study that examines the environmental impacts of management alternatives for DOE radioactive and hazardous wastes. The PEIS analyzes a range of broadly defined

3.5.8 Nevada Test Site

waste management alternatives that could affect environmental resources across the country. The analysis will help decisionmakers make quantitative comparisons between the alternatives that will lead, in turn, to a national strategy and decisions on waste management.

The waste management alternatives described in this PEIS could affect a number of environmental resources (human health and safety, socioeconomic conditions, etc.). For this PEIS, DOE developed an approach for the characterization of these resources in relation to the affected environments at sites across the country. In addition, the PEIS provides general and cumulative information on the affected environments at DOE sites that can be used in future sitewide or project-level NEPA analyses.

Comment (1803)
As noted in the WM PEIS, NTS is one of only two sites assessed as a potential regional and/or centralized waste disposal location for large volumes of defense low-level and low-level mixed radioactive waste.

Response
NTS is considered as a disposal location under four of the seven low-level waste Regionalized Alternatives. Of those, under three alternatives (Regionalized Alternatives 3, 4, and 5), NTS is one of six disposal locations, and under the fourth, it is considered as one of two possible disposal sites.

Comment (2337)
My choice for low-level mixed waste is Regionalized Alternative 1; Site Treatment Plans enhance this choice. NTS has been chosen as a candidate for storage because of a pending permit. Without knowing the contents or conditions of said permit, I question whether Nevada can accommodate the increased volume. Under RCRA, *any* State accepting low-level mixed waste requires a permit. Therefore, arbitrarily choosing NTS *because* of a pending permit is invalid.

Response
The rationale and criteria for selecting candidate disposal sites for low-level mixed waste are described in Volume I, Section 6.3.5, of the WM PEIS. NTS was added as a candidate disposal site for low-level mixed waste because it has an interim-status low-level mixed waste disposal facility. As pointed out by the commentor, NTS has applied to EPA for a permit under RCRA for the disposal facility. This application requires that the waste be treated to meet RCRA's land disposal restrictions. The application is for a facility with built-in liners and a leachate collection system, but will be amended to have an alternative design, as provided for in the design and operating requirements for landfills found in 40 CFR 264.301(d). The application is pending. In summary, the potential availability of a disposal facility, not the filing of a permit application, was important in selecting NTS for analysis.

DOE's preferred alternative for low-level mixed waste disposal, and the reasons they are preferred, is provided in Section 3.7 in Volume I of the Final PEIS. The selection of this alternative was based on the decision criteria and factors described in Section 1.7.3 in Volume I of the PEIS.

Comment (3311)
According to Table 7.1-2, several of the largest inventories [of low-level waste] are at sites that have very little capacity (e.g., SRS, ORR, and the Portsmouth Plant) and are a long distance from NTS. The Hanford Site's current and planned disposal capacity will be absorbed by its own projected

inventory. Therefore, we conclude that NTS, the only site in addition to Hanford that accepts wastes generated off the site, is the current candidate for disposal of offsite, low-level waste.

Nonetheless, even with 449,000 cubic meters disposal capacity, NTS could not dispose of the inventory from even the five largest generators. NTS would have to double its low-level waste disposal capacity to accept the projected inventory from the five largest sites. It would have to triple its capacity to accept the projected waste from the 27 sites evaluated in the WM PEIS. And again, this does not include environmental restoration waste. How would the various treatments affect the volumes (reference p. 7-3) requiring disposal? Would additional treatment significantly reduce the curies disposed, and if so, by how much?

Response
DOE used the existing and planned low-level waste facilities and capacities listed in Volume I, Table 7.1-2, to establish the baseline capacities for treatment and disposal and to determine the need for new or expanded facilities. Planned facilities include only the facilities for which a conceptual design has been completed.

The WM PEIS analysis assumes use of existing and planned facilities until their capacities are met. If additional capacity is needed, use of new generic facilities is assumed. These conceptual facilities provide the difference in treatment, storage, and disposal capacity between the baseline reported in Table 7.1-2 and what is necessary to manage the waste a given site would receive under any given alternative. Conceptual facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). Where necessary for analysis, DOE assumed that the impact of existing facilities essentially reflects the impact of generic facilities.

Ten sites conduct different degrees of low-level waste treatment using existing facilities. Size reduction and compaction facilities typically used to reduce the total volume of waste requiring disposal are the most prevalent existing facilities for low-level waste treatment. Six DOE sites have operating low-level waste disposal facilities. Of these, three (INEL, LANL, and ORR) accept only onsite wastes, one (SRS) accepts small amounts of waste from several small generators, and two (the Hanford Site and NTS) accept large quantities of waste from other DOE sites.

Treatment can reduce the volume of waste disposed of and can increase the stability of the disposal waste form; however, the activity (curie content) of the waste depends on the concentration of radionuclides. Treatment that changes only the physical and chemical form of the waste does not affect the concentration of radionuclides and, therefore, does not reduce the curies in the disposed of waste. Radionuclides can be destroyed through nuclear transmutation; however, the feasibility of nuclear transmutation as a treatment technology on an industrial scale is currently speculative.

Comparison of disposal volumes between minimum treatment alternatives and volume reduction alternatives for low-level waste in Appendix I in Volume IV, show how treatment can reduce disposal volumes by nearly a factor of two. The curies would remain the same.

3.5.9 Oak Ridge Reservation

Comment (1693)
Regionalizing has been done before. Major environmental problems have occurred as a result of the last effort to regionalize disposal. In reviewing the *Performance Evaluation of the Capabilities of DOE sites for Disposal of Mixed Low Level Waste*, it is apparent that ORR is technically one of the least favorable disposal sites for low-level mixed waste (LLMW). Under the regionalized alternatives, ORR would be a prime candidate for treating, storing, and disposing of LLMW. Explain how the PEIS will be modified to more closely match the capabilities of sites to handle specific waste types.

Response
The document entitled *Performance Evaluation of the Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste* is a report developed for the DOE Federal Facility Compliance Act Disposal Workgroup. The report provides simple, conservative representations of site-specific performance assessments using site-specific data and consistent analyses. This evaluation found that ORR had more limited capability for the disposal of some long-lived radionuclides, such as uranium, than other DOE sites evaluated. A site-specific performance assessment at ORR was not included as part of the performance evaluation and might produce different results.

Under the LLMW Regionalized Alternatives evaluated in the WM PEIS, ORR would dispose of only its own LLMW under Regionalized Alternative 1, dispose of its own waste as well as LLMW generated at other sites under Regionalized Alternatives 2 and 4, and ship LLMW offsite for treatment and disposal under Regionalized Alternative 3. Offsite waste accounts for 35% and 38%, respectively, of the amount of LLMW proposed for disposal at ORR under Regionalized Alternatives 2 and 4.

The results of the LLMW disposal risk analysis presented throughout Section 6.4.1 of the PEIS suggest that the disposal of LLMW at ORR under Regionalized Alternatives 2 and 4 would require more controls than those used in the generic assessment. Estimated groundwater concentrations of technetium-99 could exceed drinking water standards under the assumed conditions of the conceptual disposal scenario used in the analysis.

In the actual design of a disposal facility at ORR or any DOE site, more detailed site-specific analyses would be conducted in accordance with the requirements of DOE Order 5820.2A. The implementation of the requirements of the Order might involve (1) modifying the engineering design of the disposal facility (e.g., adding a clay liner to increase contaminant adsorption or a concrete cap to reduce water filtration); (2) modifying the form of the waste to be disposed of (e.g., changing from grout or polymer to a vitrified waste form); and (3) imposing waste acceptance criteria (i.e., restricting the amounts of radionuclides or hazardous chemicals allowed in a given disposal facility).

If DOE selects a particular site for a new waste management treatment, storage, and disposal operation as a result of the PEIS analysis, additional sitewide or project-level NEPA reviews will be needed before a facility could be sited.

Comment (1697)
The capability of ORR to dispose of LLMW is limited. It appears from Volume I, Table 3.4-1, that Regionalized Alternative 3 is the only viable Regionalized Alternative for ORR.

3.5.9 Oak Ridge Reservation

Response
The WM PEIS alternatives reflect different national configurations of particular sites evaluated for waste management. In order to determine reasonable proposed sites for regionalized waste management facilities, DOE determined where the largest waste volumes are located and where transportation requirements would be minimized. The character of the waste and existing facilities were also taken into account.

A population risk vulnerability analysis to compare low-level mixed waste and low-level waste disposal alternatives using measures that characterize their relative potential to cause disposal risk to offsite populations was added to the Final WM PEIS. Table 5.4-2 in Volume I of the WM PEIS indicates that ORR is in the highest risk vulnerability group.

DOE considered public comments and other factors (e.g., existing environmental conditions) in its selection of preferred alternatives to manage the five waste types considered in the WM PEIS. Section 3.7 in Volume I identifies DOE's preferred alternatives and the reasons they are preferred.

Comment (1871)
The Governor of Tennessee and others strongly oppose any attempt by DOE to "site" large waste management activities in Oak Ridge, Tennessee. They oppose alternatives in the WM PEIS that consider disposal of low-level mixed waste and low-level waste at ORR.

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at ORR is a reasonable option under some WM PEIS management alternatives. ORR is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation as a major site does not mean the site will be selected for a programmatic waste management role.

For low-level mixed waste, DOE evaluated seven separate alternatives. Under four of these alternatives, ORR would serve as a disposal site for low-level mixed waste. For the Decentralized Alternative and Regionalized Alternative 1, ORR would only dispose of its own waste. Under Regionalized Alternatives 2 and 4, ORR would also receive wastes from several other sites that would amount to 35% and 38%, respectively, of the total volume disposed of at ORR. Under Regionalized Alternative 3 and the Centralized Alternative, all ORR low-level mixed waste would be shipped offsite to another location for disposal.

For low-level waste DOE evaluated 14 separate alternatives, 7 of which considered ORR as a potential site for disposal. For the No Action, Decentralized, and Regionalized Alternatives 1 and 2, ORR would only dispose of its own waste. Under Regionalized Alternatives 3, 4, and 5, ORR would receive wastes from several other sites that would amount to 52% of the total volume disposed of at ORR. Under the remaining 7 alternatives, ORR low-level waste would be shipped offsite to another location for disposal.

Under the transuranic waste management alternatives, ORR would treat transuranic waste, and up to 17% of the total volume that it treats would come from other sites. However, no transuranic waste disposal would take place at ORR.

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For each of the alternatives proposed for hazardous waste management, ORR would treat some of the hazardous wastes produced onsite, with any remainder being shipped offsite for treatment at a commercial facility. Under two of the four alternatives analyzed, ORR would also receive and treat hazardous wastes from as many as four other DOE sites.

The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10, for results; see Volume III, Appendix C, for analysis methods. The analysis considered potential impacts, from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives considered in the PEIS would be small. For impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at ORR would have a significant negative impact on the natural environment or public health and safety.

DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The PEIS will help DOE make sound waste management decisions.

A population risk vulnerability analysis to compare low-level mixed waste and low-level waste alternatives using measures that characterize their relative potential to cause disposal risk to offsite populations was added to the Final WM PEIS. As shown in Table 5.4-2 in Volume I, ORR is in the highest risk vulnerability group.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. It should be noted that the WM PEIS will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies, will be considered in developing Records of Decision.

3.5.10 Paducah Gaseous Diffusion Plant

Comment (369)
Of those commentors opposing the siting of programmatic waste management activities at PGDP, some commentors gave no reason for their opposition and others gave one or more of the reasons listed below:

- Overall risks to public health and safety and the quality of the environment from normal operations, operations accidents, and truck and rail transportation accidents. DOE's questionable ability, according to one commentor, to adequately characterize potential releases of toxic substances into streams, soil, air and groundwater, the size of the potentially affected population around PGDP, and what the commentor believes are the harmful effects of suspected past releases by DOE;

- Specific risks: Earthquake hazards; the potential for groundwater and drinking-water contamination; the potential for pollution of the Ohio River and local surface water systems; the potential for disruption of ecological resources; airborne radioactivity that would result from an incinerator; potential impacts to local agriculture;

- Factors: The site is on low ground in the floodplain of the Tennessee River; there are many people living near the site; there is a "high" cancer incidence in western Kentucky; the site has a "poor" waste management history; the Ohio River is currently polluted; the technology for dealing with waste is "in its infancy"; the public opposes storing waste at the site; the Governor of Kentucky has declared that there will be no nuclear waste dumps in Kentucky;

- Opinions: That more "poisons" should not be dumped into the ground; the characteristics of these wastes are unclear; waste should be stored where it is generated; waste should be taken to unpopulated, desolate, or desert areas; wastes should not be stored in barrels that could leak and need to be replaced after 20 years; efforts should focus on cleaning up existing "pollution" and ridding PGDP of its own waste; restaurants will close because food would get poisoned.

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate reasonable alternatives to a proposed action; in this case; PGDP was analyzed as a reasonable potential waste management site for its own low-level mixed waste, low-level waste, and transuranic waste. PGDP is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation as a major site does not mean the site will be selected for a programmatic waste management role.

PGDP currently does not have an inventory of high-level waste, nor is it considered a major generator of hazardous waste. Under five of the 36 alternatives in the PEIS (the Decentralized Alternative and Regionalized Alternative 1 for low-level mixed waste, and the Decentralized Alternative and Regionalized Alternatives 1 and 2 for low-level waste) DOE would construct new disposal facilities to manage wastes at PGDP. These facilities would manage low-level mixed and low-level wastes generated at PGDP, and a small quantity of low-level mixed waste (less than 1%) and low-level waste (less than 1%) generated offsite. Under the other Regionalized Alternatives and Centralized Alternatives for these waste types, all PGDP waste would be managed at other sites. The characteristics associated with these waste types are discussed in Volume I, Section 1.5.

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The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10, for results; see Volume III, Appendix C, for analysis methods. The analysis considered potential impacts, including most of the impacts that concern commentors, from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives at all sites considered in the PEIS would be small. For those impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at PGDP would have a significant negative impact on the natural environment, public health and safety, or the local economy.

DOE recognizes that PGDP is one of the sites with the highest potential for being impacted by seismic effects (see Volume I, Section 4.3.4). However, PGDP was included as a candidate site because it passed all of the screening criteria, one of which was that candidate sites could not be within 200 feet of an active fault (see Volume I, Section 6.3.5). The site is near two active seismic zones--the New Madrid Fault zone and the Wabash Valley Fault zone (see Section 4.4.10). The potential effects of accidents initiated by earthquakes at treatment facilities were calculated in the PEIS, assuming generic facility characteristics, and were shown to be minimal. However, it should be emphasized that no decision would be made to locate new facilities for waste treatment, storage, or disposal at PGDP until DOE has considered the results of sitewide or project-level NEPA reviews. Any new waste management facility would be built to conform to Federal criteria that take into account the somewhat higher seismic risk at PGDP relative to some of DOE's other sites.

As to the other specific risks cited by the commentors, refer to the following sections of the PEIS: air quality (Sections 6.5, 7.5, and 8.5); water resources (Sections 6.6, 7.6, and 8.6); and ecological resources (Sections 6.7, 7.7, and 8.7). Risks to local agriculture are not considered in the PEIS as a specific impact parameter; however, as environmental risks would be small, there is no reason to believe that there would be any negative impact to local agriculture. Further, although the site is near the Ohio River, it would not be affected by the probable 500-year maximum flood.

The PEIS used generic treatment and disposal technologies and a number of conservative assumptions to develop its programmatic evaluations of the relative impacts of different waste management alternatives. The results of these impact analyses are screening-level estimates; more precise estimates of potential impacts can be better developed through sitewide or project-level NEPA reviews.

For example, the PEIS analysis indicates that DOE should carefully control the disposal of low-level waste at PGDP to prevent potential groundwater contamination (see Volume I, Section 7.6.2). DOE Order 5820.2A requires DOE to conduct a detailed performance assessment before it can develop a low-level waste facility. This assessment would require more detailed site-specific information to identify the precise location and design of any proposed facility. The facility design, in turn, would require a number of mitigating factors to help limit potential groundwater contamination.

DOE used data from the 1990 U.S. Census to estimate that about 500,000 people live within 50 miles from the center of PGDP. This population could possibly be exposed to emissions released to the atmosphere from waste treatment facilities. However, the WM PEIS risk analysis suggests that adverse

health effects, if any, from the operation of waste treatment facilities at PGDP would be small (Volume I, Sections 6.4, 7.4 and 8.4).

Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the PEIS. Offsite population human health risks and offsite maximally exposed individual health risks are cumulative impact parameters addressed in the PEIS (See Volume I, Section 11.12). The health risk analysis suggests that adverse health effects from the operation of waste treatment facilities located at Paducah would be small. Public health impacts from disposal would similarly be small after implementation of mitigation measures necessary to ensure that DOE would not exceed radionuclide- and/or chemical-specific limits. Volume III, Appendix D, describes in more detail waste management facility human health risk estimates.

A major focus of the PEIS is to help DOE establish a Department-wide program to safely and efficiently manage radioactive and hazardous wastes. However, issues regarding existing pollution, a site's waste management record, and actual site cleanup efforts are more appropriately evaluated in sitewide or project-level studies. Likewise, the specific types and characteristics of containers and packages that would be used in managing the different waste forms are not discriminating factors that would affect the programmatic decisions supported by the PEIS, and it is more appropriate that such factors be addressed in site-level analyses.

Properly designed and operated incinerators have been shown to be as or more effective than other proven treatment technologies and DOE does not precluding their use at any site. DOE compared impacts from incineration with non-thermal treatment technologies and identified little or no difference in treatment risks to human health; DOE documented these findings in a technical report. (M/B SR-03, September, 1995). DOE has an aggressive technical development program exploring alternatives to incineration. Alternatives will be tested and deployed depending on their potential to safely and effectively treat wastes.

DOE recognizes that the siting of waste management facilities may be perceived negatively by some persons. DOE is committed to protecting human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The PEIS will help DOE make sound waste management decisions.

As evidenced by this PEIS, DOE does not intend to "dump" waste in the ground. DOE intends to properly manage the wastes to protect human health and the environment. The opinion that waste should be managed where it is generated most closely matches the No Action and Decentralized Alternatives (see Volume I, Chapter 3), which are carefully evaluated in this PEIS.

The proximity of a waste management site to populated areas is only one of many factors in evaluating alternatives. DOE must consider and balance other factors to achieve its objective of safe and efficient treatment, safe and secure storage, and ultimate disposal of each waste type. For example, DOE must consider waste transportation requirements, and the PEIS presents alternatives that would minimize waste transportation (Decentralized Alternatives) or that would maximize waste transportation (Centralized Alternatives). Although siting waste management activities in less-densely populated or remote areas could reduce the potential for some impacts, the risks of transporting wastes over longer distances to reach remote sites would increase the potential for other impacts. Section 1.7.3 in

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Volume I lists and describes examples of the criteria and factors DOE will consider in making its decisions.

DOE prepared the PEIS as part of its effort to develop an overall national strategy on which to base waste management decisions. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA reviews, which will evaluate in greater detail the potential for environmental impacts at sites selected for programmatic waste management activities.

A population risk vulnerability analysis to compare low-level mixed waste and low-level waste alternatives using measures that characterize their relative potential to cause disposal risk to offsite populations was added to the Final WM PEIS. As shown in Table 5.4-2 in Volume I, PGDP is in the highest risk vulnerability group.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. The Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules and national priorities, as well as other DOE studies, will be considered in developing Records of Decision. Similarly, the position and comments of the Governor of Kentucky will be factored into the decisionmaking process.

Comment (2180)
Will any foreign waste be brought to PGDP?

Response
Assuming that the commentor refers to waste from outside the United States, the WM PEIS does not consider the receipt of "foreign waste" at any DOE site. Volume I, Section 1.8.1, does discuss the Foreign Research Reactor Spent Nuclear Fuel EIS, and its relationship to the WM PEIS. DOE does not plan to manage any of the foreign research reactor spent nuclear fuel (which is not considered "waste") at PGDP. The Record of Decision for the Foreign Research Reactor Spent Nuclear Fuel EIS was issued in May 1996. The decision allows for acceptance of spent nuclear fuel from 1996 to 2009 with management of the spent fuel to occur at the Savannah River Site or Idaho National Engineering Laboratory.

Assuming that the commentor refers to waste from outside Kentucky, under five of the 36 alternatives in the PEIS (the Decentralized Alternative and Regionalized Alternative 1 for low-level mixed waste, and the Decentralized Alternative and Regionalized Alternatives 1 and 2 for low-level waste) DOE would construct new waste management facilities at PGDP. These facilities would manage low-level mixed and low-level wastes generated at PGDP, and a small quantity of low-level mixed waste (less than 1%) and low-level waste (less than 1%) generated offsite. Under the other Regionalized Alternatives and Centralized Alternatives for these waste types, all PGDP waste would be managed at other sites. The characteristics associated with these waste types are discussed in Volume I, Section 1.5.

Comment (2228)
A commentor prefers a modified No Action Alternative for PGDP and to treat waste onsite or store it aboveground until onsite technologies are available. Supporting reasons are: (1) earthquakes,

(2) community safety, (3) contamination of other communities, (4) transportation accidents, and (5) worker safety.

Response
The WM PEIS human health risk assessment and the ecological risk assessment examined the potential effects on humans and the environment of waste management activities at PGDP. DOE found that public health and environmental risks would be low at PGDP under all alternatives. Health risks due to seismic events (earthquakes) are evaluated in the PEIS. PGDP site has been recognized as one of the sites with the highest potential for being impacted by seismic effects (Section 4.3.4). The site is near two active seismic zones: the New Madrid Fault zone; and the Wabash Valley Fault zone (Section 4.4.10). Accidents initiated by earthquakes at treatment facilities were included in the PEIS, assuming generic facility characteristics, and were shown to produce minimal risks. Any new waste management facility would be built to conform to Federal criteria that take into account the somewhat higher seismic risk at PGDP relative to some of DOE's other sites.

The PEIS includes a detailed assessment of risks associated with accidents from both rail and truck transportation, including low-probability/high-consequence and high-probability/low-consequence accidents. DOE found that risks from transportation accidents would be low under all alternatives. DOE provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to quickly respond to an accident and assist local emergency response personnel, if requested by local agencies. These teams will help mitigate the remaining risks associated with transportation accidents.

DOE is concerned with health and safety and the need for emergency preparedness in and around its sites. Emergency response plans are required for sites and in their surrounding communities by Federal, State, and local authorities that deal with emergency situations such as floods, tornadoes, and other natural or man-made disasters. These plans are continually updated. DOE, the U.S. Department of Transportation, and the Federal Emergency Management Agency are available to assist State and local authorities with their emergency plan reviews.

Comment (3180)
A commentor opposes disposal of either low-level waste or low-level mixed waste at PGDP. The shallow depth to groundwater and high annual rainfall would produce adverse environmental consequences if PGDP were chosen as a disposal site. PGDP is close to the Ohio River and the area has a high infiltration rate, which makes PGDP unsuitable as a disposal site.

Response
For low-level mixed waste, Section 6.2.3 in Volume I of the WM PEIS provides assumptions for facilities and disposal. The document analyzes two types of disposal: engineered disposal and shallow land burial. However, when disposing of smaller quantities of waste (i.e., less than 700 cubic meters per year) aboveground silos were assumed. Both types of low-level mixed waste disposal facilities were assumed to be designed to meet all applicable RCRA disposal requirements. Before locating a disposal facility on a site, DOE will conduct a performance assessment and define waste acceptance criteria.

Section 7.2.3 in Volume I of the PEIS identifies assumptions for facilities and disposal for low-level waste at sites with shallow groundwater and high precipitation rates. Engineered concrete structures

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are typically used for disposal to reduce potential radionuclide migration. DOE assumed the use of aboveground engineered concrete structures for sites located in the eastern United States, including PGDP.

Section 1.8.2 in Volume I of the PEIS identifies other programs and their relationship to the WM PEIS. One of these is the DOE Disposal Workgroup, which has discussed disposal of low-level mixed waste and is comprised of both DOE staff and State representatives. Section 1.8.2 states that information from the DOE Disposal Workgroup process will be considered in the WM PEIS decisionmaking process, and that identification of sites that might dispose of low-level mixed waste will follow State and Federal siting and permitting regulations.

A population risk vulnerability analysis to compare low-level mixed waste and low-level waste alternatives using measures that characterize their relative potential to cause disposal risk to offsite populations was added to the Final WM PEIS. As shown in Table 5.4-2 in Volume I, PGDP is in the highest risk vulnerability group.

Comment (4570)
A commentor asked several questions: (1) What is this comment period all about and why is the comment period so short? (2) What types of wastes were analyzed? (3) What are the half-lives of the wastes? (4) What are the waste management options for PGDP? (5) How dangerous are the options to the ecosystem? (6) When will the PGDP operating contractor answer all these questions?

Response
NEPA requires that EISs be released in draft for public review and comment to ensure that the public has the opportunity for meaningful participation in the NEPA process. NEPA requires a comment period of at least 45 days; DOE's comment period for the Draft WM PEIS totaled 150 days.

The WM PEIS analyzes management alternatives for low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. The characteristics of these wastes are addressed in the individual waste-type chapters (Chapters 6 through 10 in Volume I).

Half-lives of radionuclides in the waste range from fractions of seconds to thousands of years. The consideration of half-lives is implicit in DOE's waste classification system. For example, transuranic waste contains more than 100 nanocuries of alpha-emitting radionuclides with half-lives greater than 20 years and an atomic number greater than that of uranium (92). Section 1.5 in Volume I describes the four classes of radioactive wastes (low-level mixed waste, low-level waste, transuranic waste, and high-level waste) evaluated in the WM PEIS. Of these, low-level mixed waste, low-level waste, and transuranic waste were evaluated at PGDP.

The radionuclide content (activities) of the various radioactive wastes are described in detail in the supporting technical reports. These reports are listed in Section 15.2 in Volume I and are available in the DOE public reading rooms listed in Section 1.9 in Volume I.

The waste management alternatives are discussed in Chapter 3. Tables 3.4-1, 3.4-2, and 3.4-3 identify the proposed waste management actions at DOE sites under the alternatives for low-level mixed, low-level, and transuranic wastes, respectively. PGDP would undertake waste management activities under

some alternatives for these waste types. The impacts of all alternatives on ecological resources are discussed in the individual waste-type chapters.

In accordance with NEPA, DOE (and not the operating contractor for PGDP) is responsible for answering all comments on the WM PEIS.

3.5.11 Pantex Plant

Comment (3236)
Pantex should be excluded from any consideration as a candidate low-level radioactive mixed waste, low-level waste, or hazardous waste disposal site because (1) all hazardous waste generated at Pantex is scheduled for treatment and disposal off the site; (2) the National Governors Association Task Force and Site Treatment Plan efforts involve only treatment units (as opposed to disposal) possibly being brought to Pantex; and (3) because Pantex is located directly above the sole-source Ogallala Aquifer, the primary source of water for the multi-billion dollar agricultural industry in the Panhandle.

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for the Pantex Plant to serve as a disposal site is a reasonable option under some of the WM PEIS alternatives. Pantex is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation of a major site does not mean the site will be selected for a programmatic waste management role.

DOE considered the management of low-level mixed waste and low-level waste at the Pantex Plant. Under five of the 36 alternatives in the PEIS (the Decentralized Alternative and Regionalized Alternative 1 for low-level mixed waste; the Decentralized Alternative and Regionalized Alternatives 1 and 2 for low-level waste) DOE would construct new disposal facilities to manage wastes at Pantex. The Pantex Plant is not considered a potential centralized waste management facility in the WM PEIS and would not receive wastes from other sites under any of the alternatives. Conversely, all Pantex hazardous waste would be shipped off the site for treatment and disposal either at commercial facilities or at other DOE sites.

Waste management alternatives considered in this WM PEIS are waste-type specific. Thus, a strategy relative to hazardous waste does not necessarily apply to other waste streams. The Site Treatment Plans were developed in accordance with the Federal Facility Compliance Act for treatment of DOE low-level mixed waste. The DOE Disposal Workgroup and the National Governors Association have developed a process to identify sites subject to Site Treatment Plans that are suitable for further evaluation of their potential as disposal sites. Information obtained through this process will be considered in developing Records of Decision for the WM PEIS. Further information on this process is provided in Volume I, Section 1.8.2, of the WM PEIS.

The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6, 7, and 10 for discussions of specific impacts at the Pantex Plant; see Volume III, Appendix C, for analysis methods. In general, the environmental impacts associated with waste management activities under all alternatives at all sites considered in the PEIS would be small. For impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at Pantex would have a significant negative impact on the natural environment or public health and safety. Risks to local agriculture are not considered in the PEIS as a specific impact parameter; however, as environmental risks would be small, it is not anticipated that there would be any negative impact to local agriculture. As described in Section 4.4.11 in Volume I, although the Ogallala Aquifer is the major source of water for the Pantex region, EPA has not classified the Ogallala as a sole-source aquifer.

3.5.11 Pantex Plant

DOE is committed to properly managing its waste to protect human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its Waste Management Program that provides human health and safety assurance to the public.

DOE prepared the WM PEIS as part of its effort to develop an overall national strategy on which to base waste management decisions. Before locating waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA reviews, which will evaluate in greater detail the potential for environmental impacts at sites selected for programmatic waste management activities.

Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. The Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules and national priorities, as well as other DOE studies, will be considered in developing Records of Decision.

3.5.12 Portsmouth Gaseous Diffusion Plant

Comment (2076)
Will incineration or thermal treatment occur at the Portsmouth Plant? We do not want to be considered for thermal treatment.

Response
Thermal treatment was used as a generic technology in the WM PEIS analysis to allow a relative comparison of potential impacts across sites. DOE compared impacts from incineration with an alternative treatment technology and identified little change in the total risks to human health from treatment and disposal. DOE documented these findings in a technical report, that is available in the DOE public reading rooms listed in Volume I, Section 1.9, in the WM PEIS.

Properly designed and operated incinerators are as or more effective than other treatment technologies, and DOE does not preclude their use at any site. EPA's combustion strategy states, "If properly designed and operated in compliance with regulatory standards, combustion is a technology that provides sound management of hazardous waste." Fact sheets on radioactive and mixed waste incineration published jointly by EPA and DOE (EPA 402-F-95-004 through 007, January 1996) recognize the effectiveness of incineration as part of the DOE Waste Management Program and that alternatives are not entirely comparable. Optimal operation of incinerators in conjunction with existing pollution control technologies, can minimize generation of dioxins and furans and radiation releases.

DOE prepared the PEIS as a part of its effort to develop an overall national strategy on which to base waste management decisions. Before locating waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA reviews, which would evaluate in greater detail the potential for environmental impacts at sites selected for programmatic waste management activities and will provide a basis for selecting treatment technologies.

Comment (2093)
DOE needs to consider the transuranic elements in Building 333 at the Portsmouth Plant.

Response
In Volume I, Section 8.1.2, DOE acknowledges that there are small amounts of transuranic waste that were not assessed in the WM PEIS. These small amounts of transuranic waste would not affect programmatic results. Radioactive waste having concentrations greater than 100 nanocuries per gram of transuranic elements with half-lives greater than 20 years is considered and included as transuranic waste in the WM PEIS.

Comment (2715)
The issue of allowing additional waste to be stored on the Portsmouth Plant should consider the following factors: (1) legally right is not always morally right, as evidenced by use by the Plant of the exemption contained in 40 CFR 264 and relative to earthquake consequences for areas east of the Mississippi River, although newer data and seismic history, compounded by deep-injection processes, suggest a moral obligation to consider earthquake hazards; (2) local risk should not be increased by offsite waste just because of the economics of the region; (3) the cost to public health and the environment should always be factored into the equation when calculating the cost of a project; and (4) people already live with the constant hazard presented by leaking, corroded drums and toxics.

3.5.12 Portsmouth Gaseous Diffusion Plant

Response
DOE must comply with all applicable laws and regulations. NEPA and CEQ regulations require DOE to analyze the potential environmental consequences related to its proposed actions and to prepare a detailed statement on the consequences, alternatives to the proposed action, and measures that could avoid or minimize adverse impacts. The Portsmouth Plant is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation as a major site does not mean the site will be selected for a programmatic waste management role.

DOE considers Portsmouth a potential site for the management of low-level and low-level mixed wastes. At present, the Portsmouth Plant manages its own low-level and low-level mixed wastes. Under the Decentralized Alternative and some Regionalized Alternatives, Portsmouth is a candidate for managing not only its own low-level and low-level mixed wastes, but also wastes from other DOE sites. Under the Centralized Alternative, the Portsmouth Plant is one of seven DOE sites that would receive wastes from other sites for treatment prior to disposal.

The WM PEIS analysis calculates the potential effects of accidents initiated by earthquakes at treatment facilities. While deep-injection processes could impact seismic activity, there are no geologic faults in the Portsmouth region of influence. The potential for damage from seismic activity is small.

Eleven impact parameters were evaluated in the WM PEIS, including human health risks, economic, social, and cost impacts. Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the PEIS. Offsite population human health risks and offsite maximally exposed individual health risks at Portsmouth are cumulative impact parameters addressed in the PEIS (see Volume I, Section 11.14). The health risk analysis suggests that adverse health effects from the operation of waste treatment facilities located at the Portsmouth Plant would be small. Public health impacts from disposal would similarly be small after implementation of mitigation measures necessary to ensure that DOE would not exceed radionuclide- and/or chemical-specific limits. Volume III, Appendix D, describes in more detail waste management facility human health risk estimates. As to socioeconomic impacts at Portsmouth, the data presented in Volume II, Section 13.0, of the PEIS shows the socioeconomic impacts for treatment and disposal.

Chapters 6 and 7 in Volume I discuss the estimated impacts to selected sites from the management of low-level and low-level mixed wastes, and Chapter 11 discusses cumulative impacts from the various alternatives and from existing and planned programs. These discussions do not express potential impacts in terms of cost, but the impact analysis presented will be an important factor in the WM PEIS decisionmaking process.

A major focus of the PEIS is to help DOE establish a Department-wide program to safely and efficiently manage radioactive and hazardous wastes. However, issues regarding existing pollution, a site's waste management record, and actual site cleanup efforts are more appropriately evaluated in sitewide or project-level studies. Likewise, the specific types and characteristics of containers and packages that would be used in managing the different waste forms are not discriminating factors that would affect the programmatic decisions supported by the PEIS, and it is more appropriate that such factors be addressed in site-level analyses.

3.5.13 Rocky Flats Environmental Technology Site

Comment (1764)
A commentor believes that most members of the public would not favor a No Action Alternative for RFETS, but might consider an enhanced No Action Alternative that includes a state-of-the-art treatment facility for processing wastes.

Response
The WM PEIS analyzes 36 alternatives in four categories, and DOE believes these alternatives provide a sufficient base of information on which decisionmakers can determine DOE's waste management strategy. Volume I, Section 3.7, identifies DOE's preferred alternatives and the reasons they are preferred. NEPA allows DOE to select partial alternatives or combinations of alternatives, as long as they fall within the bounds of the alternatives considered in the PEIS. In these cases, DOE would explain in the Records of Decision how and why it made its decisions, and how the decisions related to the alternatives analyzed in the Final PEIS.

Comment (1778)
Do not bury low-level waste at RFETS. We need monitorable retrievable storage.

Response
The WM PEIS analysis finds that impacts from disposal of low-level waste at RFETS (under the Decentralized, Regionalized 1, and Regionalized 2 Alternatives) would be small. Disposal facilities would be designed and sited only after additional analyses required by the DOE performance assessment process. Facilities would be constructed and operated in compliance with applicable regulations. These actions should further minimize the potential for contamination.

DOE has identified the preferred alternative for low-level waste disposal for sites such as RFETS in Volume I, Section 3.7, of the Final WM PEIS.

Comment (2578)
Why is RFETS excluded from treating offsite transuranic waste?

Response
Based on inventory and expected generation rates, RFETS houses or is expected to generate approximately 6,200 cubic meters of transuranic waste over the next 20 years. DOE developed the transuranic waste treatment configurations to present reasonable alternatives, considering a No Action Alternative and Decentralized Alternatives under which each site would treat only its own transuranic waste. Of the three Regionalized Alternatives in which transuranic waste is consolidated at two to five sites, RFETS would treat its own waste under two alternatives, and ship its wastes off the site under the third. Under the Regionalized Alternatives, the rationale was that transuranic waste treatment should be consolidated at the four largest sites where approximately 80% of the waste is located or expected to be generated over the 20-year analytical period. RFETS does not fall into this category.

Comment (3218)
Commentors oppose the siting of programmatic waste management activities at RFETS because of the location of the site near an urban environment; bringing materials onsite for treatment and burial is not acceptable to the surrounding community; and DOE should have long-term responsibility for storing the waste rather than disposing of it.

3.5.13 Rocky Flats Environmental Technology Site

Response
NEPA and CEQ implementing regulations require DOE to consider and evaluate all reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at RFETS was analyzed as a reasonable option under some WM PEIS alternatives. RFETS is one of 17 "major" sites analyzed in the PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites. However, designation as a major site does not mean the site will be selected for a programmatic waste management role.

DOE evaluated 36 alternatives in the PEIS. Under 12 alternatives (Decentralized and Regionalized Alternatives for low-level mixed waste and transuranic waste; Decentralized, Regionalized, and Centralized Alternatives for low-level waste) new facilities would be constructed to manage wastes at RFETS. These facilities would manage wastes generated primarily at RFETS; wastes received from offsite under any of the alternatives considered would be less than 1% of the total volume of that waste type disposed of at RFETS. Under certain Regionalized and Centralized Alternatives, RFETS wastes would be managed at other DOE sites.

The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities. See Volume I, Chapters 6 through 10, for results; see Volume III, Appendix C, for analysis methods. The analysis considered potential impacts, including most of the impacts that concern commentors, from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives at all sites considered in the PEIS would be small. For those impacts that would not be small, DOE would incorporate mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements. Therefore, there is no reason to believe that waste management activities at RFETS would have a significant negative impact on the natural environment or public health and safety.

Specifically, the PEIS human health risk assessment and ecological risk assessment examined potential Waste Management Program effects on humans and the environment near RFETS. DOE found that public health and environmental risks from treatment would be low at RFETS under all waste management alternatives. Public health and environmental risk from disposal would be low after implementation of mitigation measures to ensure that DOE would not exceed radionuclide- and/or chemical-specific limits.

Disposal of waste is preferable to a long-term storage for several reasons. First, disposal involves placement of treated waste in facilities that will effectively remove the material from contact with human or environmental receptors for very long periods of time. For example, disposal of treated transuranic waste and high-level waste in geological repositories will isolate these materials for the long periods of time they are expected to remain hazardous. If these materials were kept in long-term storage facilities they could be subject to potential releases as a result of continued processing (repackaging), facility accidents, or natural disasters. Second, fewer resources are required to dispose of treated materials than to store them for indefinite periods of time. For example, operation of disposal facilities is expected to require only security and monitoring functions after emplacement of the wastes, whereas storage in aboveground facilities would have higher operational costs.

3.5.13 Rocky Flats Environmental Technology Site

DOE is committed to protecting health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The WM PEIS will help DOE make sound waste management decisions.

The proximity of a waste management site to populated areas is only one of the factors in evaluating alternatives. DOE must consider and balance other factors to achieve its objective of safe and efficient treatment, safe and secure storage, and ultimate disposal of each waste type. For example, DOE must consider waste transportation requirements, and the PEIS presents alternatives that would minimize waste transportation (Decentralized Alternatives) or that would maximize waste transportation (Centralized Alternatives). Although siting waste management activities in less-densely populated or remote areas could reduce the potential for some impacts, the risks of transporting wastes over longer distances to reach remote sites would increase the potential for other impacts. Section 1.7.3 in Volume I lists and describes examples of the factors and criteria DOE will consider in the decisionmaking process.

DOE prepared the PEIS as part of its effort to develop an overall national strategy on which to base waste management decisions. Before selecting locations for waste management facilities on sites, DOE will consider the results of existing relevant or required new sitewide or project-level NEPA reviews, which would evaluate in greater detail the potential for environmental impacts at sites selected for programmatic waste management activities.

Section 3.7 in Volume I of the WM PEIS identifies DOE's preferred alternatives and the reasons they are preferred. These are not final decisions. The Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS. The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules and national priorities, as well as other DOE studies, will be considered in developing to Records of Decision.

Comment (3260)
The WM PEIS Summary document, Section 6.2.1, states that all sites are assumed to have adequate capabilities to package and store future-generated transuranic waste (TRUW). It is not clear that this is the case at RFETS.

DOE should clarify to what extent this assertion is true for RFETS and all assumptions underlying this assertion. To what degree does the proximity of RFETS to a large metropolitan area figure into the selection of alternatives to package and store future-generated TRUW?

Response
To establish the existing capacities for TRUW treatment and identify the need for new or expanded facilities, DOE compiled a list of existing and planned TRUW facilities. Total capacities of these identified facilities are presented in Table 8.1-2, Volume I. Six sites, including RFETS, have existing or planned treatment facilities. These facilities are each capable of performing different aspects of treatment including aqueous treatment, shredding, solidification, thermal treatment, and repackaging. DOE also assumed that the basic capabilities to package and store TRUW are available at every site that would generate TRUW in the future. This includes 11 sites projected to generate contact-handled

3.5.13 Rocky Flats Environmental Technology Site

TRUW and 5 sites with projected remote-handled TRUW, as shown in Table 8.1-1 in Volume I of the WM PEIS.

Based upon its current and projected waste volumes, RFETS is considered as a candidate site for TRUW treatment and storage under two alternatives and treatment only under two additional alternatives. Criteria, such as risk to nearby populations are included in the risk and impacts analyses, as described in Volume I, Chapter 8, of the WM PEIS. Impacts to RFETS would be small.

Comment (3267)
The WM PEIS contains alternatives within each category that would allow for shipment of waste to RFETS for treatment. Some alternatives also call for onsite disposal of materials at RFETS. The WM PEIS should not consider alternatives that require materials to be imported to RFETS, nor those that require onsite disposal at RFETS.

Response
NEPA requires DOE to analyze reasonable alternatives. RFETS is a large site that currently generates or is projected to generate three of the waste types analyzed in the PEIS. Inventoried and projected volumes indicate that RFETS has the fifth largest low-level mixed waste and transuranic waste volumes, and eighth largest low-level waste volume of the 54 DOE sites considered. Although the volumes are relatively small compared to total waste within the complex, it is reasonable to consider RFETS as a candidate treatment, storage, and disposal site under some alternatives.

3.5.14 Sandia National Laboratories-New Mexico

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3.5.15 Savannah River Site

Comment (182)
DOE needs to clarify the role of the SRS Consolidated Incineration Facility as a potential Regionalized Alternative for the acceptance of low-level mixed waste (LLMW).

Response
The WM PEIS evaluated both on- and offsite waste to be treated at the SRS Consolidated Incineration Facility. Volume I, Section 6.3.3, identifies sites that would ship LLMW to SRS for treatment under the Regionalized Alternatives. The Consolidated Incineration Facility is considered only for non-alpha LLMW; therefore, it would only treat waste from the Charleston Naval Shipyard, the Norfolk Naval Shipyard, and the Pinellas Plant. However, alpha LLMW treatment is also evaluated for SRS, with any alpha LLMW at Bettis Atomic Power Laboratory, the Mound Plant, the University of Missouri, and WVDP sent to SRS for treatment. The maximum percent of offsite LLMW to be treated at SRS under any alternative would be approximately 1%, with the remaining 99% originating at SRS. Additional alpha LLMW treatment capacity would be required to accommodate the treatment of on- and offsite alpha LLMW at SRS.

Comment (1682)
A commentor opposes the use of SRS for dumping, storage, or disposal of radioactive waste because of the past history of environmental neglect at the site and the risk of an increased incidence of cancer in area.

Response
NEPA requires DOE to consider and evaluate reasonable alternatives to a proposed action; in this case, the potential for siting some waste management activities at the SRS is a reasonable programmatic waste management alternative. SRS is one of 17 "major" sites analyzed in the WM PEIS. See Volume I, Section 4.2.1, for a full description of how DOE identified major sites.

SRS was analyzed as a candidate location for management of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. For low-level mixed waste, DOE evaluated nine separate alternatives. Under four of these alternatives, SRS would serve as a disposal site for its own low-level mixed waste, and would also receive wastes from seven smaller sites that would amount to only 1% of the total volume disposed of at SRS.

For low-level waste, DOE evaluated 14 separate alternatives, 7 of which considered SRS as a potential site for disposal. Under the No Action, Decentralized, and Regionalized 1, 2, 3, 4, and 5 Alternatives, SRS would dispose of its own waste and a small quantity (less than 1%) of waste generated offsite. Under Regionalized Alternatives 6 and 7, SRS would receive wastes from several other sites that would amount to 51% of the total volume disposed of at SRS. Under the five Centralized Alternatives, SRS low-level waste would be shipped offsite to another location for disposal.

Under the transuranic waste management alternatives, SRS would treat transuranic waste, and up to 17% of the total volume that it treats would come from other sites. However, no transuranic waste disposal would take place at SRS.

SRS currently stores high-level waste onsite. Under each of the alternatives for managing this waste type, all of the existing and planned high-level waste being stored at SRS would eventually be transported

3.5.15 Savannah River Site

offsite. Under Regionalized Alternative 1, SRS would also receive and temporarily store high-level waste from WVDP prior to its shipment to a permanent storage location.

Four alternatives were analyzed for hazardous waste management. Under the No Action Alternative, SRS would continue to ship hazardous waste offsite for commercial treatment. Under the Decentralized and Regionalized 1 Alternatives, SRS would treat some of the hazardous wastes produced onsite, with any remainder being shipped offsite for treatment at a commercial facility. Under Regionalized Alternative 2, all SRS hazardous wastes would be shipped to another DOE "hub" site (ORR) for treatment.

The PEIS analyzes for each candidate site the potential for environmental impacts resulting from programmatic waste management activities (see Volume I, Chapters 6 through 10 for results; see Volume III, Appendix C, for analysis methods). The analysis considered potential impacts from normal operations, operations accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives considered in the PEIS would be small. For those impacts that are not small, DOE would incorporate mitigation measures to reduce or eliminate the impacts. Therefore, there is no reason to believe that waste management activities at SRS would have a significant negative impact on the natural environment or public health and safety.

Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the PEIS (Volume I, Sections 6.4, 7.4, 8.4, 9.4, and 10.4). Offsite population human health risks and offsite maximally exposed individual health risks are also cumulative impact parameters addressed by the PEIS (see Volume I, Section 11.17). The health risk analyses indicate that there is a potential for increased adverse health effects from the operation of waste treatment or disposal facilities located at SRS. However, if DOE decides to site a new waste management facility at SRS, it would establish design and operational limitations to ensure that releases from the facility would be maintained below regulatory limits. Appendix D in Volume III describes in more detail waste management facility human health risk estimates.

Recent studies, as summarized in Appendix E of the Tritium Supply and Recycling PEIS (DOE, 1995), indicate no excess cancer incidence or mortality in the general public in the vicinity of the SRS, although evidence of an excess number of leukemia deaths has been reported in workers at the SRS. These reports of excess cancers are being investigated.

The WM PEIS examines potential radiation exposure to offsite populations resulting from implementation of the waste management alternatives. In addition, in the evaluation of cumulative impacts, estimates of annual radiation doses from existing activities and other ongoing actions at the sites are considered. Historical site-specific radiation doses have not been addressed because the availability of this information is limited. However, estimated offsite population risks from the proposed waste management actions generally would add little incremental risk to whatever the historical radiation exposures might be at the various sites.

DOE is committed to managing its waste to protect human health and the environment. DOE takes its responsibility and accountability for waste management decisions seriously and intends to select a configuration for its waste management complex that provides human health and safety assurance to the public. The WM PEIS will help DOE make sound waste management decisions.

3.5.15 Savannah River Site

Section 3.7 in Volume I of the WM PEIS, identifies DOE's preferred alternatives and the reasons they are preferred. The subsequent Records of Decision will announce DOE's decisions and the reasons for the decisions if they differ from the preferred alternatives provided in the Final PEIS.

3.5.16 Waste Isolation Pilot Plant

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3.5.17 West Valley Demonstration Project

Comment (555)
Why didn't DOE consider disposal of low-level mixed waste and low-level waste at WVDP, which already has two disposal facilities?

Response
DOE considered WVDP a candidate site for disposal of its own low-level mixed waste and low-level waste. WVDP was not considered as a candidate site for disposal of wastes from other DOE sites. All reported WVDP low-level mixed waste was categorized as alpha low-level mixed waste. WVDP has no disposal facilities for disposal of alpha low-level mixed waste and all of that waste is currently shipped to SRS for disposal. In addition, DOE anticipates that WVDP has and will generate only a small amount of low-level mixed waste (55 cubic meters), as compared to other DOE sites. See Figure 6.1-1 in Volume I of the WM PEIS. For these reasons, and because the West Valley Demonstration Act likely precludes management of waste generated elsewhere, WVDP was not considered as a candidate disposal site for low-level mixed waste from other sites.

With respect to low-level waste, WVDP was considered as a candidate disposal site for low-level waste generated onsite under the Decentralized Alternative. DOE did not analyze disposal at WVDP of low-level waste generated at other sites because of the relatively low volume of low-level waste at WVDP (42,000 cubic meters), as compared to other DOE sites. See Figure 7.1-1. Further, because of the interrelationship between low-level waste and low-level mixed waste, DOE used the same treatment and disposal locations for low-level waste and low-level mixed waste.

As described in Section 1.8.1, DOE and the New York State Research and Development Authority are currently preparing an EIS for Completion of the WVDP and Closure or Long-Term Management of Facilities that is being closely coordinated with the WM PEIS and will access the site-specific impacts of future waste management at WVDP.

Comment (4444)
WVDP would not be a good regional site, as it already has problems with waste leaching.

Response
DOE considered the management of low-level mixed waste, low-level waste, transuranic waste, and high-level waste at WVDP. DOE would construct new treatment and/or disposal facilities to manage wastes at WVDP under 3 of the 36 alternatives considered in the WM PEIS (the Decentralized Alternatives for low-level mixed, low-level, and transuranic wastes). Under these alternatives, WVDP would only treat and/or dispose of waste generated onsite. WVDP is not considered a potential regionalized or centralized waste management site and would not receive wastes from other sites. Under the Regionalized Alternatives, low-level mixed waste and low-level waste would be shipped off the site for treatment and/or disposal, transuranic waste would be shipped off the site for treatment pending disposal, and high-level waste would be shipped off the site for storage pending disposal in a geologic repository.

As discussed in PEIS Volume I, Section 4.4.17, groundwater monitoring at WVDP in 1991 showed that all parameters except gross beta and tritium were within comparison criteria. However, monitoring at 10 offsite residential wells indicated no evidence of contamination by activities at WVDP. Sitewide or project-level NEPA analyses will evaluate in greater detail the design of specific facilities and the potential for environmental impacts at sites selected for programmatic waste

3.5.17 West Valley Demonstration Project

management activities. Issues such as containment structures to prevent waste leaching would be addressed in such analyses. DOE and the New York State Energy Research and Development Authority have prepared a draft EIS for completion of the WVDP and closure or long-term management of the Western New York Nuclear Service Center that is being closely coordinated with the WM PEIS and will assess the site-specific impacts of future waste management at WVDP.

Comment (143)
A commentor is not convinced that Yucca Mountain is a satisfactory storage site.

Response
The question of whether Yucca Mountain is a suitable disposal site is outside the scope of the WM PEIS. DOE is investigating the suitability of the Yucca Mountain site as the Nation's first licensed geologic repository for spent nuclear fuel and high-level radioactive waste. DOE is preparing a Yucca Mountain Repository EIS and has established a tentative date of 2000 for the Record of Decision. Because the Yucca Mountain site is the only candidate repository site currently being studied, DOE used its location to analyze the impacts of transporting high-level waste to a potential disposal facility.

Comment (196)
DOE needs to consider what assurances there are that WIPP will open and what conditions are associated with that assumption.

Response
For analytical purposes, DOE assumed that WIPP will operate as a transuranic waste repository. However, the No Action Alternative does evaluate the impacts if there is a delay in the receipt of transuranic waste at WIPP for disposal and waste continues to be stored at the generating sites for the 20-year period of analysis. DOE has prepared the WIPP SEIS-II to evaluate the impacts associated with transuranic waste disposal at WIPP. The WIPP SEIS-II No Action Alternatives evaluate the continued management of transuranic waste at the generator and/or treatment sites, and decommissioning of the WIPP facility.

Comment (1140)
The WM PEIS inappropriately continues to exclude consideration of high-level and transuranic waste disposal sites. The PEIS must include waste disposal alternatives other than Yucca Mountain and WIPP because one or both of those sites may never become operational. Even if they become operational, Yucca Mountain could not handle all high-level waste and WIPP cannot handle all transuranic wastes.

Response
Because the environmental evaluation process for geologic high-level waste (HLW) disposal was established by the Nuclear Waste Policy Act, the WM PEIS does not analyze the environmental impacts of disposal at Yucca Mountain or alternative locations for a geologic repository. The WM PEIS does analyze the environmental impacts of longer-term storage of treated HLW in the event that the construction and operation of a national geologic repository for HLW is delayed. Yucca Mountain is currently being studied for its suitability as a potential site for a geologic repository. If Yucca Mountain is found suitable, the Secretary of Energy will recommend the site to the President, at which time Yucca Mountain will be the proposed site for the first geologic repository. If the HLW repository is not established at Yucca Mountain, DOE would have to reevaluate its long-term plan for disposition of HLW.

The WM PEIS analysis of high-level waste storage includes consideration of high-level waste canister storage requirements if a permanent geologic repository does not open until after 2015. Under this scenario, which is analyzed as part of the Centralized Alternative, all canisters would be shipped to Hanford for storage until a geologic repository begins accepting high-level waste. Impacts are

3.6 Geologic Repositories

evaluated on an incremental annual basis. For the purposes of analysis, DOE assumes that WIPP will become operational. Although the WM PEIS does not evaluate WIPP or its suitability for disposal, the No Action Alternative does evaluate the impacts if there is a delay in the receipt of transuranic waste (TRUW) at WIPP and waste continues to be stored at the generating sites.

DOE has already examined alternatives to geologic disposal at WIPP in previous NEPA documents. Moreover, the disposal impacts from operating WIPP as a TRUW repository are addressed in the WIPP SEIS-II. The WIPP SEIS-II No Action Alternatives evaluate the continued management of TRUW at the generator and treatment sites, and decommissioning of the WIPP facility. These alternatives analyze environmental impacts if the waste were not disposed of at WIPP.

The capacity of WIPP is limited by the WIPP Land Withdrawal Act (Public Law 102-579) and by the Consultation and Cooperation Agreement with the State of New Mexico. Under these limits, as analyzed in the WIPP SEIS-II, WIPP would not be able to accommodate all of DOE's defense remote-handled transuranic waste.

Comment (1513)
The public is concerned about accepting more waste into the State of New Mexico at WIPP. The people of the State of New Mexico do not want WIPP to open. The Mayor of Carlsbad, New Mexico, might want WIPP, but the citizens do not.

Response
The decision of whether to operate WIPP as a transuranic waste repository is outside the scope of the WM PEIS. Rather, as identified in Volume I, Section 1.1, the WM PEIS analyzes alternative locations for treatment and storage sites. However, for purposes of analysis, DOE assumed WIPP would be operational as a transuranic waste disposal facility.

As described in Volume I, Section 1.8.1, DOE has prepared the WIPP SEIS-II to evaluate the potential environmental impacts of transuranic waste disposal at WIPP. This information will be used to support DOE's decision on whether to operate WIPP as a transuranic waste disposal facility.

In addition, disposal of transuranic waste cannot begin until DOE meets the requirements imposed under the WIPP Land Withdrawal Act and other applicable regulations.

Comment (1621)
A commentor supports the use of Yucca Mountain for storage of high-level waste.

Response
Thank you for your comment.

Comment (1636)
DOE should consider other sites besides Yucca Mountain for high-level waste (HLW) storage.

Response
Because the environmental evaluation process for geologic disposal was established by the Nuclear Waste Policy Act, the WM PEIS does not analyze environmental impacts of disposal at Yucca Mountain or alternative locations for a geologic repository. However, the WM PEIS does analyze the

environmental impacts of the longer term storage of treated HLW in the event that the construction and operation of a national geologic repository is delayed.

The total HLW volume of 378,000 (inventory plus generation within the next 20 years) is equivalent to an estimated 21,600 canisters of vitrified HLW. Under the No Action Alternative and Decentralized Alternative, the Hanford Site, INEL, SRS, and WVDP would store HLW canisters. Under Regionalized Alternatives 1 and 2, the Hanford Site, INEL, and SRS would store HLW canisters. Under the Centralized Alternative, the Hanford Site would store HLW canisters.

DOE is addressing possible environmental impacts from the construction, operation, and eventual closure of a potential repository for spent nuclear fuel and HLW at Yucca Mountain in a separate EIS.

Comment (2215)
I am getting sick of hearing about Yucca Mountain. I believe in Santa Claus more than I believe in Yucca Mountain.

Response
Thank you for your comment.

Comment (3214)
The WM PEIS does not analyze alternatives to the Yucca Mountain repository. DOE should examine all alternatives for management of high-level waste, including other disposal sites, extended storage at the point of generation, and regionalized and centralized storage. The impacts of transporting waste to Yucca Mountain, and for all other alternatives, should be examined.

Response
Because the environmental evaluation process for geologic disposal was established by the Nuclear Waste Policy Act, the WM PEIS does not analyze environmental impacts of disposal at Yucca Mountain or alternative locations for a geologic repository. However, the WM PEIS does analyze the environmental impacts of the longer term storage of treated high-level waste in the event that the construction and operation of a national geologic repository is delayed. A separate EIS will be prepared as part of the evaluation of the Yucca Mountain site as a repository.

If the high-level waste repository is not established at Yucca Mountain, DOE would have to reevaluate its long-term plan for the disposition of high-level waste. The PEIS does analyze the environmental impacts of longer term storage of treated high-level waste in the event of a delay in the construction and operation of a national geologic repository for high-level waste. It also addresses regionalized and centralized storage of vitrified high-level waste and transportation of the vitrified waste to the storage location.

The potential impacts of transporting high-level waste to Yucca Mountain for disposal will be evaluated in the Repository EIS. Transportation-related impacts for the alternatives considered in the WM PEIS are discussed for each waste type under health risks, air quality, and environmental justice (e.g., for low-level waste, see Sections 6.4, 6.5, and 6.10 respectively), and in Volume IV in Appendix E.

3.6 Geologic Repositories

Comment (3333)
The Waste Management Program supposes a licensed geologic repository, although WIPP is unsuitable because of (1) its failure to meet EPA standards; (2) questionable deals cut between DOE and EPA to weaken oversight; (3) the presence of dangerous gases that cannot be monitored; and (4) the presence of tritium, which also threatens the Ogallala Aquifer.

Response
The WM PEIS does not analyze the environmental impacts of disposal at WIPP or alternative locations for a geologic repository. Rather it evaluates all reasonable programmatic alternatives for transuranic waste treatment and storage configurations. For purposes of analysis, DOE assumed that WIPP will become operational. Although the WM PEIS does not evaluate WIPP or its suitability for disposal, the No Action Alternative does evaluate for the period of analysis (20 years) the impacts if there is a delay in the receipt of transuranic waste at WIPP and waste continues to be stored at the generating sites.

The disposal impacts from operating WIPP as a transuranic waste repository are addressed in the WIPP SEIS-II. The WIPP SEIS-II No Action Alternatives will in part evaluate the continued management of transuranic waste at the generator and/or treatment sites, and decommissioning of the WIPP facility. These alternatives will be analyzed to provide a baseline for environmental impacts if transuranic waste were not disposed of at WIPP. This information will be used to support DOE's decision of whether to operate WIPP as a transuranic waste disposal facility.

Comment (3599)
The WM PEIS continues the saga of the DOE asserting that it is going to prove that waste will not migrate beyond the WIPP boundary within the 10,000-year statutory requirement, regardless of the gas generation problem. We understand that the WM PEIS is a document based on changing processes and decisions that impact the document. Nonetheless, it is difficult to take the assumptions and petitions for exemptions seriously because the underlying focus is not the health and safety of the environment and the people and animals that live within the area, but to get the waste out of sight and out of mind as quickly as possible. The assumption of non-defense waste at WIPP and the no-migration petition are two examples of that focus.

Response
As described in Section 1.8.1 in Volume I of the WM PEIS, which highlights a number of DOE NEPA documents that are related to the WM PEIS, the impacts of disposal of transuranic waste (TRUW) at WIPP, including the types of TRUW to be disposed of and the long-term performance of the repository, are evaluated in the WIPP SEIS-II. The WM PEIS assumes, for analytical purposes only, that WIPP will operate as a TRUW disposal facility, but also analyzes the impacts of no TRUW disposal at WIPP and continued storage at the generating sites.

Since publication of the Draft WM PEIS, the 1997 Defense Authorization Act, which contains amendments to the WIPP Land Withdrawal Act, was signed into law on September 23, 1996. The amendments exempt waste to be disposed of at WIPP from RCRA's provisions regarding land disposal restrictions, thus eliminating the need to obtain a No Migration Determination prior to commencing proposed disposal operations. The Final WM PEIS reflects this change in requirements.

Comment (3931)
Several commentors stated that the WM PEIS assumption that Yucca Mountain will be licensed as the nation's permanent geologic repository is unrealistic, especially in light of Secretary O'Leary's indications that there is only a 50% chance of this occurring. Some commentors further indicated that DOE must fully address Yucca Mountain in a credible programmatic EIS, including industry-known problems concerning the site such as exceedance of dose limits and inadequate disposal capacity.

Response
The WM PEIS does not evaluate disposal of high-level waste or spent nuclear fuel because this issue (and associated dose limit and capacity concerns) is not within the scope of DOE's proposed action. The facility at Yucca Mountain would have space for at least a portion of the high-level waste canisters if it is developed. As stated in Volume I, Section 1.8.1, DOE is preparing a separate EIS for disposal of high-level waste and spent nuclear fuel at Yucca Mountain. Because the environmental evaluation process for geologic disposal was established by the Nuclear Waste Policy Act, the WM PEIS does not analyze environmental impacts of disposal at Yucca Mountain or alternative locations for a geologic repository. However, the WM PEIS does analyze the environmental impacts of the longer-term storage of treated high-level waste in the event that construction and operation of a national geologic repository is delayed. In addition, because the Yucca Mountain site is the only candidate repository site being studied at this time, DOE used this location to analyze the impacts of transporting high-level waste to a potential disposal facility.

Two different timing scenarios were evaluated in the WM PEIS to determine the impacts of storing vitrified high-level waste prior to disposal in a geologic repository. In the first scenario, DOE assumed that the geological repository would begin accepting DOE-managed high-level waste in 2015. In the second scenario, acceptance of DOE-managed high-level waste at the repository is assumed to be delayed past 2015. For the latter case, impacts of high-level waste storage are presented on an annualized or incremental basis to account for variability in the length of any potential delays. If DOE is unsuccessful in obtaining regulatory approval for Yucca Mountain, it would have to reevaluate its long-term plans for disposal of high-level waste.

Comment (3940)
Does DOE plan to site the WIPP, near Carlsbad, New Mexico, regardless of the results of site characterization and feasibility studies presently being conducted?

Response
Since 1970, DOE has stored all of its transuranic waste, including transuranic waste containing hazardous components that are subject to RCRA. DOE could decide to dispose of this post-1970 retrievably stored transuranic waste in the WIPP geologic repository near Carlsbad, New Mexico, after the completion of appropriate NEPA analyses and if acceptable disposal performance can be demonstrated and regulatory requirements can be met. Several studies are underway to characterize and more fully understand the potential long-term behavior of the disposal of transuranic waste at WIPP. One of these studies is the WIPP Disposal Phase Supplemental EIS (SEIS-II), which has been prepared by DOE to evaluate the environmental impacts of disposing of transuranic wastes at WIPP. Based on the results of these studies and independent of the WM PEIS, DOE will determine whether to dispose of transuranic waste at WIPP and the extent to which transuranic waste must be treated before disposal. However, to reduce the potential for delays in future transuranic waste disposal at WIPP,

3.6 Geologic Repositories

DOE will use the WM PEIS analysis to support the decision(s) about where to treat and store transuranic waste before it is disposed of at WIPP.

Comment (4045)
The timelines for both WIPP and Yucca Mountain have been extended as new regulatory and environmental issues emerge related to these facilities. Therefore, DOE should not assume that WIPP and Yucca Mountain will be available in the future. The PEIS should give greater weight to alternatives that are not based on a reasonably foreseeable centralized geologic repository.

Response
The evaluation of transuranic waste treatment and storage alternatives in the WM PEIS, which provides advance planning information on transuranic waste even if the operation of WIPP is delayed, also required that transportation to a repository location be assessed. For the WM PEIS analysis, WIPP was chosen as the final destination for evaluation of transportation impacts; operation of the WIPP repository was not evaluated.

DOE has prepared the WIPP SEIS-II to evaluate the environmental impacts of disposing of transuranic waste at WIPP. As part of the WIPP SEIS-II, the No Action Alternatives evaluate the continued management of transuranic waste at the generator facilities and decommissioning or other disposition of the WIPP facility. These alternatives will evaluate environmental impacts if the waste were not disposed of at WIPP. The WM PEIS transuranic waste No Action Alternative also evaluates the impacts of continued storage of transuranic waste at the generator sites for the period of analysis (20 years).

Section 9.1.1 describes why Yucca Mountain was used in the high-level waste analyses. In part, this section states that since Yucca Mountain is the only site that is required to be evaluated as a high-level waste repository by the Nuclear Waste Policy Act, Yucca Mountain was assumed, for purposes of analysis, to be the location of the high-level waste repository. Impacts from the construction, operation, and closure of a geologic repository at Yucca Mountain will be examined in the Yucca Mountain Repository EIS, although the Nuclear Waste Policy Act, as amended, does not require DOE to examine alternative locations. The WM PEIS does analyze the environmental impacts of the longer term storage of treated high-level waste in the event that the construction and operation of a national geologic repository is delayed.

4. Site Characteristics and Affected Environments

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(No comments were received for this section)

4.1 Environmental Resources and Conditions

Comment (251)
Referring to the "unusually high incidence of breast cancer in the county," a commentor stated that DOE lacks information and understanding of the human element that makes up the local environment around Argonne National Laboratory-East (ANL-E).

Response
The WM PEIS health risk analysis addresses the potential risks from the construction and operation of new waste treatment, storage and disposal facilities. Volume I, Section 5.4.1, of the WM PEIS provides a description of the methods used to assess health risks. The results for each waste type are presented in Chapters 6 through 10. In addition, Chapter 11 summarizes the risks of the waste management actions for a combination of the applicable waste types at each site. Chapter 11 also addresses, by site, the cumulative health impacts of the proposed waste management actions, the existing conditions, and other proposed actions at the site.

Note that the WM PEIS health risk analysis considers site baseline risk only as a component of cumulative impacts. In Chapter 11, baseline risk is considered as the potential effect of existing site-related actions on population exposure and risk. The analysis does not include regional epidemiological or health statistics information, such as the breast cancer incidence in the counties surrounding ANL-E. The estimated risks of the proposed waste management actions at ANL-E should be considered as excess latent cancer incidence or fatality risks that would be added to the existing baseline. The estimated incremental risks from the proposed treatment and disposal of low-level mixed waste and low-level waste at ANL-E are presented in Section 6.4 and 7.4 in Volume I, respectively, and in the Volume II Site Data Tables. For both waste types, less than one additional cancer incidence is estimated in the offsite population living within a 50-mile radius of the site as a result of the proposed treatment actions. Probabilities of cancer fatality for the offsite maximally exposed individual are less than 1 in 1 million. Disposal risks for the hypothetical farm family maximally exposed individual are less than 1 in 1 million for low-level mixed waste and 3 in 100,000 for low-level waste.

Comment (1554)
The Hanford Site map in Figure 4.4-4 contains numerous deficiencies in labeling, and an inaccurate site boundary. The NTS map also has inaccurate borders. It should include Area 51, and not include Pahute Mesa.

Response
The Hanford Site map (Figure 4.4-4 in Volume I) was corrected for the Final WM PEIS to provide accurate labeling and site boundaries.

The borders of the NTS map shown in Figure 4.4-8 in Volume I of the WM PEIS have also been revised. However, the WM PEIS Affected Environment Technical Report indicates that Pahute Mesa is managed as part of NTS. The NTS boundaries are designated by four Public Land Orders and a Memorandum of Understanding with the Air Force for the Pahute Mesa area. Land withdrawn under Public Land Order 1662 is not considered under any alternative for use by DOE and, therefore, is not addressed in the WM PEIS.

Comment (1644)
The PEIS should address the issue of air quality in Nevada.

4.1 Environmental Resources and Conditions

Response
WM PEIS Volume I, Section 4.4.8, and the WM PEIS Affected Environment Technical Report describe the air quality at Nevada Test Site (NTS). The State of Nevada is divided into Air Quality Control Regions (AQCRs). NTS is located in Nevada AQCR No. 147. This region is designated as an attainment or unclassified area with respect to the National Ambient Air Quality Standards. An attainment area is an area with air quality better than those standards. The nearest nonattainment area is in Las Vegas Intrastate AQCR No. 13, which includes Clark County. This AQCR is classified as nonattainment for carbon monoxide and particulate matter less than 10 microns in diameter.

Major sources of nonradiological air emissions from NTS are test drilling, mining, and sampling operations for underground nuclear tests and, possibly, evaporation of containment pond water. Other air pollutant emissions are from construction activities, fugitive dust from unpaved roads, fuel burning equipment, open burning, fuel storage facilities, and asbestos removal activities. These activities contribute to the existing air quality within AQCR No. 147.

Comment (1718)
In Volume I, Tables 4-10 and 4-11, provide information that separates radioactive materials totals from radioactive waste totals for incoming and outgoing shipments.

Response
Tables 4.3-6 and 4.3-7 (formerly Tables 4-10 and 4-11) show the incoming truck and rail shipments, respectively, of hazardous materials to each of the major waste generating and storage sites during Fiscal Year 1993. The data provided in Tables 4.3-6 and 4.3-7 are for the purposes of establishing a transportation baseline for the current rail and truck shipments to and from DOE sites. Source data are derived from the 1993 Shipment Mobility/Accountability Collection and the Waste Manifest System FY 1993. Data are presented for each site without reference to source or destination of shipments. This database includes all radioactive materials shipments, not just waste shipments. The database does not specifically characterize the components that make up the site shipments beyond a division into radioactive and other hazardous materials categories. Because the table is intended as a summary of transportation-related activity in general, it is not useful as a source for waste volume, or other materials volume information.

Comment (1726)
In Volume I, Section 4.4.9, include information on the variety of Federal and State protected plant life that can be found on the Oak Ridge Reservation (ORR).

Response
Section 4.4.9 in Volume I of the WM PEIS is a summary of the affected environment information for ORR. Additional information on ecological resources at ORR, including sensitive plant species, is contained in Section 2.8.4 of the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (1729)
The WM PEIS refers to radioactive and nonradioactive parameters that exceeded water quality comparison criteria at ORR in 1992. Please include information about the parameters that exceeded comparison criteria in 1993 and 1994.

4.1 Environmental Resources and Conditions

Response
In general, DOE elected not to update or supplement the data in the WM PEIS with more recently published data because conditions rarely change drastically from year to year. Exceptions were made in instances where DOE determined that the updated data might affect the comparisons of alternatives. DOE believes that the water quality information provided gives an adequate characterization of the conditions at the sites, especially for a programmatic EIS that will not select locations for waste management facilities on the sites. More up-to-date site-specific information would be included in sitewide or project-level NEPA analyses.

Data on water quality parameters for 1993 and 1994 are available in the ORR environmental reports for those years.

Comment (1829)
The WM PEIS does not sufficiently reflect reasonable present and future conditions to allow one to draw conclusions about the impacts of the proposed actions at the ANL-E.

Response
To conduct any analysis using data that is continually being updated, the data must be "locked" at some point in time. If the data were not locked, and the analysis were updated each time new data are available, the analysis would be a "moving target" that would never be completed. As described in Section 4.4.1 in Volume I of the Draft WM PEIS and in the Draft WM PEIS Affected Environment Technical Report, the information on current conditions at ANL-E was obtained largely from reports prepared from 1990 through 1994. The low-level mixed waste volumes used in the Draft WM PEIS were obtained from the 1994 Mixed Waste Inventory Report.

More recent data at ANL-E shows a 60-fold decrease in waste generation. As a consequence, all low-level mixed waste impacts were included with the updated, lower, estimates of low-level mixed waste for ANL-E. The Final WM PEIS was revised to reflect resulting impacts from this reevaluation.

Comment (2078)
The ecological resources discussion in Volume I, Section 4.4 2, is grossly inadequate. Brookhaven National Laboratory (BNL) is located in the Central Pine Barrens State Forest Preserve, which is protected under New York State law. The site is also located within the environmentally sensitive Peconic National Estuary, which has been designated as part of the Pine Barrens Maritime Bioreserve and the National Estuary Program. Effluent from the BNL wastewater treatment plant discharges into the Peconic River, and groundwater at BNL recharges into the Peconic, Greater South, or Moriches Bays. These bays are among the most productive estuaries in the Country. They are primarily known for the production of filter feeding foods, such as clams, oysters, and scallops. Filter feeders are especially prone to bioaccumulation of toxic substances, primarily due to the amount of water filtered by each organism. A possible release of radioactive and/or hazardous materials into an estuary where commercial harvests of filter feeders occurs is not environmentally sound.

Response
BNL is in an area designated by the Pine Barrens Protection Act as "Compatible Growth Area" and "Core Preservation Area." A Compatible Growth Area is that portion of the pine barrens that has been designated to be compatible for limited development. The Core Preservation Area is the area designated to receive greater protection from development.

The headwaters of the Peconic River Estuary are also located on BNL. While this estuary is groundwater-fed, discharge from BNL's sewage treatment plant makes up much of the surface flow in the upper reaches of the Peconic River. This surface flow typically dries up prior to leaving BNL property. Groundwater beneath BNL would recharge downstream sections of the Peconic River and, to a lesser extent, the Carmans River. These rivers discharge into the Peconic Bay and Bellport Bay portion of the Great South Bay, respectively. Theoretically, a portion of groundwater beneath BNL will eventually recharge the Moriches Bay; however, given the slow rate of groundwater movement, this has not yet occurred.

DOE considers impacts to the pine barrens and Peconic and Carmans River estuaries in all BNL project-level NEPA reviews. In addition, DOE consults the Central Pine Barrens Planning Commission about many activities at BNL and provides the Commission the opportunity to comment on environmental assessments prepared under NEPA. Also, the New York State Department of Environmental Control considers the estuaries and pine barrens during relevant permit actions. This open communication between DOE, the State of New York, and the Central Pine Barrens Planning Commission will continue.

The WM PEIS does not specifically address the potential impacts to aquatic organisms from the treatment, storage, and disposal of waste management waste, although groundwater contamination from disposal of low-level mixed waste and low-level waste is expected to be limited by design and siting considerations, as described in Sections 6.6.2.1 and 7.6.2 in Volume I of the WM PEIS.

Section 5.4.3 in Volume I states that seepage of contaminated groundwater from disposal facilities could contaminate surface water and that this would be expected to occur at sites with shallow groundwater and surface water bodies that are fed by groundwater discharge (springs). Where contaminated groundwater discharges to the surface, dilution in "clean" surface waters would cause concentrations of contaminants in surface water to be lower than concentrations in groundwater. Section 5.4.3 also states that DOE will evaluate the performance of disposal facilities at each site, and if significant groundwater contamination were predicted, changes in the waste acceptance criteria would be made to limit disposal of the waste with the potential to cause significant groundwater contamination. In no case would DOE knowingly dispose of waste in violation of legal requirements.

In addition, the Final WM PEIS was revised to include a qualitative analysis of the vulnerability of the DOE sites to surface-water impacts. This new text is located in Section 5.4.3 in Volume I and Section C.4.3.4.10 in Volume III. This text states that although BNL is somewhat vulnerable to surface-water contamination, impacts from the incremental addition of waste management activities are not expected to be major.

Comment (2130)
The Ohio Department of Health has detected radiation in Piketon, in our houses, on our yards, in our gutters, on our sidewalks, and in our water. DOE needs to be concerned about damage being done to people, pets, and personal and public property from the fallout from the Portsmouth Plant.

Response
A brief description of the existing environmental conditions at Portsmouth is provided in Section 4.4.12 in Volume I of the WM PEIS. Additional information is provided in the WM PEIS Affected

4.1 Environmental Resources and Conditions

Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9, Volume I, of the Final WM PEIS.

DOE prepares annual site environmental monitoring reports that provide information about environmental monitoring activities and releases. These reports are available to the public. In 1992, DOE reported a radiation dose of 0.26 mrem to the maximally exposed individual from airborne radionuclides. This is well below the National Emission Standards for Hazardous Air Pollutants standard of 10 mrem per year. It is DOE policy to maintain releases at a level that is as low as reasonably achievable. DOE is committed to operating its facilities and managing its wastes safely and in compliance with all applicable laws and regulations.

DOE encourages the public to immediately report any unusual activities and concerns related to its sites, to the site management.

Comment (2138)
The public is concerned about the water supply around Paducah Gaseous Diffusion Plant (PGDP) and the Portsmouth Plant. DOE needs to consider that the Portsmouth Plant is located above an aquifer, and that leaks of hazardous materials at PGDP could contaminate the water. The WM PEIS does not mention that Cairo, Illinois, which is downstream of PGDP, gets its drinking water from the Ohio River.

Response
DOE understands that PGDP and the Portsmouth Plant have the potential to impact the surface water and groundwater near the sites. These impacts are evaluated at a programmatic level in the WM PEIS. DOE would consider site-specific control measures when planning new facilities or activities for specific sites. These control measures could include: modifying the design of generic disposal facilities (used in the PEIS analysis) to fit site-specific conditions; modifying waste form requirements; optimizing the location of a facility at a site; and imposing waste acceptance criteria.

Any eventual waste storage or disposal facilities would be structured with sufficient containment and would be carefully monitored. Furthermore, sites would be equipped with sufficient safety and emergency response measures to minimize the potential for leaks to contaminate surface water or groundwater. The WM PEIS Affected Environment Technical Report contains more detailed descriptions of the sites. Section 2.9.2.1 of the WM PEIS affected Environment Technical Report accounts for the fact that Cairo, Illinois, is downstream of PGDP and obtains its drinking water from the Ohio River. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2216)
DOE needs to explain why there is no wildlife in the neighboring creeks around PGDP. DOE claims there is no contamination of a dangerous level. This does not seem likely.

Response
There is wildlife in the neighboring creeks around PGDP. As described in the WM PEIS Affected Environment Technical Report, PGDP is surrounded by the West Kentucky Wildlife Management Area. Beaver, mink, muskrat, frogs, turtles, and several fish species reside in neighboring creeks around PGDP. Fish and wildlife in and around the creeks are monitored and sampled on a regular

basis by the Commonwealth of Kentucky. Low levels of polychlorinated biphenyls and radionuclides have been discovered in one of the creeks close to PGDP. Controls designed to limit access to these areas were presented to the public for comment, sanctioned by the Commonwealth, and instituted. A second creek had even lower levels of contamination and the Commonwealth concluded that no controls were necessary. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2387)
Place the listed endangered species into context by discussing and comparing the relationships within the local and regional ecosystem. Simply listing the endangered species does not communicate the potential impacts of waste management activities.

Response
DOE did not attempt to evaluate impacts to endangered or threatened species, either directly from waste management activities or through effects on their local or regional ecosystems, in the PEIS. Such analyses would be too complex for a programmatic evaluation of effects at 17 different sites and would require identifying specific waste management facility locations at each site; siting location decisions are not being made in the PEIS. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA reviews, which would include analyses of potential impacts to ecosystems, particularly any effects on threatened and endangered species or critical habitats. The WM PEIS identifies listed endangered and threatened and other sensitive species at the candidate sites simply to highlight for DOE decisionmakers the need to identify and address potential ecological impacts once DOE makes initial waste management facility siting proposals.

Comment (2482)
Attainment status should be clarified for Idaho National Engineering Laboratory (INEL), since there are INEL facilities within less than 50 miles of a nonattainment area for PM_{10} (portions of Bannock and Power Counties).

Response
Attainment and nonattainment areas are areas with specific boundaries designated by EPA pursuant to its air quality regulations. The WM PEIS considers a site to be in a nonattainment area only if a part of the site is actually located within a nonattainment area or borders a nonattainment area. Therefore, INEL is considered to be in an attainment area for all criteria air pollutants.

Comment (2487)
The WM PEIS states that most DOE sites are in geologically stable areas, that the greatest seismic risks are believed to be at Lawrence Livermore National Laboratory (LLNL) and PGDP, and that no DOE site is in an area of known substantial volcanic hazard. A commentor argues that INEL, based on its inclusion within the Intermountain Seismic Zone and close proximity to two historical magnitude 7+ earthquakes, is in a region of significant seismic potential and that this is supported by the region being included in seismic hazard zone 3. Additionally, due to the recent (approximately 1,200 years before present) volcanic activity within about 20 miles of the site, INEL is at least in a region of uncertain volcanic hazard.

4.1 Environmental Resources and Conditions

Response
The WM PEIS Affected Environment Technical Report contains more information on historic environmental conditions at INEL. Section 2.3 of that report states that INEL lies outside the Centennial Tectonic Belt, an area of seismic activity within the Intermountain Seismic Belt. Seismographs installed in 1970 show that the eastern Snake River Plain has experienced only microearthquakes (earthquakes with a magnitude less than 1.5) and that the numbers of microearthquakes are very small compared to the numbers of earthquakes outside the Snake River Plain. In fact, since 1972, only 19 microearthquakes have been recorded within the eastern Snake River Plain. The closest large earthquakes to INEL were the 1959 Hebgen Lake earthquake (magnitude 7.5) and the 1983 Borah Peak earthquake (magnitude 7.3). Both were felt at INEL, but neither caused damage to INEL facilities. Based on known earthquake sources and a hypothetical unknown random earthquake in the eastern Snake River Plain, it is estimated that an earthquake with a maximum horizontal acceleration of about 0.15g has a probability of occurrence of 1 in 5,000 per year at a centralized INEL location (Idaho Chemical Processing Plant). Note that a seismic hazards study is currently being performed at INEL. This study is expected to be completed in fiscal year 1997.

Section 2.3 of the WM PEIS Affected Environment Technical Report further states that no historical eruptions have occurred on the eastern Snake River Plain and volcanic hazards to INEL are primarily related to future basaltic and rhyolithic eruptions along the volcanic rift zones in the eastern Snake River Plain. The likelihood of basalt lava inundation or related ground disturbance is estimated to be less than 1 chance in 40,000 per year for the southern INEL. Risks from these phenomena in the northern INEL are even lower. The probability of significant impacts from all other volcanic phenomena, such as growth of new rhyolite domes on the eastern Snake River Plain or thicker than 8 centimeters (3.3 inches) ashfall from distant volcanoes, is estimated to be less than 1 chance in 100,000 per year due to the combined effects of great distance, infrequency, low volume, and topographic or atmospheric barriers to the dispersal of ash on INEL. Therefore, INEL was not considered to be in an area of substantial volcanic hazard.

The WM PEIS Affected Environment Technical Report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2490)
In Volume I, Table 4-9, how can the peak load (550 megawatts) be greater than the total capacity (351.74 mega voltampere) at Hanford?

Response
The commentor is correct; the peak load should not be greater than the total capacity. According to the WM PEIS affected environment technical report (DOE, 1995), the peak load for Hanford should be 59.36 megawatts. DOE corrected the table (now Table 4.3-5).

Comment (2491)
Volume I, Section 4.4.5: The first bullet under *Air Quality* omits Clark and Bannock Counties. Should this bullet include all of the counties in the socioeconomic region of influence?

Response
INEL is located in Air Quality Control Region (AQCR) 3, which includes Butte, Jefferson, Bonneville, and Bingham Counties, but not Clark and Bannock Counties. AQCRs are designated by EPA and were

created by EPA for regulatory purposes that are not related to the creation of the socioeconomic regions of influence for the WM PEIS.

Comment (2492)
Volume I, Section 4.4.5, and Volume III, Section C.4.2.1.3.1 and Table C.4-3, state that Butte, Jefferson, Bonneville, and Bingham are classified as attainment areas for the six National Ambient Air Quality Standards. To designate an area as in attainment, ambient air monitoring must be performed to verify the attainment status. If an area has not had ambient air monitoring performed, like most of the area described, it is determined to be unclassified. In Volume III, the area around INEL is considered in attainment.

Response
The commentor is correct that an area that has not had ambient air monitoring performed should be designated unclassified. However, as of 1996, INEL is located in an attainment area for ambient air quality. The State of Idaho and EPA classify the counties surrounding INEL as attainment areas for the six National Ambient Air Quality Standards criteria air pollutants.

Comment (2493)
Volume I, Section 4.4.5, states that no known Federally or State-listed threatened, endangered, or candidate plant species are found at INEL and that eight Federal candidate species are found at the site. This seems contradictory.

Response
DOE revised Volume I, Section 4.4.5, of the WM PEIS to clarify that no known Federally or State-listed threatened or endangered plant species are found on INEL. However, one plant is listed by the State of Idaho as imperiled, and eight Federal candidate species (two are State species of special concern) and five State species of special concern are found on INEL.

Comment (2495)
Volume I, Section 4.4.5, gives the names of the major surface water features on and around INEL and then states that none of the rivers flow off the site. This is misleading, because the rivers all flow toward INEL, with only the Big Lost River actually flowing onto INEL in years of high precipitation.

Response
DOE has revised Section 4.4.5 in Volume I of the WM PEIS to clarify that the rivers flow toward INEL and that stream flows are often depleted before reaching INEL.

Comment (2496)
Volume I, Section 4.4.5, states that the Idaho Chemical Processing Plant the Naval Reactors Facility, and Test Area North would be flooded in the event that the Mackay Dam fails. This contradicts the conclusion of Koslow and Van Haaften (*Flood Routing Analysis for a Failure of Mackay Dam*, EEG-EP-7184, 1986). Please verify that the statement is correct. If it is found that the statement is not correct, please clarify that the existing INEL flood diversion system should prevent flooding of INEL facilities in the event that a catastrophic failure of the Mackay Dam occurs.

4.1 Environmental Resources and Conditions

Response
The WM PEIS Affected Environment Technical Report states that flooding scenarios that involve the failure of MacKay Dam have been evaluated. The results indicate that in the event of a dam failure, there would be flooding at the Idaho Chemical Processing Plant, the Naval Reactors Facility, and Test Area North. The low velocity and shallow depth of the water would not, however, pose a structural damage threat to these facilities. Section 4.8.1.3 in Volume 2 of the SNF/INEL EIS, which referenced the Koslow and Van Haaften report cited in the comment, is consistent with these statements.

Comment (2497)
Volume I, Section 4.4.5, states that no onsite sampling of surface water is performed at INEL because no surface water flows off the site. This is misleading and inaccurate; surface water is sampled on the site when flows occur by both the State of Idaho INEL Oversight Program and by the U.S. Geological Survey INEL Project Office.

Response
The WM PEIS Affected Environment Technical Report states that, because the creeks and rivers at INEL are ephemeral, surface water sampling on INEL can only be performed infrequently, after heavy precipitation events. DOE modified the sentence in Volume I, Section 4.4.5, to reflect the information in the technical report.

Comment (2499)
The WM PEIS ignores all land uses but grazing. The Spent Nuclear Fuel EIS lists grazing, wildlife management, rangeland, mineral and energy extraction, recreation, and crops.

Response
Section 4.1 in Volume I of the WM PEIS indicates that the data and analyses included in the WM PEIS are commensurate with the importance of the potential impact, and that information less crucial to the analysis is summarized or referenced. The discussion in Section 4.4.5 presents the dominant land uses for INEL. A more detailed description of land uses in the INEL region of influence can be found in Section 2.3.5.5 of the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2599)
Volume I, Table 4-12, lists one INEL site on the National Register of Historic Places, but Section 4.4.5 states there are two.

Response
DOE revised Table 4.3-8 in Volume I of the WM PEIS to provide more detailed information on the National Register of Historic Places status of known archaeological sites. For INEL, this table indicates that one property has been listed on the Register and one property has been designated as eligible. DOE also revised the related text description of cultural resources at INEL (Section 4.4.5 in Volume I of the WM PEIS).

Comment (2625)
Volume I, Section 11.5: There are *two* phosphate plants in Pocatello, Idaho, that release radionuclides to the atmosphere.

Response
DOE revised the discussion of INEL cumulative impacts in Volume I, Chapter 11, of the Final WM PEIS to indicate two phosphate plants are present in Pocatello. Information on these facilities was not included in the cumulative impacts analysis. However, it is unlikely that the omission would cause the relative impact of alternatives to change. DOE considers the current cumulative impacts analysis sufficient to make programmatic decisions.

Comment (2865)
Volume I, Section 4.4.5, lists Interstate 90 in the infrastructure description for INEL. Interstate 90 is not even close to the INEL. This section should list Interstates 15, 86, and possibly 84, as well as U.S. Highway 20.

Response
DOE deleted the reference to Interstate 90 from Section 4.4.5 in Volume I of the WM PEIS and added the correct roads in the vicinity of INEL.

Comment (2871)
Volume I, Section 4.3.4, should note and discuss the presence of highly permeable soils that do not naturally attenuate many contaminants. This is the case at BNL and it should be noted.

Response
Section 4.4.2 in Volume I states that soils on the BNL site consist of deep, well-drained to excessively drained, coarse-textured soils, although detailed site-specific information on geology and soil and water resources conditions is not included in Chapter 4.

Section 2.15.2.1 of the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS, contains more detailed information on soil and groundwater conditions at BNL. Section 2.15.2.2 of the WM PEIS Affected Environment Technical Report states that the major groundwater units in the BNL region of influence include the deeper lower aquifer system (Magothy and Raritan Formations) and the shallower Pleistocene Upper Glacial Aquifer. The Upper Pleistocene deposits are generally highly permeable--water penetrates these deposits readily-and little direct runoff into surface streams occurs. On average, about 50% of the annual precipitation percolates through the soil to recharge groundwater, and less than 2% becomes surface-water runoff.

BNL has been identified as being over a deep recharge zone for the lower aquifer system. About two-fifths of the recharge from rainfall moves into the deeper aquifers. About 350 billion gallons of recharge per year occurs from precipitation in Suffolk County.

Comment (2874)
There is no clear definition of the region of influence (ROI) related to the INEL. It seems that the ROI should include all counties that might potentially be impacted by the waste management activities. Regarding groundwater and possibly air quality, this would include the region to the southwest (Magic Valley), since any contamination would move toward that area. At a minimum, the ROI should include the entire Snake River Plain. The ROI for socioeconomics leaves out Madison County. A significant number of site workers live in Rexburg, and that community is probably an economic hub for much of Clark and Jefferson Counties.

4.1 Environmental Resources and Conditions

Response
Because the geographic area affected by any anticipated impacts will differ depending on the environmental parameter under consideration, the ROIs for groundwater, air quality, socioeconomics, etc., will differ. Table 4.2-1 in Volume I of the WM PEIS presents the ROI definition for each WM PEIS environmental parameter. Environmental conditions in the actual ROIs for INEL are presented in the discussion of INEL in Section 4.4.5 in Volume I of the WM PEIS and in much greater detail in Section 2.3 of the WM PEIS Affected Environment Technical Report.

The analytical basis for the socioeconomic ROI is explained in Section 5.4.5 in Volume I of the WM PEIS. This ROI was based on the residence patterns of the current site workforce plus the host county. For INEL, this six county area included 95% of the total site workforce. As described in the Impacts Methods and Results Technical Report the six-county ROI for INEL includes Bannock, Bingham, Bonneville, Butte, Clark, and Jefferson Counties.

Comment (2876)
Volume I, Section 4.3.5, should note that the Peconic River watershed, to which BNL is adjacent, is known to contain the highest concentration of rare and endangered plant and animal species in New York State.

Response
Section 4.3.5 in Volume I of the WM PEIS presents an overview of types of ecological resources considered in the PEIS. Section 2.15.4 of the WM PEIS Affected Environment Technical Report contains a detailed description of the ecological resources at BNL. That section describes the terrestrial communities at BNL: common fauna (mammals and birds), ecosystems that promote biodiversity, unique habitats, and nonactive species.

The technical report also states that as of September 1992, the State of New York included the banded sunfish (*Enneacanthus obesus*) as a species of special concern. The Peconic River is one of only two locations in the State known to support a population of banded sunfish. State-protected wildlife found in the Peconic basin include the tiger salamander, swamp darter (candidate for threatened species status), and the spotted turtle (species of special concern).

Comment (2878)
The list of ecological resources in Volume I, Section 4.3.5, which is oriented toward officially endangered and threatened species, should also note species that are rare or in significant decline but not officially listed. These include neotropical migratory songbirds such as warblers.

Response
The WM PEIS Affected Environment Technical Report contains detailed descriptions of ecological resources at the major sites considered in this PEIS. Federal threatened, endangered, and candidate species, and State threatened and endangered species and species of concern are considered. This level of information is adequate to support programmatic decisions. Sitewide and project-level NEPA reviews would more fully analyze potential impacts to threatened, endangered, and rare species.

Comment (2880)
Volume I, Table 4-6, and Chapters 6 and 7, note only one State-listed endangered species in the BNL Region of Influence. BNL is known to either contain or potentially contain many more endangered and

rare species than is noted. Furthermore, according to Table 4-3, the Region of Influence is to include the site and adjacent resource areas where sensitive habitats or sensitive species could be affected by the proposed action. Based on this definition and footnote "a" to Table 4-6, the WM PEIS grossly underrepresents the endangered, threatened, and rare species on and adjacent to BNL. The fact that the Peconic River and its associated wetlands and tributaries, an area known to contain the highest concentration of rare and endangered plant and animal species in New York State, are located on BNL should have generated a much more extensive list. (The commentor provided a list of species that "should be included in the site data for BNL.") BNL's own Draft Site-wide Biological Inventory Report notes some of these species as being present on the site. Furthermore, the Peconic River, found on the BNL site, flows into the Peconic Bay system, in which a number of Federally listed endangered sea turtles, particularly the rarest, Kemp's Ridley, are often found.

Response
DOE agrees and has revised Volume I, Table 4.3-2, to list one Federally and State-listed endangered, one State-listed endangered, four State-listed threatened species and 13 species of special concern for BNL. Table 4.3-2 provides a summary of the Federal and State-listed threatened and endangered species information by site. The ecological resources text section on BNL in Chapter 4 has also been updated to reflect the more recent BNL data obtained from the site's 1995 biological inventory. Section 2.15.4 of the WM PEIS Affected Environment Technical Report provides a more detailed description of the ecological resources at BNL.

When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to threatened and endangered species and critical habitats based on site-specific conditions.

Comment (2892)
In Figure I-2b the location of the Poospatuck Indian Reservation is not correct. The Poospatuck Tribal lands are located on the Mastic peninsula, approximately 5.5 miles due south of BNL. The arrow on Figure I-2b actually locates the Shinnecock Native American Nation. The WM PEIS should be corrected to note that the Poospatuck and Shinnecock Native American Tribal Lands are located within 50 miles of BNL.

Response
Maps in Section C.4.7 in Volume III of the Final WM PEIS have been revised to reflect the presence of any Federally recognized Native American Tribes at each site. Although there also could be Tribal groups in the BNL region that are not Federally recognized, the WM PEIS does not consider these groups as cultural units (though it does consider their members in the evaluation of environmental justice impacts). The Poospatuck and the Shinnecock Tribes are included in the evaluation of environmental justice impacts even though they are not designated as Federally recognized Tribal groups.

"Recognized Native American groups" refers to those Native American groups recognized by the Federal Government as having cultural identity with an ancestral claim to lands on or in proximity to a DOE site. DOE has added a definition of Federally recognized Native American groups to Section 4.3.7 in Volume I of the WM PEIS. Table 4.3-3 has been retitled to indicate that the groups listed are Federally recognized.

4.1 Environmental Resources and Conditions

Comment (2897)
Volume I, Section 4.4.16, states that since there is no radioactive material at the Waste Isolation Pilot Plant, no radiological measurements have been performed. This statement is incorrect; preoperational radiation surveillance has been conducted by the New Mexico Environmental Evaluation Group."

Response
DOE corrected Section 4.4.16 in response to this comment.

Comment (2898)
The 3,608 available acres shown in Volume I, Table 4-8, for BNL is incorrect. According to the Future Land Use Plan for BNL (1995), the total developed area of the site is approximately 1,655 acres, leaving 3,608 acres of undeveloped land. However, this undeveloped land includes extensive wetlands areas, surface waters, areas where the water table is less than 10 feet beneath the surface, significant ecological habitats and buffer areas that have obviously not been subtracted from the site's total 5,263 acres. Therefore, DOE should not claim in Volume I, Section 5.4.4, that the figure for land available was obtained by subtracting both existing developed and land unavailable including wetlands and buffers, from the total site acreage. Furthermore, Volume I, Chapters 4 and 7, should note that all of the BNL site is located in the State-designated Central Pine Barrens and much of the site is located in the Core Preservation Area, which is designated for preservation. The Central Pine Barrens is an area recognized by New York State in Article 57 of the State Environmental Conservation Law for the significance of its ecological and groundwater resources. Therefore, the figure of 3,608 acres is wrong and must be corrected, taking into account all of the environmentally sensitive areas discussed above.

Response
DOE revised Volume I, Section 4.4.2, of the WM PEIS to show that, after subtracting developed areas, wetlands, and areas where the water table is close to the surface, approximately 2,900 acres would be available for waste management facility development at BNL.

DOE revised Section 4.4.2 to indicate that BNL is located in the Central Pine Barrens and the Peconic Estuary Systems.

Comment (2901)
Volume I, Sections 4.3.11 and 6.10.2.4.3, state that cultural resources inquiries were also sent to the State Historic Preservation Offices. It should be noted that the New York State Office of Parks, Recreation and Historic Preservation does not have complete records of archaeological and prehistoric resources. Accordingly, the New York State Museum Anthropological Survey section, the Suffolk County Archaeological Association, the Nassau County Museum, and the Department of Anthropology at the State University at Stony Brook should also be contacted. It should also be noted that much of BNL is considered to have high likelihood for the presence of aboriginal cultural resources, particularly in areas near the Peconic River. Accordingly, a complete cultural resources survey of the site, including standard subsurface testing, should be conducted.

Response
Because DOE has not proposed specific locations for waste management facilities on sites, it could not perform thorough analyses of potential cultural resources impacts. DOE recognizes that existing

cultural resources documentation might be insufficient for final facility location decisions to be made, especially where a site has not been the subject of a comprehensive cultural resource investigation.

Section 4.4.2 in Volume I of the Final WM PEIS notes that BNL has not been subjected to a comprehensive cultural resource investigation, but that three areas of BNL have been designated as eligible for inclusion on the National Register of Historic Places. A more detailed discussion of the cultural and historic background of BNL is presented in Section 2.15.7.1 of the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

As noted in Volume I, Section 5.4.10, implementing regulations of the National Historic Preservation Act of 1966 require Federal agencies to determine the effect of proposed actions on significant historic properties within the defined area of potential effects. Therefore, a complete cultural resources survey of the site would be required before any final facility location decision. DOE would seek input from local and State societies, museums, libraries, and academic institutions to augment information from the State Historic Preservation Office. DOE appreciates the commentor's assistance in providing names of potential additional sources of information.

Comment (2906)
Volume I, Section 4.4.2, discounts and underplays the significance of the water resources found on and near BNL. Significant surface waters, including the Peconic River headwaters, are found adjacent to BNL on the west side of William Floyd Parkway and northwest of the site. In addition, groundwater flows south from BNL toward the Forge River, a major river on the south shore of Brookhaven Town. Also, BNL is located in the Federally designated Peconic Estuary and development and activities at BNL are of great significance for this system, including the presence of brown tide in the estuary. The WM PEIS water resources subsection fails to note that BNL lies over a deep-flow aquifer and that BNL contains a groundwater divide from which groundwater flows eastward and southward, thereby creating greater potential for groundwater contamination. BNL also contains both discharge and recharge zones. These factors must be accounted for in Section 4.4.2.

Response
Section 4.4.2 in Volume I of the WM PEIS is a summary of information contained in Section 2.15 of the WM PEIS Affected Environment Technical Report. This technical report provides more detailed information on water resources at BNL. The report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

If BNL were selected for disposal, the facility would be designed and located in accordance with all applicable regulations. Best management practices for stormwater management would be implemented to ensure that no significant quantities of potentially contaminated runoff would reach the river. In addition, a detailed performance assessment would be prepared that would evaluate the performance of the disposal facilities over time. The performance assessment would be considered in the decisions about where and how to build the disposal facility.

Comment (2907)
DOE should use more recent data in the discussion of water resources in Volume I, Section 4.4.2.

4.1 Environmental Resources and Conditions

Response
In general, DOE elected not to update or supplement the data in the WM PEIS with more recently published data because conditions rarely change drastically from year to year. Exceptions were made in instances where DOE determined that the updated data might affect the comparisons of alternatives. DOE believes that the water quality information provided gives an adequate characterization of the conditions at the sites, especially for a programmatic EIS that will not select locations for waste management facilities on the sites. More up-to-date site-specific information would be included in sitewide or project-level NEPA analyses.

Comment (2908)
Volume I, Section 4.4.2, should include a discussion of the possibility of perched groundwater feeding the Peconic River.

Response
Section 4.4.2 in Volume I of the WM PEIS is intended to provide a broad overview of the affected environment at BNL. Additional information is presented in the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I.

Section E.2.15.2.1 of the technical report states that BNL is on the western rim of the Peconic River drainage basin. The onsite tributary of the Peconic River both recharges and receives water from the groundwater aquifer, depending on the elevation of the water table. In times of drought, the tributary typically recharges to groundwater, while in times of normal to above average precipitation, the tributary receives water from the aquifer. Liquid effluent from the BNL Sewage Treatment Plant constitutes the principal source of water in the tributary's river bed during drought periods. During times of low precipitation, water in the tributary does not flow offsite.

DOE has confirmed the presence of perched groundwater while conducting monitoring of groundwater quality and elevation around the Peconic River and surrounding wetlands. Since specific locations for waste management facilities on the sites are not being selected at this time, site-specific issues such as the potential impacts from perched groundwater on the Peconic River would be considered during sitewide or project-level NEPA analyses.

Comment (2909)
Volume I, Section 4.4.2, briefly mentions the significance of the underlying aquifer as being a sole-source aquifer. First of all, it should be noted that the aquifer underlying Long Island was designated a sole-source aquifer by the EPA pursuant to 42 USC 300h-3(e) (published in the *Federal Register* on June 21, 1988). BNL is in the midst of a deep recharge zone for Long Island's sole source aquifer system. Two and a half million people draw their water from this system. Soils of this aquifer are very permeable and would easily transmit contaminants to great depths. Residence times in the deeper aquifers is measured in centuries. The WM PEIS discussion of the aquifer system is extremely inadequate and more detail must be provided.

Response
Section 4.4.2 in Volume I of the WM PEIS summarizes the information contained in Section 2.15 of the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading

rooms listed in Section 1.9 in Volume I of the Final WM PEIS. The discussion requested in the comment is in the technical report.

Comment (2915)
Volume I, Section 4.4.2, geology and soils: Gardiner's clay is not a glacial deposit--it is a Cretaceous-age deposit. Its presence at BNL has not been confirmed and is, in fact, widely doubted. There are intervals of a clay layer between the Magothy-Matawan Deposit and the glacial deposits. However, it is believed that there is a strong hydrologic connection between the upper and lower aquifers under most of the BNL site; thus its designation as a deep recharge zone.

Response
The source document used by DOE, the *Brookhaven National Laboratory 1993 Technical Site Information Document*, describes Gardiner's clay as a glacial deposit. Figure 2.15-3 in the WM PEIS Affected Environment Technical Report shows the clay being thin or absent near BNL. This figure also shows BNL in the deep recharge zone for the lower aquifer system. Section 2.15.2.2 of the affected environment technical report states that about two-fifths of the recharge from rainfall moves into the deeper aquifers. The affected environment technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. The BNL information document is cited in the affected environment technical report.

Comment (2916)
Volume I, Section 4.4.2: Unconsolidated sediments above the "basement rock" are usually not called "rock."

Response
The commentor is correct. DOE replaced the term "rock units" with "geologic units" in Section 4.4.2 in Volume I of the WM PEIS.

Comment (2928)
Volume I, Section 4.4.2, oversimplifies the complexity of land use surrounding the BNL site. It should note significant existing or planned residential, commercial and industrial developments, parklands and recreation areas, and cultural and ecological resources.

Response
Section 4.4.2 in Volume I of the WM PEIS was intended to provide a broad overview of the affected environment at BNL. Additional information, including surrounding land use, is contained in Section 2.15 of the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS.

The proximity of residential, commercial, recreational, and ecological resources to sites selected for new waste management operations would also be considered as a part of sitewide or project-level NEPA analyses.

Comment (2948)
At BNL, the wastewater flow is greater than 90% of the receiving water's baseline flow rate. This should be noted as a site-specific exception in Volume I, Section 5.4.3.

4.1 Environmental Resources and Conditions

Response
Although it is true that effluent from BNL's sanitary wastewater treatment plant forms a large percentage of the flow in the upper reaches of the Peconic River, this is considered to be a baseline condition. The analysis performed in the WM PEIS examines the percent change in current conditions due to effluent discharges associated with the waste management alternatives. As described in Sections 6.6.1 and 7.6.1 in Volume I, the change in current effluent discharges would be less than 1%.

Comment (2958)
The ecological resources discussion in Volume I, Section 4.4.2, is grossly inadequate. The following concerns should be addressed. Open space in a highly developed region of the Country such as BNL plays a more significant role than in more rural areas. DOE figures show that the region of influence for BNL is the greatest of all the sites under consideration, and yet BNL is among the smallest of the candidate sites, and has one of the smallest acreage's available for waste management facilities among the candidate sites. The impact of developing this open space should be discussed.

Response
The WM PEIS ecological resources impacts analysis included evaluation of the potential loss or degradation of terrestrial habitats and the potential toxicity resulting from exposure to radioactive and hazardous contaminants released from waste treatment facilities. As shown in the Volume II data tables for BNL, low-level mixed waste facilities would require no more than 1.6 acres at BNL. In addition, the construction of low-level waste facilities would require no more than 2.8 acres at BNL. Even given the revisions to the BNL available land estimates presented in Volume I, Table 4.3-4, sufficient land appears to be available at BNL to implement any proposed waste management actions. The small amount of land required for the low-level mixed waste and low-level waste facilities should give DOE a great degree of flexibility in making facility location decisions. Mitigative measures can also be used to ensure that site clearing would not affect nearby sensitive habitats.

Comment (3003)
Volume I, Section 4.4, presents information regarding the affected environment at major waste sites. This information is not consistently presented across sites even though some of the information, like meteorological records or depth to groundwater, might be the site-specific information pulled in to certain portions of the analysis.

Response
Chapter 4 of the WM PEIS is not intended to provide comprehensive information on all site parameters. Rather, the most pertinent facts are presented. A list of appendices and technical reports is provided in Volume I. These reports provide more comprehensive information than could be presented in the body of the WM PEIS. Affected environments at individual WM PEIS sites are detailed in a two-volume affected environment technical report.

Source data for the analysis are derived from multiple sources such as site development plans and environmental reports, DOE and national laboratory technical reports, and national databases such as from the U. S. Bureau of the Census. Whenever possible, DOE used existing data in conducting the analysis; however, when addressing so many sites and corresponding regions of influence, some limitations on data availability and uniformity can be anticipated.

4.1 Environmental Resources and Conditions

To assure a consistent and uniform analysis across all 17 sites, standard, generic models (or modules in the case of the cost analysis) were used to describe potential activities for each of the waste management sites. Use of these models greatly assists the comparability of the analysis. Because individual variations among the sites cannot be incorporated into these generic descriptions, the correlation between the generic description and the conditions at any one site are imperfect. These variations are assumed as part of the overall comparison of alternatives and addressed as a recognized limitation on the analysis.

Comment (3008)
Single-year weather summaries are of no use for decisionmaking that is expected to have implications over centuries. Average summary data, covering decades at a minimum, should be included for all sites.

Response
Section 4.4 in Volume I was intended to provide summaries of the most important features of the affected environment for each of the major sites. The characterization of the affected environment (including meteorological conditions) was used to establish baseline conditions against which to measure the potential impacts of the waste management alternatives. This information enabled DOE to compare the waste management programmatic alternatives, and to make decisions at the programmatic level.

The WM PEIS impacts methods and results technical report provides more detailed information on environmental modeling/analysis criteria. Criteria used were functions of the models and generally not based on data specific to a single year. For meteorological data, 5-year wind rose data from the National Weather Service were used. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The precision of the modeling was sufficient to enable comparisons across sites. More detailed/precise analyses will be conducted as part of a project-level NEPA reviews.

Comment (3038)
Using 1992 as a baseline year to describe the affected environment at each site suggests that much of the data are out of date. Where possible in Section 4.4, summary information should be updated.

Response
To allow completion of the Draft WM PEIS impacts analyses, the base year for the analysis data was set at 1992. Continuing revisions with more recent data would have prevented publication of the Draft PEIS within a reasonable time frame. Some sections of the WM PEIS have been revised in response to public comments to include updated information. However, DOE did not make changes to the PEIS solely to present more recent information. Changes were generally limited to those that might reasonably be expected to affect the decisions to be made based on the WM PEIS. All changes made from Draft to Final WM PEIS are indicated with a sidebar next to the changed text, or shading in tables.

Comment (3040)
Section 4.3.5 does not discuss the land area that constitutes habitat for threatened or endangered species, although the land area involved may be quite extensive.

4.1 Environmental Resources and Conditions

Response
Volume I, Section 4.3.5, provides an overview of the ecological resources identified in defining the baseline conditions at each of the sites. DOE has modified Section 4.3.5 to refer the reader to additional information contained in the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS.

Section 5.4.4.1 of the WM PEIS describes the evaluation of habitat impacts and Section 5.4.4.3 describes how effects on sensitive species were addressed. The WM PEIS analysis is a screening-level assessment conducted to identify potential impacts. The land area designated by the sites for waste management activities or calculated in the PEIS as available for waste management facility construction generally excludes habitats supporting endangered or threatened species. This waste management designated or available acreage was used to evaluate waste management facility construction requirements in the PEIS. Results indicate DOE has more than sufficient lands available to support new waste management facilities so as not to require use of any lands supporting threatened and endangered species. Site-specific analyses would further evaluate the extent and severity of any ecological resource impacts resulting from the potential implementation of waste management actions.

Comment (3041)
The number of threatened and endangered species at each site is an inadequate basis for decisionmakers to compare siting options because there are more facets to ecological resources. For example, Table 4-6 fails to mention the discovery by the Nature Conservancy of three plant and seven insect species new to science at the Hanford Site and also fails to mention how much of the Hanford Site contains State priority habitat.

Response
Volume I, Table 4.3-2, presents summary information for each site. Detailed information about the ecological resources at the Hanford Site is presented in Section 2.2.4 of the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS.

A detailed analysis of impacts to sensitive species and habitats was not conducted in the PEIS because specific waste management facility locations have not been proposed. Impacts to sensitive species, including species listed as threatened or endangered by the U.S. Fish and Wildlife Service or by the State of Washington as sensitive or of concern, would be addressed in sitewide or project-level analyses. Based on the small fraction of land required for waste management facilities at any site, DOE would have sufficient flexibility in locating facilities on sites to avoid or mitigate impacts to sensitive species and habitats.

Comment (3043)
It is not clear where the figure of 14,496 acres in Table 4-8 for waste management facilities originated. The reference appears to be U.S. DOE 1995, but is not clearly cited. This figure is 140% above the 6,000 acres recommended by the Hanford Future Site Uses Working Group. If the additional acreage is located on the Central Plateau, then waste management activities will have significant effects on State Priority Habitat (shrub steppe) and Priority Species, which could lead to listing for several shrub-steppe-dependent species.

Response
The total acreage data for each site shown in Volume I, Table 4.3-4 (formerly Table 4-8), were compiled from *DOE Real Property: A Yearly Statistical Handbook, FY 1993*. The available acres for waste management facilities were obtained from available site development reports. These sources of information are listed in Volume I, Section 4.3.8, of the Final WM PEIS.

DOE has updated Table 4.3-4 to indicate that there are 6,000 acres available at Hanford for waste management facilities. The 6,000-acre figure excludes acreage that was originally considered available for waste management facilities. DOE revised other sections of the WM PEIS to reflect this new acreage figure.

According to Section 11.6 in Volume I of the PEIS, the proposed waste management alternatives for all of the waste types considered at Hanford would require a maximum of about 178 acres (Table 11.6-1). Therefore, given that the available acreage is 6,000 instead of 14,500, any of the waste management alternatives would still require only a small percentage of available land area.

DOE revised Section 11.6 to indicate that the Draft Hanford Remedial Action EIS analyzed remediation to a level suitable for unrestricted land use for portions of the Columbia River area, as well as the area on the river where reactors are located. All other areas at Hanford were analyzed under alternatives which call for restricted use, except for the Central Plateau, which would be used for waste management activities (an exclusive use).

Section 4.4.4 identifies the wildlife and plant species that could potentially be affected by waste management activities at Hanford.

Comment (3046)
Table 4-12 does not note that archaeological surveys have been completed for only a fraction of the Hanford Site.

Response
To provide a basis for the comparison of the acreage surveyed for archaeological resources with the total site acreage, DOE has updated Table 4.3-8 in Volume I to indicate both the number of acres at each site and the percentage of the total site that have been inventoried. The revised table shows that 21,358 acres, or 6%, of the Hanford Site have been surveyed sufficiently to identify all readily apparent archaeological properties.

Comment (3047)
Section 4.4.4 is not sufficient to understand the affected environment at Hanford, because it completely ignores the nature and extent of contamination and wastes currently on the site. The description of the environment and its significance is overly brief (e.g., there is no mention of the regional importance of the Columbia River).

Response
To keep the WM PEIS to a manageable size, DOE elected to provide summary descriptions of the sites' affected environments in Chapter 4, Volume I, of the WM PEIS. The WM PEIS Affected Environment Technical Report provides detailed descriptions of the WM PEIS sites including site contamination. The technical report is available in the DOE public reading rooms listed in Volume I,

4.1 Environmental Resources and Conditions

Section 1.9, of the Final WM PEIS. Some of the information that the commentor is interested in is located in the introductory text of Chapter 4 in Volume I of the WM PEIS. Hanford's wastes are listed in Volume I, Chapter 1 and Chapters 6 through 10. Section 4.3.3 in Volume I briefly describes surface water, groundwater, and sediment contamination at the sites, and Section 4.3.4 describes soil contamination at the sites.

Comment (3048)
The water resources section should include the amount of annual precipitation for the Hanford Site, which is approximately 16.5 centimeters on Central Hanford.

Response
The WM PEIS Affected Environment Technical Report contains more detailed information on environmental conditions at the sites. Precipitation is a meteorological event and is described in the air quality section of the technical report. Section 2.2.3 of the WM PEIS Affected Environment Technical Report states that average annual precipitation at the Hanford Meteorological Station Tower is 16 centimeters (6.3 inches). The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3052)
In Volume I, Section 4.4.4, the statement that, at Hanford, soils vary from sand to silty sand and sandy loam, but are predominantly sandy loams, is true only for surficial soils. For example, the Hanford Formation, a deposit of coarse-grained soils ranging in size from fine gravels to boulders, comprises most of the soil column above the basalt.

Response
As used in the WM PEIS, the term "soil" is defined as the upper layer of earth in which plants can grow, that generally exhibits some soil horizon development. Therefore, unconsolidated sediments within the Hanford Formation are not considered soils in the WM PEIS. Nonetheless, to clarify this point, DOE revised Section 4.4.4 in Volume I to read, "Surficial soils vary from sand to silty sand and sandy loam, but are predominantly deep, well-drained sandy loams."

Additional information on the affected environments at the sites is provided in the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public readings rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3053)
In Volume I, Section 4.4.4, Hanford affected environment description, the first bullet under ecological resources, should read "The Hanford Site contains the largest tract of undisturbed native shrub steppe remaining in the State of Washington, and is 6 linear miles from the second largest tract in the State, the Yakima Training Center. The National Biological Service [sic] has listed native shrub and grassland steppe in Washington and Oregon as an endangered ecosystem."

The third bullet should read "Of ecological importance, the Hanford Reach is the only significant mainstream spawning habitat remaining for Fall Chinook salmon. The Hanford Reach comprises the only significant remaining section of the inland Columbia River where White Sturgeon are able to spawn. Three plant and seven insect species new to science have been discovered on the Hanford Site since 1994, indicating a unique ecosystem exists at the Hanford Site."

Response
DOE made the requested changes to Section 4.4.4 in Volume I of the WM PEIS.

Comment (3072)
The WM PEIS does not contain enough site-specific geological and hydrological information to adequately analyze the impacts of waste management at Hanford, or at any of the other sites.

Response
Chapter 4 in Volume I contains summary information on the affected environments at the sites. Although additional information on geology and soils and hydrologic systems would help to round out the affected environment descriptions presented in the WM PEIS, additional details for the 17 major sites evaluated would have added significantly to the size of the document. DOE determined that it would be adequate to include this information the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. For additional detailed information on the Hanford Site, consult the Tank Waste Remediation System, Hanford Site Final EIS, 1996, and the Hanford Remedial Action EIS.

Comment (3077)
WM PEIS discussions of land-use impacts (Sections 6.11, 7.11, 8.11, 9.11, and 10.11) should include tables that list the suitable acreage for each site, especially since the data tables do not contain this information.

Response
Table 4.3-4 in Volume I identifies the land available for waste management facilities at the DOE sites. To keep the PEIS to a manageable length, these data are not reproduced in each impact chapter.

Comment (3115)
The numbers in Table C.4-19 are misleading because (1) it is not clear whether the wastewater capacity shown is for sanitary or process wastewater; (2) it is not clear how these numbers were obtained; and (3) for most of the Hanford Site, the capacity for sanitary wastewater is much less than the current demand.

Response
All data contained in Volume III, Section C.4.9.3, represent baseline onsite infrastructure capacities and current use only. For wastewater capacity and current use, the data presented include sanitary wastewater only. No process wastewaters are included. DOE added a note to Volume III, Table C.4-20, to clarify that the data pertains to sanitary wastewater only.

The data in Table C.4-20 are generally contained in the WM PEIS affected environment report (DOE, 1995). The data in the technical report were obtained from numerous sources, which are identified in the technical report. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The data obtained for Hanford indicate that current use is less than the available sanitary wastewater treatment capacity (see Table C.4-20).

4.1 Environmental Resources and Conditions

Comment (3116)
The description of Native American Resources in Section C.4.10.1.2 seems applicable to all of the Hanford Site, based on reserved rights with local tribes under the Treaty of 1855.

Response
DOE agrees that the language in Section C.4.10.1.2 would appear to indicate that all of the Hanford Site can be considered "Native American Resources," if literally interpreted. This was not the intent and DOE has modified the language to more accurately reflect the law and DOE policy.

DOE recognizes that American Tribal Governments have a special government-to-government relationship with the U.S. Government as defined by history, treaties, statutes, court decisions, and the U.S. Constitution. Although the U.S. Department of the Interior, through the Bureau of Indian Affairs, has the principal responsibility for upholding obligations of the Federal Government to Native Americans, the responsibility extends to all Federal agencies. As stated in the revised Section 1.4.5 in Volume I, and consistent with DOE American Indian Policy, at each DOE site with areas of cultural or religious concern to them, Native Americans will be consulted about the potential impacts of proposed DOE actions on these resources.

Comment (3117)
In Section C.4.10.2, it is not clear whether a "historic property" would include the Hanford B-Reactor and whether its preservation would be balanced against use of other Hanford lands more culturally important to Native American tribes.

Response
The identification of the Hanford B Reactor as a cultural resource is a function of its status as having been designated for listing on the National Register of Historic Places. As a result, it comes under the protection of Section 106 of the National Historic Preservation Act of 1966 and must be considered in the WM PEIS analysis for any potential adverse impact by the proposed actions. The determination that a given site meets eligibility criteria for listing on the National Register of Historic Places is an action independent of the PEIS and, therefore, outside the scope of this analysis.

For purposes of the PEIS description of cultural resources, a National Register of Historic Places property is presented without placing any other value on the quality of the property. Therefore, no effort is made to determine if one site is more or less valuable or deserving of protection. DOE is required to consider all such properties as equally subject to protection under the law.

Comment (3120)
Chapter 4 contains sparse information, which leads to the "unknowns" mentioned in Section C.4.10.3.

Response
The "unknowns" mentioned in Volume III, C.4.10.3, refer to two aspects of cultural resources assessment. First, the locations of waste management activities at individual sites have not been identified. Second, the survey status at different sites varies; few sites have undergone sitewide systematic surveys and, as a result, all cultural resources have not been identified. The level of detail provided in Chapter 4 does not lead to these unknowns, these unknowns lead to the level of information provided in Chapter 4.

4.1 Environmental Resources and Conditions

To keep the WM PEIS to a manageable size, DOE elected to provide summary descriptions of the sites' affected environments in Chapter 4 in Volume I, and present the detailed descriptions of the affected environments in a technical report. References to the technical report are included in Chapter 4 in Volume I and Appendix C in Volume III, and a reference to the report was added to the text in Section C.4.10.3 in Appendix C. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3153)
The WM PEIS uses obsolete or inaccurate data for various DOE sites, including Pantex. For example, the document contains no analysis of the emissions from the Burning Grounds and more than 100 other emissions points that are identified in the Pantex Resource Conservation and Recovery Act (RCRA) permit but do not have ongoing air monitoring. Therefore, statements about specific air emissions cannot be supported.

Response
As described in Section 5.4.2 in Volume I, the WM PEIS examines impacts to air quality from the incremental addition of waste management emissions. These waste management emissions are evaluated to determine if they would have major adverse impacts to existing air quality in the air quality control region. The impacts of non-waste management activities are outside the scope of the WM PEIS.

Existing facility emissions are considered as impacts of existing operations in the cumulative impacts section (Chapter 11 in Volume I). Additional details of the impacts of these site-specific activities are included in sitewide EISs that have been prepared for many DOE sites, including Pantex.

Section 4.4.11 in Volume I and Section 2.10 in Volume II of the WM PEIS Affected Environment Technical Report contain an overview of the more pertinent facts characterizing the affected environment for Pantex. The WM PEIS Affected Environment Technical Report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Sitewide and project-level NEPA analyses can more fully consider site-specific air quality conditions and impacts.

Comment (3196)
Seismic risks at Hanford are mischaracterized. Contrary to Section 4.4.4, all of Eastern Washington is regulated as a Seismic Zone 2B, not 1. Also in Section 4.3.4, Hanford is in a Seismic Zone 2B, not Zone 1. This section states that the accident scenarios were based in part on the seismic rating of the sites. These need to be recalculated for Hanford. Additionally, there are many surface features that align from the west-northwest to the east-southeast across the site. These surface features coincide with a broad band of small earthquake activity stretching from Puget Sound to the INEL site. These features and earthquake activity suggest possible unidentified faults throughout the region. It is therefore difficult to be sure that a fault does not exist within 200 feet of any proposed facility. These features and earthquake activity should be assessed and incorporated into the accident and risk assessments. Also, the Uniform Building Code requires the use of a 1.5 importance factor for construction of facilities such as those considered in the WM PEIS.

Response
The reference to Seismic Zone 1 for Hanford was removed from the Final WM PEIS, since this information is not consistent with the detail presented for the other sites. Section 4.4.4 in Volume I of the WM PEIS was changed to indicate that the seismicity of the Columbia Plateau is relatively low,

although shallow, low-intensity earthquakes occur throughout the Hanford Site area. Nevertheless, the seismic zone designation of any of the DOE sites did not factor into the accident analysis. An assumption of the analysis was that the probability of failure due to earthquakes was the same across all DOE sites, and that facility engineering would ensure that this was the case because more robust construction would be required at the more earthquake prone sites.

The information in Section 4.4.4 summarizes the detailed information presented in the WM PEIS Affected Environment Technical Report. The report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. With respect to unidentified faults, Section 2.2.1.1 of the technical report describes existing known faults within the Hanford area and seismic history of the Columbia Plateau. DOE knows of no capable faults within 200 feet of the Hanford Site 200 Areas where waste management facilities would most likely be sited.

If DOE selected Hanford for a new waste management treatment, storage, or disposal facility as a result of the WM PEIS analysis, the specific design basis and exact locations of the waste management facilities would be identified; reviews would consider potential earthquake impacts. DOE would design, construct, operate, and maintain waste management facilities in accordance with appropriate local seismic standards. The Uniform Building Code importance factor would be considered in design of waste management facilities at all DOE sites, including Hanford.

Comment (3199)
The WM PEIS does not adequately consider site-specific environmental factors. Since it will be used in the decisionmaking process to identify preferred strategies and sites for waste management, the WM PEIS should include all applicable site-specific environmental factors in the analysis.

Response
Due to its programmatic nature, the WM PEIS does not include project-level analyses. Rather, the WM PEIS analysis is generic in character to allow for meaningful comparison of potential programmatic alternatives. However, before DOE selects locations for waste management facilities on sites, it will consider the results of project-level NEPA reviews.

Comment (3200)
Volume I, Section 4.3.5. In addition to species listed or under consideration for listing as rare, threatened, or endangered by the State and Federal governments, The Nature Conservancy recently completed one phase of an ecologic assessment of the Hanford Site. They identified several species of plants and animals that were previously unknown. Their analysis focused along the river. DOE canceled planned surveys of the rest of the site. These should be reinstated, with priority given to the shrub steppe habitat on the Central Plateau. This is needed before site selections are considered.

Response
Section 2.2.4 of the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS, contains a detailed description of the ecological resources of the Hanford Site. Summary information for the Hanford Site is presented in Section 4.4.4 in Volume I of the WM PEIS.

While DOE intends to use the WM PEIS as a tool to help select sites for waste management activities, DOE will not select specific locations for waste management facilities at sites based on this PEIS.

Specific locations will be selected based on sitewide or project-level NEPA reviews, which would consider impacts to sensitive species or habitats at particular locations on sites.

The commentor's request to reinstate the survey has been forwarded to the DOE Richland Operations Office.

Comment (3204)
Volume I, Section 4.3.11: Cultural resources also include all of the lands obligated under Tribal Treaty restrictions. The American Indian Religious Freedom Act and the Native American Graves Protection and Repatriation Act might also apply.

Response
Section 1.4.1 in Volume I identifies several applicable laws and regulations, including the American Indian Religious Freedom Act and the Native American Graves Protection and Repatriation Act. A more detailed definition of the elements included in the term "cultural resources" is provided in Section 5.4.10. DOE revised Section 4.3.11 to include a cross-reference to the more detailed discussion in Section 5.4.10.

Comment (3265)
Section 4.4.13 gives Rocky Flats Environmental Technology Site (RFETS) wind speed and direction information from Stapleton International Airport in Denver, rather than from the Rocky Flats site. The prevailing winds at Stapleton International Airport are in a pattern opposite to that which exists at RFETS. Please describe the impact of this mistake on the analysis of alternatives related to RFETS.

Response
National Weather Service wind rose data, including data collected at Stapleton International Airport, was utilized only to obtain descriptive data in a consistent format for all sites. The wind rose data are presented in the WM PEIS Affected Environment Technical Report and summarized in Chapter 4 in Volume I of the WM PEIS. However, these data were not used in the impacts analysis. The impacts analysis used wind direction data obtained from meteorological towers at the sites.

Comment (3269)
The NTS region of influence should be expanded to include all of Clark County, Nevada, where significant impacts could occur. All potential impacts addressed in the WM PEIS are confined to a 50-mile radius around the potential waste management facilities at NTS, which eliminates major population, resort, commercial, and transportation centers that could be affected by implementation of the waste management alternatives.

Response
As presented in Table 4.2-1 in Volume I of the WM PEIS, general regions of influence for 13 environmental resources considered in this document often vary by resource. Not all regions of influence are confined to a 50-mile radius around the potential waste management facilities. For example, the socioeconomic region of influence includes the site, the counties that contain the site or a part of the site, and counties in the area where 90% of the site employees reside. Thus, all of Clark County is in the NTS socioeconomic region of influence. The air quality analysis also considers impacts to Clark County.

4.1 Environmental Resources and Conditions

Comment (3374)
The region of influence (ROI) for PGDP is not accurate. It actually includes these additional counties: Lyon, Livingston, Crittendon, Caldwell, Trigg, Calloway, Fulton, Hickman, and parts of other counties to the northeast in Kentucky; Pope, Hardin, Gallatin, Saline, Williamson, Union, Johnson, Alexander, and Pulaski in Illinois. There are also counties in Tennessee and southeastern Missouri within the ROI. "It appears DOE is deliberately trying to fool the public into thinking the affected environment is less than it really is...The failure of DOE to accurately describe the ROI indicates a foundational failure to properly analyze the impacts of the proposal."

Response
As described in Volume I, Section 4.2.2, of the WM PEIS, the area encompassed by an ROI varies by site according to the potentially affected environmental resource area. For example, the ROI for air quality extends a considerable distance from the site boundary, while the ROI for cultural resources consists primarily of the onsite area that might be disturbed by implementation of the proposed action. The ROI cited in the comment as inaccurate appears to be the ROI for socioeconomic conditions, which is defined to include the site, counties that contain the site or part of the site, and counties in which 90% of site employees reside. In contrast, the ROI for human health risk at PGDP includes the site and nearby offsite area (within 50 miles from the center of the site) where worker and general public exposure is likely. According to the definition of ROI for socioeconomic conditions, the counties included in the WM PEIS for the PGDP ROI are accurate.

Comment (3375)
Within the PGDP region of influence, there is wide variety of agricultural activities. There are vegetable farms, cattle, swine, chickens, orchards, and row crops all very near to PGDP. There are processing facilities for just about all of these agricultural products, and significant amounts are locally marketed at various times of the year. This is not mentioned or analyzed at all.

Response
A more detailed description of PGDP regional and site land uses is provided in Section 2.11.5.5 of the WM PEIS Affected Environment Technical Report. This report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

As described in Section D.2.4.1 in Volume III of the PEIS, health risk analysis does include evaluation of an agricultural exposure pathway for offsite population receptors. This pathway results from releases of radionuclide and chemical contaminants to the atmosphere from waste management treatment and storage facilities. Airborne contaminants are assumed to be deposited onto surface soils, where they are taken up by plants. The plants are consumed by the local population, and are fed to livestock, which is also consumed by the local population. Offsite population receptors, therefore, are assumed to be exposed to contaminants released from treatment and storage facilities through inhalation of airborne contaminants, as well as by ingestion of contaminated locally produced plants and livestock.

Comment (3379)
DOE should look carefully at the PGDP region of influence in Missouri. There may very well be wild and scenic rivers within that area. Also, there are five candidate wild and scenic rivers, at least four of which are within the region of influence in Illinois.

Response
Section 4.2.2 in Volume I states that the region of influence for water resources includes surface water bodies within the site's boundaries and adjacent surface water bodies that could be affected by site activities. DOE considers surface water bodies in Missouri and Illinois (except for the Ohio River) to be outside the PGDP region of influence.

Comment (3398)
Southern Illinois, western Kentucky, and southeastern Missouri all contain some of the most ecologically significant areas in the Midwest. This needs to be acknowledged and considered in the WM PEIS. An internationally significant wetland area, the Cache River area in southern Illinois, is not only within the PGDP region of influence (ROI), but very near the site. This is certainly an area of ecological concern. There are at least five Congressionally designated wilderness areas in southern Illinois within the ROI in the Shawnee National Forest, and more than likely wilderness areas in the ROI in Missouri. These areas, as well as other designated natural areas, are locations of numerous State-listed threatened and endangered species in Illinois and Missouri. What about The Land Between the Lakes? This area is certainly ecologically important, and is the location of the gray bat, a Federally listed species not mentioned in the affected environment description. The Land Between the Lakes is within the ROI and not that far from PGDP. It provides habitat for many species that have no other such habitat in western Kentucky. For example, Price's Groundnut, a Federally listed endangered plant species occurs in The Land Between the Lakes. There are sites for Mead's milkweed within the ROI in southern Illinois. Mead's milkweed is a Federally listed endangered plant species. There is habitat for the peregrine falcon, another Federally listed species, in the ROI. The information in the WM PEIS concerning this issue is incomplete.

Response
As stated in Section 4.2.2 in Volume I, the area encompassed by the ROI varies by site according to the potentially affected environmental resource area. For example, the ROI for air quality extends a considerable distance from the site boundary, while the ROI for cultural resources consists primarily of the onsite area that might be disturbed by facility development of the proposed action. The ROI for ecological resources includes the site and adjacent areas where sensitive habitats or sensitive species could be affected by the proposed action and, in particular, could be exposed to contaminants from waste management activities through one or more pathways. DOE considers most areas in Missouri and Illinois to be outside the PGDP ecological resources ROI and, therefore, has not included them in the site descriptions.

The Cache River in southern Illinois flows west and then south to its confluence with the Ohio River near Cairo, Illinois. At its closest point to PGDP, it is about 10 miles away, and at its confluence, about 15 miles away. The confluence of the Cache and the Ohio Rivers is downstream from PGDP; however, it is sufficiently distant via the surface water pathway that significant dilution of any pollutants would occur in the Ohio River. Where the Cache River is closest to PGDP, it is not in the direction of prevailing winds.

The Shawnee National Forest is quite large. Its closest part is approximately 10 miles from PGDP and its farthest part is about 100 miles. Most of the Shawnee National Forest is more than 25 miles from PGDP, with no water pathway between it and PGDP. Because of the absence of a water pathway and the Shawnee being distant from PGDP via the air pathway, it is not in the PGDP ecological resources ROI.

4.1 Environmental Resources and Conditions

The Land Between the Lakes is 30 miles from PGDP, is upwind when the prevailing winds blow, and is upstream from any surface-water connection. In the PGDP Annual Environmental Reports, exposure of deer in The Land Between the Lakes is considered to be a background standard. DOE does not consider The Land Between the Lakes part of the PGDP ROI for ecological resources. As stated in Table 4.2-1 in Volume I, Section 4.2.2, of the Final WM PEIS, the ROI for ecological resources includes the site, adjacent resource areas, and the transportation corridors between the sites.

Comment (3399)
NEPA requires that the public be fully informed of the proposed actions and that the agency fully disclose the impacts. This cannot be done if the affected environment is not sufficiently or accurately described.

Response
DOE believes that the affected environments at the sites are adequately described in the WM PEIS and has fully disclosed the potential impacts of the waste management alternatives. The affected environment descriptions in Chapter 4 in Volume I provide a brief summary of environmental conditions at the sites. The WM PEIS affected environmental technical report contains more detailed descriptions of the sites. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3400)
As to the figures in Table 4.3-6 and Table 4.3-7, it is obvious from adding and subtracting the various figures from the three facilities shipping by rail that PGDP is shipping to Portsmouth, and that ORR and Portsmouth are shipping back to PGDP. In Volume I, Table 4.3-7, "Rail Shipments During Fiscal Year 1993," Portsmouth and PGDP received 117 and 106 incoming rail shipments of radioactive materials, respectively. Other listed major sites received none. From the same chart, Portsmouth and PGDP had 98 and 117 rail shipments, respectively. Where were these shipments sent? No other sites report incoming rail shipments. Were these shipments sent back and forth between PGDP and Portsmouth exclusively? What is the material that is being shipped to PGDP from ORR and Portsmouth? If this is waste, it might represent further evidence that DOE is implementing a decision regarding waste movement prior to completion of the WM PEIS. What materials are being shipped out of PGDP, either by truck or rail? The amount going in is much greater than the amount going out.

Response
Shipments coming into PGDP are uranium hexafluoride; those going out are enriched uranium hexafluoride. Neither of these materials is considered waste. The data provided in Table 4.3-6 and Table 4.3-7 are for the purposes of establishing a transportation baseline for the current rail and truck shipments to and from DOE sites. Source data are derived from the 1993 Shipment Mobility/Accountability Collection and the Waste Manifest System FY 1993. Data are presented for each site without reference to source or destination of shipments. This database includes all radioactive materials shipments, not just waste shipments. The database does not specifically characterize the components that make up the site shipments beyond a division into radioactive and other hazardous materials categories. Because the table is intended as a summary of transportation-related activity in general, it is not useful as a source for waste volume, or other materials volume information.

4.1 Environmental Resources and Conditions

Comment (3404)
The New Madrid fault is perhaps the most dangerous earthquake fault in the Nation. Scientists predict a 90% chance of a major earthquake in the New Madrid fault within 10 to 20 years. PGDP is on the edge of the highest intensity zone for a New Madrid event, and is possibly located in liquefaction soils. This is the worst possible place for a long-term nuclear storage and treatment facility. An earthquake could cause a release of radiation. The consequences from pollution by stored nuclear waste will be catastrophic.

Response
As described in Section 2.9.2 of the WM PEIS Affected Environment Technical Report, PGDP is near the northeastern end of the New Madrid fault zone. Within a 322-kilometer (200-mile) radius, six additional fault zones have been recognized, including the Rough Creek, Saint Genevieve, Cottage Grove, Shawnetown, Wabash Valley, and Illinois-Kentucky Mineral District. There is no evidence to support faulting of post-Paleocene surface strata in the PGDP region of influence; however, faults found in the Paleocene strata have been proposed to be capable. A capable fault (active fault) is one that has had movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the last 500,000 years.

Section 2.9.2 also states that the site is near two active seismic zones--the New Madrid fault zone is located immediately to the south-southwest and the Wabash Valley fault zone is located immediately northeast. The largest earthquake in the region occurred in 1812 and was centered in the New Madrid fault zone. The earthquake had a magnitude of 7.3 on the Richter scale, with an epicenter 96 kilometers (60 miles) southwest of the site. The intensity of the earthquake in the region near PGDP was estimated to be Modified Mercalli Intensity X. An earthquake of this magnitude destroys most masonry and frame structures; destroys some well-built wooden structures and bridges; causes serious damage to dams, dikes, and embankments; and causes slope failures. An earthquake with a maximum horizontal acceleration of 0.45g has an annual probability of occurrence of 1 in 1,000 at PGDP.

Accidents initiated by earthquakes at treatment facilities were included in the WM PEIS, assuming generic facility characteristics, and were shown to produce minimal risks at PGDP. See Sections 6.4.3 and 7.4.3 in Volume I for analysis results. Additional information on accident scenarios and health risks from accidents initiated by earthquakes is provided in Appendix F (Volume IV) and Appendix D (Volume III), respectively.

Any waste management facility constructed at PGDP would be built to conform to Federal criteria that take into account the higher seismic risk at PGDP relative to some of DOE's other sites.

Comment (3544)
The Hanford ecological resources description should state that there are 24 (as opposed to 10) major plant communities on the site.

Response
DOE revised Volume I, Section 4.4.4, to indicate that there are 24 major plant communities on the Hanford Site.

4.1 Environmental Resources and Conditions

Comment (3727)
The public is concerned about the apparent disproportionate number of cancer deaths and the high incidence of pediatric cancer in DuPage County, Illinois.

Response
The WM PEIS health risk analysis estimates that there would be no significant health impacts in the offsite population surrounding ANL-E resulting from the proposed waste management actions. The analysis addresses only the potential future incremental risk of new waste management actions. This risk would be additive to the baseline cancer risk in the region, some of which might be related to past and current ANL-E actions. The WM PEIS does not attempt to characterize the existing baseline health risk through the use of regional epidemiological or health statistics information.

At the public hearing held at ANL-E on January 24, 1996, Dr. Holly Howe, Chief of the Epidemiology Department of the Illinois Department of Public Health was asked by DOE to speak about the results of a recent local cancer study. The residents of Lemont, Illinois, requested that the Illinois Department of Public Health initiate a study of the pediatric cancer incidence. The Division of Epidemiologic Studies performed a study based on hospital reports found in the Illinois State Cancer Registry for the years 1986 through 1993. Seventeen cases of childhood cancer were observed in the study area, while 13 cases were expected; this difference was determined in the study to be not statistically significant. The most frequently reported childhood cancer type was leukemia, with six cases observed and three cases expected; this difference also is not statistically significant (Illinois Department of Public Health, 1995).

Comment (3754)
In one place the WM PEIS indicates that the size of ANL-E is 266 square miles. In another, it says 1,700 acres.

Response
The most recent survey of the ANL-E site shows an area of approximately 1,500 acres, which is the size identified in Section 4.4.1 in Volume I of the WM PEIS. Table 4.3-4 in Volume I of the PEIS has been revised to show the correct size of ANL-E.

Comment (3763)
DOE needs to include the groundwater flow direction for ANL-E in the PEIS.

Response
Section 4.4.1 in Volume I is a summary of information contained in a technical report. More detailed information is contained in Section 2.14.2.2 of the WM PEIS Affected Environment Technical Report, which states that at ANL-E, water flows through the upper aquifer (Niagara and the Alexandria dolomite aquifer) in a southern direction. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3949)
DOE assumes that sites where cultural resource studies have not been done have no cultural resources. DOE cannot assume that no cultural resources exist until cultural resources studies have been conducted, with appropriate input from the public and directly affected populations.

Response
Although the WM PEIS could not evaluate cultural resources impacts in detail, it does identify the sites with known cultural resources based on the extent to which each site has already been surveyed for those resources. This analysis does not, however, contain any assumption with respect to the presence or absence of resources from the areas that have not been surveyed. Information on the status of cultural resources surveys and registered cultural resources at the sites was compiled from environmental reports provided by the sites. Details of status, listings, and sources are provided in the WM PEIS Affected Environment Technical Report (available in the DOE reading rooms listed in Volume I, Section 1.9, of the Final PEIS).

Volume I, Table 4.3-8, lists the 17 major sites considered in the PEIS and the extent to which these sites have been surveyed for cultural resources. DOE revised the table and its related text to emphasize the percentage of each site's total area that has not been inventoried for resources.

Based on the WM PEIS land-use analysis, which indicates that only a small fraction of available land would be required for waste management facilities, DOE believes it will have sufficient flexibility in locating waste management facilities to be able to avoid or mitigate cultural resources impacts. Sitewide or project-level analyses would include a more detailed examination of existing and newly identified cultural resources at the sites. Before beginning construction of any new facilities, sites are required to conduct specific cultural resources surveys of any potentially affected land.

Comment (3950)
Great Serpent Mound in Adams County of Ohio is a sacred site to many Native American peoples. It is not identified in DOE's WM PEIS as a cultural resource, even though it qualifies by agency standards as a site eligible for inclusion as a national landmark.

Response
The affected environment for the assessment of cultural resources includes the total area within the site boundary and the areas near the site that might experience some physical effect associated with site actions. (See Volume I, Table 4.2-1.) The Great Serpent Mound and the entire area of Adams County are outside this defined region for the FEMP and the Portsmouth Plant. Therefore, although the Great Serpent Mound is a major cultural resource, it is not included in the cultural resources analysis for the WM PEIS.

Comment (3960)
Cultural resources inside or outside the property boundaries must first be identified by a credible cultural resource study. No such study exists for Portsmouth, although a study is presently being funded by Meade Paper, Lockheed-Martin, Dow Chemical, and Ashland Oil for the Ohio River Corridor.

Response
Cultural resources impacts are not directly evaluated in the WM PEIS because the specific locations for proposed waste management facilities are not identified. However, the analysis performed indicates that sufficient land is available at sites to locate waste management facilities to avoid adverse impacts to cultural resources. A site cultural resources survey would be required prior to any final siting decision and the start of any new construction.

4.1 Environmental Resources and Conditions

The PEIS recognizes the importance of a credible cultural resources survey in determining the nature and extent of potential impacts at individual sites. The status of cultural resources surveys at each of the 17 major sites considered in the PEIS is presented in Table 4.3-8 in Volume I of the WM PEIS. As noted in the table, no cultural resources survey has been conducted for the Portsmouth Plant.

Comment (3961)
Volume I, Section 4.3.2: What criteria were used to determine which "large sites" receive air quality monitoring of a radius of only 6.2 miles and which receive air quality monitoring of a radius of 50 miles?

Response
Section 4.3.2 of the Draft WM PEIS describes how monitoring data for the WM PEIS were collected. How and where air quality monitoring stations are established is outside the scope of the WM PEIS.

In accordance with EPA-recommended modeling techniques, the region of influence includes a circular area with a radius of at least 6.2 miles. For some large sites, a radius of as much as 50 miles was considered, to include information on the existing air quality environment from monitoring stations located on the site, or as close to the site as possible. Section 4.3.2 in Volume I of the Final WM PEIS was revised to clarify the air quality region of influence concept.

Comment (3972)
Table 4-8 identifies 4,003 acres of Federal land at the Portsmouth Plant, with 3,203 available for waste management facilities. Do these figures include lands now in use and/or under United States Enrichment Corporation management? Does privatization transfer ownership of the Portsmouth Plant lands to USEC and, thereby, impact lands available for DOE waste management uses? Do the 3,203 acres identified as available for waste management activities include the two solid waste management units currently under U.S. EPA and Ohio EPA remediation activities?

Response
The data presented for the Portsmouth Plant in Table 4.3-4 (formerly Table 4-8) (Volume I) include the total site acreage and the acreage available for waste management facilities. The total acreage includes land under USEC management.

A "privatized" facility is considered (only for the purposes of the WM PEIS analysis) to be a former DOE facility (typically located on a DOE site) that is operated, maintained, and eventually decontaminated and decommissioned by a private entity. Under this definition, the transfer of ownership from DOE to USEC would constitute privatization. However, should USEC operate as a private entity, it would operate for the exclusive use of DOE. This would include the construction and subsequent operation of any new waste management facilities. Therefore, lands available for DOE wastes management uses at the Portsmouth Plant would not be affected by privatization. Currently, the facilities at the Portsmouth Plant are leased to USEC to conduct ongoing enrichment operations as provided in the Energy Policy Act of 1992. The USEC Privatization Act provides that this lease be transferred to the privatized corporation and that it have an exclusive option to extend this lease. DOE remains the owner of the Portsmouth Plant. This lease agreement between DOE and USEC does not limit any of DOE's options for waste management or environmental restoration. Further explanation of privatization and how it relates to the WM PEIS can be found in Section 1.7.4 in Volume I of the PEIS.

The 3,203 acres excludes the land leased to the United States Enrichment Corporation in the developed core area, but includes all lands outside the core area, including a number of areas being investigated for suspected contamination.

Comment (3977)
In Volume I, Section 4.3.9, please clarify whether the Breeder Reactor at the Portsmouth Plant is used for onsite operational needs or whether it is a backup source of power. What does DOE list as the major provider of electrical service to the Portsmouth Plant? Could the Tennessee Valley Authority be the major provider? I feel this is a significant question for DOE response given the considerable use of electricity by the Portsmouth Plant (roughly the equivalent of the City of Los Angeles) and the probable transfer of the Tennessee Valley Authority's vast resources and power-generating facilities to the private sector. The Ohio Valley Electric Corporation is listed as supplying electrical power, current site load of 1,537 megawatts requiring 4,500 tons of coal per month. Could DOE please clarify and explain where power for this site is generated and how? Table 4-9 lists total capacity power at the Portsmouth Plant as 1,929 megawatts. Is this from onsite generation of electric power?

Response
Issues surrounding the future source of the power for the Portsmouth Plant are outside the scope of the WM PEIS, but can be addressed by local DOE officials as part of site planning. As indicated in Section 2.11.6 of the WM PEIS Affected Environment Technical Report (available in the DOE reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS), electric power to the Portsmouth Plant is currently provided by the Ohio Valley Electric Corporation using a coal-fired system. As the commentor has noted, the current site load of 1,537 megawatts is well within the current site capacity of 1,929 megawatts.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

Comment (395)
At Hanford, the Columbia Reach and the native shrub-type habitat must be protected from degradation as a result of waste management actions. Existing groundwater contamination plumes under the Hanford Site are already reaching the Columbia river. We cannot afford further sacrifices at Hanford or to the surrounding natural environment.

Response
About 6 percent of the Hanford Site has been used for defense production and waste management purposes. Because much of the Hanford Site has been undisturbed for nearly 50 years, the Site contains one of the largest remaining relatively undisturbed shrub-steppe habitat areas in Washington State. Shrub-steppe habitat is vegetation that flourishes on arid lands in areas with extreme temperature ranges. Shrub-steppe is considered a priority habitat by Washington State because of its importance to sensitive wildlife. About one-half of the land located on the Hanford Site has been designated as an ecological study area or wildlife refuge. These areas include the Fitzner Eberhardt Arid Lands Ecology Reserve located south and west of the 200 Areas and areas north of the Columbia River.

Much of the defense production activity occurred in the 200 Areas and, therefore, much of the land in the 200 Areas is disturbed. The 200 Areas also are the location of large low-level waste burial grounds. The 200 Areas and the surrounding Central Plateau have been identified as potential exclusive-use waste management areas to support the Hanford Site's waste management and environmental restoration programs. Because of past disturbances in the 200 Areas, the shrub-steppe habitat, wildlife typically found in the shrub-steppe habitat, and archaeological sites are limited.

Based on projected land requirements, DOE analyzed the potential for proposed waste management activities to affect sensitive habitats and species. The analysis indicated that the land required for the construction of waste management facilities would be a small fraction of available nonsensitive lands, which would enable DOE to avoid direct impacts to sensitive lands. Further, DOE would have enough flexibility in locating facilities on sites to avoid indirect impacts, such as those that could result from building access roads.

DOE has not included environmental restoration in the scope of this PEIS. The Hanford Remedial Action EIS and Comprehensive Land Use Plan are addressing issues of environmental restoration.

Comment (451)
DOE is allowing BNL to destroy the Carmans River by dumping gallons of contaminated wastewater.

Response
DOE is unaware of any such dumping of contaminated wastewater into the Carmans River. BNL has five National Pollutant Discharge Elimination System (NPDES) permitted outfalls to recharge basins, and one NPDES permitted outfall to the Peconic River. Wastewater is discharged at an average rate of 3.8 million liters (1.0 million gallons) per day *(Brookhaven National Laboratory 1993 Technical Site Information Document)*. Permit compliance for all NPDES outfalls was 99.9% percent in 1991. Discharges to the Peconic River met all radioactive discharge limits. Only iron, pH, and 1,1,1-trichloroethane exceeded permit limits on limited occasions (Brookhaven National Laboratory, *Site Environmental Report for Calendar Year 1991* [BNL-52347]).

4.2 Existing Contamination/Historic Releases/Past DOE Practices

In addition to NPDES outfall monitoring, the Peconic River is monitored for radioactive and nonradioactive parameters at three onsite and four offsite locations. In addition, the Carmans River is sampled as a background location. In 1991, all radionuclide concentrations were within applicable limits and did not exceed 10 percent of the State and Federal Drinking Water Standards. All nonradioactive analyses were consistent with the offsite control location and with historical data except for toluene, 1,1,1-trichloroethane, and xylene. In 5 out of 100 samples, 1,1,1-trichloroethane was present at concentrations ranging from 3 to 6 micrograms per liter. The exceedances for toluene and xylene concentrations just above the analytical detection limit of 3 micrograms per liter occurred once at a sampling point 25 kilometers (16 miles) downstream from the sewage treatment plant discharge. This occurrence is probably associated with a non-BNL source. Table 2.15-3 in Volume I of the WM PEIS summarizes results of surface water quality monitoring for 1991 (Brookhaven National Laboratory, *Site Environmental Report for Calendar Year 1991* [BNL-52347]). The maximum concentration of trichloroethylene was above its comparison criteria at least once in 1991. Any information relating to the allegation that the Carmans River is being contaminated by BNL should be forwarded to DOE. The commentor is also welcome to attend any of the DOE-sponsored public forums at BNL to express concerns. BNL is in the process of helping the community establish a community forum. This group will be open to the public and will provide an opportunity for people to voice their concerns and issues regarding BNL.

Comment (483)
What, if any, studies have been conducted to assure those of us who live near LLNL that we are safe from radioactive contamination? The WM PEIS must include a complete report on the full impacts to the Livermore community.

Response
The WM PEIS is a national and programmatic study to assist DOE in formulating and implementing a strategy to manage its radioactive and hazardous wastes. The PEIS includes estimates of health risks for the proposed waste management alternatives. DOE considered LLNL for management of low-level mixed waste, low-level waste, and transuranic waste, and describes the potential health risks associated with managing these wastes in Volume I, in Sections 6.4, 7.4, and 8.4, respectively. The PEIS also estimates the cumulative health risk from adding proposed waste management actions to other past, present, and reasonably foreseeable future actions and presents the cumulative impacts for LLNL in Section 11.8. If DOE selects LLNL for a new waste management operation, additional studies might be required.

The LLNL and SNL-CA Sitewide EIS prepared by DOE in 1992 contains additional detail on the health risks from radionuclides released from the sites. In addition, DOE prepares annual Site Environmental Reports that describe the results of site monitoring and summarize each site's compliance with applicable regulations. These reports also provide estimates of doses received by the public from releases of radionuclides. The EIS and annual reports are available to the public for review in the LLNL and SNL-CA public reading rooms.

Comment (1558)
The WM PEIS should include a detailed map of plutonium-239 concentrations left on the ground by the explosions at NTS.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

Response
Contamination from weapons testing at NTS and the cleanup of any existing contamination are outside the scope of the WM PEIS. This information is presented in the NTS Sitewide EIS, which is discussed in Volume I, Section 1.8.1, of the WM PEIS. A copy of that EIS is available at the DOE Nevada Operations Office public reading room located at 2621 Losee Road, Building B-3, Las Vegas, Nevada.

Comment (1574)
Commentors are concerned that the recently discovered deep aquifer system at Los Alamos National Laboratory (LANL) has been contaminated by site activities. Some state that the hydrogeology of the site is not well understood and site-specific water quality impacts should be addressed in the WM PEIS.

Response
While the WM PEIS considers the potential impacts of waste storage and disposal at the programmatic level, DOE will consider site-specific control measures when it develops project-level plans for specific sites. These control measures could include modifying the design of generic disposal facilities (used in the PEIS analysis) to fit site-specific conditions; modifying waste form requirements; optimizing the location of a facility on a site; and imposing waste acceptance criteria.

Any eventual waste storage or disposal facility located at LANL would be built with sufficient containment and would be carefully monitored. Furthermore, the site would be equipped with sufficient safety and emergency response measures to minimize the potential for leaks to contaminate surface water or groundwater.

The WM PEIS Affected Environment Technical Report contains additional information on hydrogeologic conditions at LANL. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. The LANL Sitewide EIS currently in preparation will contain a more detailed description of the water contamination referred to in this comment.

Comment (1604)
A commentor stated that he is a landowner adjacent to Site 300, has experienced major health problems, and does not know if they can be attributed to Site 300 activities.

Response
The WM PEIS evaluates the potential health impacts from postulated future activities to determine the degree to which human health and the environment could be impacted and the best course of action to follow to minimize these impacts. Although the WM PEIS contains information on existing public health risk near LLNL, the Site Environmental Reports and the 1992 LLNL Sitewide EIS are the primary sources that should be consulted to obtain information relevant to determining potential health effects that might result from operations at Site 300. These reports are available in the LLNL public reading room. Local health agencies could also be consulted for possible epidemiological information on health effects.

Comment (1626)
NTS already has extensive contamination and it should be cleaned up, especially the groundwater.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

Response
Environmental restoration activities are not within the scope of the WM PEIS. NTS has entered into a Federal Facility Agreement/Consent Order with the State of Nevada to characterize the groundwater and surface contamination to determine the required amount of remediation, if any.

Comment (1707)
More research needs to be done on the long-term effects of plutonium exposure on people living in communities near RFETS. For example, a study should be done on the long-term effects of the 1969 fire.

Response
The WM PEIS examines potential radiation exposure, including exposure to plutonium isotopes, to the offsite population from the implementation of the WM PEIS alternatives. In addition, the evaluation of cumulative impacts considers estimates of annual radiation doses from existing activities and other ongoing actions at the sites (see Volume I, Chapter II). A dose reconstruction study investigating historical exposure data is underway at RFETS. DOE funded this project, the final phase of which should be complete by Spring 1997.

Comment (1710)
Uranium should be listed in Volume I, Section 4.3.3, sediment section, as a sediment contaminant at ORR. Technetium should be listed in Section 4.3.3, groundwater section, as a groundwater contaminant at ORR.

Response
DOE made the requested changes in 4.3.3.

Comment (1724)
The WM PEIS should identify the 17 contaminants that exceeded comparison criteria for 1992 at ORR.

Response
Table 2.8-7 in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS, lists the following 17 groundwater contaminants that exceeded comparison criteria at ORR in 1992: 1,2 dichloroethane, 1,1-dichloroethylene, benzene, cadmium, carbon tetrachloride, chromium, cobalt-60, fluoride, gross alpha, gross beta, manganese, nitrate, pH, tetrachloroethylene, trichloroethylene, tritium, and vinyl chloride.

Comment (1780)
DOE should address containment activities at RFETS immediately, rather than waiting for a detailed study.

Response
The WM PEIS addresses the treatment and disposal of low-level mixed and low-level wastes and the treatment and storage of transuranic waste at RFETS. It does not address the containment or remediation of existing contamination at the site, which DOE will handle under its Environmental Restoration Program. Site-specific environmental analyses will address remediation of existing contamination at sites.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

Comment (2101)
A commentor stated that DOE needs to take responsibility for offsite contamination in areas around the Portsmouth Plant where children play and swim. Health is being compromised by lack of communication with the public.

Response
The affected environment section in Volume I (Chapter 4), and the WM PEIS Affected Environment Technical Report (which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS) describe existing conditions at the Portsmouth Plant. These descriptions include the results of environmental monitoring of media affected by past practices.

DOE has a policy of full disclosure of information regarding releases to the environment. Each DOE site prepares annual environmental monitoring reports that provide information about releases and environmental monitoring activities. These reports are readily available to the public. The 1992 Portsmouth Plant Environmental Report states that discharges from the site appear to have no noticeable effect on radioactivity levels in the Scioto River.

Although of great concern to DOE and the Nation, cleanup of contamination caused by past practices is outside the scope of the WM PEIS.

Comment (2145)
The holding ponds overflow at the Portsmouth Plant during a rain event. DOE needs to consider that contamination is flowing into the Scioto River.

Response
Section 4.4.12 in Volume I of the WM PEIS describes existing conditions at the Portsmouth Plant. Additional information is presented in Section 2.11.2.1 of the WM PEIS Affected Environment Technical Report, which states that the Portsmouth Plant National Pollutant Discharge Elimination System (NPDES) outfalls are monitored for radioactive and nonradioactive parameters. In 1992, permit compliance for all NPDES outfalls was 99.1%.

In 1992, discharges from the Portsmouth Plant affected the receiving streams minimally and were comparable to past discharges. Little Beaver Creek was the only surface-water body that appeared to show slightly elevated radionuclide levels downstream versus upstream levels. Portsmouth Plant discharges appear to have no noticeable effect on radioactivity levels in Big Run Creek or in the Scioto River. No sediment contamination was found in the Scioto River.

The WM PEIS Affected Environment Technical Report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2192)
DOE should not use the old cooling tower at PGDP for stream stripping contaminated groundwater. It is unsafe and NEPA documentation is poor.

Response
The WM PEIS does not analyze specific waste management technologies because it will not be used to select such technologies. Moreover, the activity described in the comment would be considered an

environmental restoration activity. Environmental restoration activities are not analyzed in the WM PEIS, other than to examine the extent to which some environmental restoration waste volumes could affect the comparison among waste management alternatives (see Appendix B in Volume III). The impacts of specific environmental restoration activities will be analyzed through the RCRA or CERCLA process, or other site-specific environmental analyses.

Comment (2212)
A commentor expressed concern that Little Bayou Creek is contaminated by waste from activities carried out at PGDP.

Response
Section 4.4.10 in Volume I of the WM PEIS, and the WM PEIS Affected Environment Technical Report, which can be found in the DOE reading rooms listed in Volume I, Section 1.9, of the PEIS, describe existing conditions at PGDP. These descriptions include results of environmental monitoring of media affected by past practices.

As described in Section 2.9.2.1 of the WM PEIS Affected Environment Technical Report, in 1992, downstream sediments on Big Bayou Creek contained uranium levels 3.5 times higher than sediments from the upstream monitoring location (4.6 versus 1.3 micrograms per gram). Downstream sediments on Little Bayou Creek contained uranium levels 36 times higher than upstream sediments (107 versus 2.8 micrograms per gram). None of the locations contained levels of neptunium-237, plutonium-239, technetium-99, or thorium-230 above the detection limit. In addition, polychlorinated biphenyls were detected in Little Bayou Creek at a maximum concentration of 0.7 microgram per gram.

As described in Section 2.9.9.1 of the WM PEIS Affected Environment Technical Report, in 1992, DOE estimated a maximum multimedia radiation dose of 2.8-millirem per year from ingestion of contaminated sediment and exposure to radiation from spending one-half hour per day, every day, fishing in the most contaminated area of Little Bayou Creek. This exposure is well below the DOE 100-millirem per year standard for multimedia exposure.

Comment (2450)
The WM PEIS should state whether groundwater quality at INEL has improved or deteriorated since 1992. In 1992, elevated levels of 14 contaminants were found in site wells.

Response
DOE revised Section 4.4.5 in Volume I to state that groundwater monitoring at INEL in 1992 showed levels above comparison criteria for four contaminants at onsite wells and for only one contaminant at onsite wells in 1994.

Comment (2485)
Detailed information on the known groundwater and soil contaminants at INEL would be useful in determining the magnitude of existing problems. For example, is the plutonium soil contamination a concern for future groundwater contamination?

Also, Volume I, Section 4.3.3, lists groundwater contaminants that have been detected at INEL. This list is inconsistent with the Spent Nuclear Fuel EIS in that it fails to mention iodine-129, cobalt-60,

4.2 Existing Contamination/Historic Releases/Past DOE Practices

cesium-137, plutonium-238, -239, and -240, americium-241, chromium, lead, mercury, chloride, sulfate, and nitrate.

Response
Section 4.3.3 in Volume I of the WM PEIS is a summary of the known water resource contamination. The list provided is not meant to be all inclusive. The detailed information requested in the comment is provided in Section 2.3.2.2 of the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Even more detailed information on this subject is available in the technical reference documents cited in Section 2.3.2.2 of the Affected Environmental Technical Report.

Comment (2494)
Volume I, Section 4.4.5 identifies uranium recovery from highly enriched spent fuels as a major source of air pollution at INEL. This process has not been performed at INEL since sometime before the decision in April 1992 to cease fuel reprocessing in the DOE complex.

Response
The commentor is correct and DOE has deleted the incorrect statement from the WM PEIS.

Comment (2873)
Sediment contamination is also present at BNL and should be included in Volume I, Section 4.3.4. This is particularly significant due to BNL's presence over a sole-source aquifer and the presence of highly permeable soils throughout the site.

Response
DOE assumes that the commentor is referring to soils contamination described in Section 4.3.4 in Volume I of the WM PEIS and not sediment contamination described in Section 4.3.3. The list of soils contaminated provided in Section 4.3.4 in Volume I was not meant to be comprehensive. Additional information on the affected environments at the sites is provided in the WM Affected Environment Technical Report, which is available in the DOE reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Section 2.15.1.2 of the WM PEIS Affected Environment Technical Report states that offsite soil samples are routinely analyzed for radionuclides. In 1991, no radionuclides attributable to BNL operations were detected in any of the soil samples.

Existing contamination, and the cleanup of any contaminated areas at the sites, are part of environmental restoration activities at the site, which are outside the scope of the WM PEIS. Furthermore, because waste management activities are not expected to add to existing levels of soil contamination, they are not addressed in the cumulative impacts analysis.

Comment (2911)
Volume I, Section 4.3.3, of the Draft WM PEIS stated that contamination is usually limited to onsite areas at DOE facilities. This is not the case at BNL, which has pervasively contaminated the surrounding region with a variety of compounds. Tritium is known to have contaminated surface water and groundwater at BNL. BNL is also the cause of dissolved metals occurring above State drinking water standards, both on and off the site. These omissions should be corrected.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

In addition, the statement in Volume I, Section 4.4.2, that BNL offsite concentrations do not exceed drinking water standards is incorrect. Offsite concentrations for several organic compounds and metals in plumes from contaminated areas within the site exceed drinking water standards. Some of these plumes have become the focal point of significant public concern. The nature and extent of these plumes and all exceedances should be listed.

Response
Section 4.3.3 in Volume I of the WM PEIS was revised to indicate that tritium is a groundwater contaminant at BNL. This section is a partial summary of the known water resource contamination and was not meant to be all inclusive. The WM PEIS Affected Environment Technical Report contains more detailed information on current contamination at BNL. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

In addition, DOE revised Section 4.4.2 in Volume I of the WM PEIS to state that offsite concentrations of certain contaminants at BNL *do* exceed drinking water standards. Section 4.4.2 is also a summary of information contained in the WM PEIS Affected Environment Technical Report.

Section 2.15.2.2 of the technical report states that in 1991, groundwater at BNL was monitored at 81 wells, including 17 offsite private wells, for radioactive parameters and at 71 wells for nonradioactive parameters. Some groundwater contamination has migrated off the site at concentrations exceeding New York State Drinking Water Standards. The full extent of offsite contamination is currently being evaluated under an Interagency Agreement between the New York State Department of Environmental Conservation, EPA, and DOE.

Comment (3005)
Tables 6.7-2 and 7.7-2 indicate the numbers of Federal and State endangered and threatened species at low-level mixed waste and low-level waste sites under each of the alternatives. The numbers in these tables do not coincide with the information on threatened and endangered species contained in Section 4.4 for FEMP or Portsmouth.

Response
DOE revised Section 4.4.12 in Volume I to state that one candidate species (listed as State threatened), four State endangered species, five State threatened species, four State potentially threatened species, and seven State special-interest species occur near the Portsmouth Plant. Section 4.4.3 in Volume I was also revised to reflect the correct number of threatened and endangered species at FEMP. No Federally listed threatened or endangered plant or animal species are known at FEMP. However, potential habitat exists for the Indiana bat (Federal and State endangered). Running buffalo clover, a Federally listed endangered plant species, occurs near FEMP. Seven state-listed endangered species (including the Indiana bat) and three state-listed threatened species occur or potentially occur at FEMP.

Comment (3007)
Section 4.4 (for all sites) should contain information on what contaminants exceed comparison criteria.

Response
Section 4.4 in Volume I of the WM PEIS is intended to provide a broad overview of the affected environment for the DOE sites and, therefore, does not include information on specific contaminants.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

The WM PEIS Affected Environment Technical Report listed in Volume I of the Final PEIS provides more detailed site-specific information.

As stated in Section 4.4, more precise information on site environmental parameters would be provided in site environmental monitoring reports and sitewide or project-level NEPA documents.

Comment (3039)
Table 4-5 does not include important contaminants, such as chromium and nitrates, that are major contaminants in sediments and groundwater, respectively, at Hanford.

Response
Table 4-5 in Volume I of the Draft WM PEIS lists the criteria pollutant attainment status at the 17 major sites. DOE assumes that the commentor is instead referring to the text of Section 4.3.3 on the pages adjacent to Table 4-5.

Section 4.3.3 in Volume I of the Draft WM PEIS is a partial summary of the known water resource contamination and is not meant to be comprehensive. The WM PEIS Affected Environment Technical Report contains more information on current sediment and groundwater contamination at Hanford. Section 2.2.2.2 of the technical report states that maximum concentrations of chromium nitrate and tritium in the groundwater were above their comparison criteria at least once in 1992. This document further states that tritium and nitrate groundwater contaminant plumes occur over 316 square kilometers (122 square miles) of Hanford. Other contaminants, for example, chromium cyanide, have been detected in groundwater in areas surrounding disposal sites. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3050)
The statement in Volume I, Section 4.4.4, that four major plumes enter the Columbia River in at least three locations is an extreme simplification. The carbon tetrachloride plume, which is one of the most extensive at the Hanford Site, could enter the river in high concentrations in approximately 100 years. Thus, referencing only plumes currently entering the Columbia River minimizes potential problems stemming from waste management activities.

Response
The description of existing contamination in Section 4.4.4 in Volume I of the WM PEIS and Section 2.2.2.2 of the WM PEIS Affected Environment Technical Report (which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the WM PEIS) is provided only to give the reader background information about conditions at the site. The technical report does list carbon tetrachloride among the Hanford Site's groundwater contaminants and Section 4.3.3 in Volume I notes that solvents are known groundwater contaminants at Hanford. No attempt was made in the WM PEIS to predict future plume movement, since future remediation activities could change the extent of groundwater contamination. For more detailed information on the Hanford Site, please consult the Tank Waste Remediation System, Hanford Site Final EIS, 1996, and the Hanford Remedial Action EIS.

To the extent information is available, impacts from other programs and actions are considered in the cumulative impacts analysis in Volume I, Chapter 11, of the Final WM PEIS.

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Comment (3193)
Volume I, Chapter 4, does not identify the two major groundwater plumes that extend beyond the facility boundaries at PGDP.

Response
DOE revised Section 4.4.10 in Volume I to note that two plumes of groundwater contamination extend into an offsite area. Section 4.4.10 is a summary of information contained in Section 2.9.2.2 of the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3194)
See Volume I, Section 4.3.3. Known groundwater contaminants at Hanford also include uranium, iodine-129, carbon tetrachloride, chromium, cobalt-60 and nitrate.

Response
The commentor is correct about the contaminants at Hanford. Section 4.3.3 in Volume I of the WM PEIS is not intended to provide a comprehensive list of contaminants. However, the WM PEIS Affected Environment Technical Report notes that groundwater contamination at Hanford includes uranium, iodine-129, carbon tetrachloride, chromium, cobalt-60, and nitrate as known groundwater contaminants. The technical report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS.

Comment (3197)
Volume I, 4.3.4: High-level, low-level, uranic, transuranic, and mixed waste were disposed of directly to the ground at Hanford. Many of the high-level waste tanks have leaked large quantities of high-level mixed and transuranic waste to the soil. Every fission product and actinide with a sufficiently long half-life to remain is present at various locations around the site.

Response
Since environmental remediation was removed from the scope of the PEIS, DOE does not focus on contamination at the sites. Environmental remediation activities are undertaken pursuant to CERCLA and the Hanford Site Tri-Party Agreement.

Volume I, Sections 4.3.3 and 4.3.4, of the WM PEIS provide a summary of known water, soil, and sediment contamination at the sites. These sections were not intended to be comprehensive listings of the contaminants. Additional information on contaminants at the Hanford Site is provided in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3225)
See Section 4.4.4. Many of the wetlands at Hanford are contaminated with radioactive materials from the operations of the reactors along the Columbia River.

Response
Cleanup actions at the DOE sites are not within the scope of the WM PEIS. However, Chapter 11 does address potential impacts from environmental restoration operations that could contribute to the overall environmental impacts resulting from DOE waste management and other activities. DOE recognizes

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and is addressing cleanup of contaminated sites, including situations such as contaminated shoreline seeps at Hanford. Section 2.2.2.1 of the WM PEIS Affected Environment Technical Report contains a detailed description of the surface water and sediment quality data for the Hanford Site, including descriptions of existing radionuclide contamination. The Affected Environment Technical Report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3403)
The WM PEIS discloses that there is a serious risk from neptunium-237 contamination at PGDP. Where did the neptunium come from? How long has it been there, and how is it being stored? Neptunium-237 is a very long-lived, toxic isotope. Has DOE been testing for neptunium-237 in the groundwater up until now?

Response
Neptunium-237 is an alpha-emitting radionuclide with a half-life of 2.2 million years. It was introduced into the enrichment cascades at PGDP in the early 1970's when reprocessed fuel was blended with other feedstocks. Some low-level waste at PGDP contains neptunium-237.

Neptunium-237 was identified in the 1992 version of the waste management information system database that provided the low-level waste site-specific waste information used in the WM PEIS. This information is presented in the WM PEIS Low-Level Waste Technical Report referenced at the end of Chapter 7 in Volume I.

As described in Section 2.9.2 of the WM PEIS Affected Environment Technical Report, analyses for neptunium-237 are routinely performed for environmental media at PGDP. However, it is not routinely detected because it is present in such low concentrations.

Comment (3531)
In the affected environment description of NTS, DOE should explain the statement, "Groundwater monitoring in 1991 indicated that eight contaminant comparison criteria were exceeded at onsite wells" and use more recent groundwater monitoring data than 1991.

Response
In general, DOE elected not to update or supplement the data in the WM PEIS with more recently published data because conditions rarely change drastically from year to year. Exceptions were made in instances where DOE determined that the updated data might affect the comparisons of alternatives. DOE believes that the water quality information provided gives an adequate characterization of the conditions at the sites, especially for a programmatic EIS that will not select locations for waste management facilities on the sites. More up-to-date site-specific information would be included in sitewide or project-level NEPA analyses.

The WM PEIS Affected Environment Technical Report contains more detailed information on environmental conditions at the sites. Section 2.7.2.2 of the report states that water supply wells at NTS are routinely monitored for radioactive and nonradioactive parameters, as required by the Safe Drinking Water Act, State of Nevada regulations, and DOE Orders. Table 2.7-4 of the report summarizes the monitoring results for 1991. Maximum concentrations of bismuth-214, gross alpha, lead-212, lead-214, nitrate, pH, plutonium-239 and -240, and total dissolved solids were above their

comparison criteria at least once in 1991. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3757)
Past waste storage and handling activities were unsafe and dangerous to the environment. In the year 2020, let us hope that we will not hear how stupid we were in the 1990s.

Response
The WM PEIS will help DOE develop a comprehensive national strategy to manage its radioactive and hazardous wastes in a safe and efficient manner. By careful study and planning of waste management at the national and site levels, DOE hopes to correct past waste management practices to ensure protection of the public, workers, and the environment in the future.

Comment (3781)
For 50 years, airborne contamination has occurred at ANL-E, and gardening and construction recirculated the contamination in the air. Air quality is currently affected by treatment of waste onsite. Inhalation of isotopes is even more risky than isotopes found in drinking water.

Response
As described in Section 4.4.1 in Volume I of the WM PEIS, in 1992 the radiation dose from airborne radionuclides to a maximally exposed individual at ANL-E was 0.0085 mrem. This is well below the 10 mrem per year National Emission Standards for Hazardous Air Pollutants limit. The collective radiological dose from airborne radionuclide emissions to the ANL-E region of influence health risk population was 16.8 person-rem.

As detailed in Section 5.4.1 in Volume I, the WM PEIS human health risk analysis assesses the atmospheric pathway (including inhalation) as a major exposure pathway for a variety of potentially exposed populations and individuals. Section 5.4.2 addresses the methodology for air quality impacts, which were assessed for the construction of new treatment, storage, and disposal facilities, for the operation and maintenance of the facilities, and for shipment of wastes between sites. For the waste management alternatives relating to ANL-E, the analysis found that human health risks and air quality impacts would be low. Sections 6.4, 6.5, 7.4, 7.5, 8.4, and 8.5 contain more detail related to these issues.

Comment (3787)
DOE needs to better inform the public about the potential for existing contamination in the area around ANL-E. Radionuclides in the Illinois River water is a problem.

Response
Additional information on surface water resources at ANL-E is presented in Section 2.14.2.1 of the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Approximately 0.5 miles from ANL-E, Sawmill Creek, which is joined by two ANL-E onsite streams, enters the Des Plaines River. According to 1993 monitoring data, concentrations of radionuclides in Sawmill Creek were low and only a small fraction of the DOE-derived concentration guides for water. Dilution in the Des Plaines River reduced the concentration of the measured radionuclides below their

respective detection limits. The Illinois River is approximately 30 miles southwest of ANL-E where it is formed by the Des Plaines River and the Kankakee River. DOE is not aware of any radioactive contamination in the Illinois River.

Comment (3859)
Handling of past contamination does not instill public confidence.

Response
DOE is committed to operating its facilities in a safe and efficient manner. This includes selecting facility locations and waste management technologies that result in a minimum of health risk and environmental impact. The WM PEIS is part of the process to ensure that the potential impacts to the public and environment are accounted for when DOE makes programmatic decisions on waste management activities.

Most health risk concerns at DOE sites are from former operations that occurred when accepted waste management practices were less rigorous than those in force today. Health risks from current DOE waste management operations are generally low. DOE is committed to reducing radiation exposure to levels as low as reasonably achievable.

Comment (3876)
The people around ANL-E are familiar with waste dumping. Remember the Red Gate Woods area? Most of the radioactively contaminated wells had to be capped or disabled.

Response
Wells in the Red Gate Woods area were contaminated with tritium from dumping of radioactive waste during the late 1940s and early 1950s. These wells are now being monitored by environmental surveillance personnel at ANL-E. DOE is committed to disposing of radioactive waste in a way that is safe to humans and the environment. DOE's Order 5820.2A requires that such waste be disposed of in disposal facilities. The combination of disposal waste form and facility design must ensure that the standards of the Safe Drinking Water Act and other standards to protect human health and the environment are met.

Comment (3913)
DOE needs to explain what waste is presently onsite at ANL-E and what the plans are for this temporary storage. DOE needs to explain who is going to watch over the currently stored low-level waste.

Response
Storage, which plays a role in all waste management activities, consists of the collection and containment of waste to await treatment or disposal. DOE is responsible for its Department-wide waste, including the low-level waste at ANL-E.

The Final WM PEIS reports the following quantities of waste material at ANL-E as the current inventory: 34 cubic meters of low-level mixed waste (Table 6.1-1), 880 cubic meters of low-level waste (Table 7.1-1), and 15 cubic meters of transuranic waste (Table 8.1-1). ANL-E does not store high-level waste, and DOE did not consider the site for future high-level waste management. The PEIS

does not present an inventory of hazardous waste because this waste type is stored on the site for a limited time only to accumulate sufficient quantities for treatment.

Chapters 6, 7, 8, 9, and 10 of the PEIS describe the waste management activities and siting options for each waste type. Appendix I contains newly available data on low-level waste inventories at ANL-E and DOE has incorporated these data into the analysis of alternatives in the Final PEIS.

Comment (3962)
Does uranium contamination exist in sediment offsite or onsite at PGDP and the Portsmouth Plant? The Little Beaver, Big Beaver, Big Run, and Scioto Rivers have been documented by Ohio EPA and the U.S. EPA as having contaminated sediment offsite at Portsmouth.

Response
Chapter 4 in Volume I of the WM PEIS summarizes environmental conditions at the sites. The WM PEIS Affected Environment Technical Report contains more detailed descriptions of the sites. For PGDP, Section 2.9.2.1 of the technical report states that stream sediments are routinely monitored at site locations for radioactive and nonradioactive parameters. In 1992, downstream sediments on Big Bayou Creek indicated uranium levels of 4.6 micrograms per gram. Downstream sediments on Little Bayou Creek indicated uranium levels of 107 micrograms per gram. For the Portsmouth Plant, Section 2.11.2.1 of the technical report states that stream sediments are routinely monitored for radioactive parameters at 4 onsite and 13 offsite locations. In 1992, minor sediment contamination was found in the east drainage ditch, Little Beaver Creek, and Big Beaver Creek. In addition, some contamination was found in two onsite locations in Big Run Creek. No sediment contamination was found in the Scioto River. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3963)
Section 4.4.12 in Volume I states that groundwater monitoring at the Portsmouth Plant in 1992 showed eight parameters above comparison data. Does this mean that groundwater contamination has been documented on the site, off the site, or both?

Response
Chapter 4 in Volume I of the WM PEIS summarizes detailed descriptions of the affected environments found in the WM PEIS Affected Environment Technical Report. Section 2.11.2.2 of the WM PEIS Affected Environment Technical Report states that onsite groundwater at Portsmouth is monitored for radioactive and nonradioactive parameters and water levels at more than 245 wells. Maximum concentrations of 1,1,1-trichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, chloroform, chromium, gross alpha, gross beta, and trichloroethylene were above their comparison criteria at least once in 1992. Offsite groundwater is monitored for radioactive parameters at 11 locations. None of the results were above their comparison criteria. The WM PEIS Affected Environment Technical Report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

DOE has revised Section 4.4.12 in Volume I of the WM PEIS to state that for the Portsmouth Plant, no contaminants exceeded comparison criteria in measurements of offsite groundwater.

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Comment (4017)
DOE should add the following sites with known groundwater contaminants to Volume I, Section 4.3.8: (1) BNL, because of tritium (see Baseline Environmental Management Report, Volume II, DOE-EM-232); and (2) WVDP, because of strontium contamination (see Doc ID WVDP-220).

Response
DOE assumes that the commentor is referring to Section 4.3.3 and not 4.3.8 in Volume I of the WM PEIS.

As stated in the PEIS, the list provided in Section 4.3.3 in Volume I was not meant to be all-inclusive. Additional information on the affected environments at the sites is provided in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Section 2.15.2.2 of the technical report states that, at BNL, the only average radionuclide concentrations that exceeded concentration limits were gross beta and strontium-90. The high radionuclide concentrations occurred onsite near the landfill areas and the hazardous waste management facility. The maximum offsite tritium concentration in drinking water wells in 1991 was 3,780 picocuries per liter compared to the 20,000 picocuries per liter drinking water standard. The information in the WM PEIS Affected Environment Technical Report was obtained from individual site data reports. Volume II of the 1995 Baseline Environmental Management Report does identify tritium in groundwater at BNL. However, this contaminant is found in specific locations in groundwater onsite at BNL, and the extent of contamination is not yet known. Moreover, some of the contamination is the result of environmental restoration activities.

In Section 4.3.3, WVDP is identified as a site that has surface water contaminated with strontium.

Comment (4019)
In Volume I, Section 4.3.4, DOE should add BNL and WVDP to the list of sites with known soil contaminants because of cesium contamination at those sites (see the Baseline Environmental Management Report, Volume II, DOE-EM-232). Known contaminants at BNL also include petroleum products, metals, solvents, and other radionuclides.

Response
The affected environment descriptions in Chapter 4 in Volume I of the WM PEIS summarize the information in technical reports. As stated in Section 4.3.4, the list provided contains examples and, therefore, was not meant to be comprehensive. Additional information on the affected environments at the sites is provided in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Section 2.15.1.2 of the report, which pertains to BNL, states, "Offsite soil samples are routinely analyzed for radionuclides. In 1991, no radionuclides attributable to site operations were detected in any of the soil samples." Table 2.19-3 of the report lists the maximum concentrations of radionuclides in soils at WVDP, including cesium.

The WM PEIS Affected Environment Technical Report also indicates that the maximum concentration of cesium-137 in drinking water wells at BNL is significantly less than the comparison criteria of 120 picocuries per liter established by EPA in its Primary Drinking Water Regulation. WVDP does not use groundwater as a source of drinking water, and Section 2.19.2.2 of the technical report

indicates that groundwater monitored at 10 offsite residential wells shows no evidence of contamination by WVDP activities.

The information in the WM PEIS Affected Environment Technical Report was obtained from individual site data reports. Volume II of the 1996 Baseline Environmental Management Report does identify cesium-137 and other contaminants in soils at BNL. However, these soils are in specific locations onsite at BNL, and the extent of contamination is not yet known. The 1996 Baseline Environmental Management Report does not indicate the presence of soil contaminated by cesium-137, nor other specific substances at WVDP.

Comment (4433)
Much radionuclide exposure data in the Draft WM PEIS was taken from the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992*, which apparently fails to cover major sources of radionuclide exposure at the sites covered in the WM PEIS. Taxpayer dollars were wasted using this source of information, especially if the summary report fails to cover radionuclide exposures as comprehensively as Site Environmental Reports. No detailed justification for basing the characterization of site impacts on the air emissions report rather than on Site Environmental Reports was given, nor was the significance of the missing information revealed.

Response
The WM PEIS Affected Environment Technical Report contains radionuclide exposure information from site Annual Environmental Reports. The report indicates that some sites have exposure data estimates for different years (1991 through 1993), for different pathways (airborne exposure and/or multimedia exposure), and different treatments of background radiation exposure, including radon. To provide some consistency among the sites, DOE used the report, *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992*, which provided estimates of offsite maximally exposed individual exposures to radionuclides in 1992 for all major sites considered in the PEIS. These values are presented in Chapters 4 and 11 in Volume I and in the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Because the air pathway was considered to be the only important pathway for exposures to the public, other pathways were not evaluated in the PEIS. Existing contamination that might contribute to exposures through other pathways were not included in the analysis.

Comment (4490)
Section 4.3.1 of the Draft WM PEIS should include summarized data on radon exposure from waste at DOE sites and on exposure from other pathways. As shown below, the result is a misleading characterization in the Draft PEIS of radiation and radionuclide exposure to the general public and associated human health impacts at DOE sites.

1992 RADIATION EXPOSURE TO THE MOST EXPOSED INDIVIDUAL (mrem)

Site	WM PEIS	1992 Site Environmental Report		Ratio
ANL-E	0.0085	0.34	air including radon	40
		0.41	air, ingestion, radiation	48
BNL	0.11	0.92	including fish	8.4
ETEC	-	0.0001		-
FEMP	0.0021	51	from Radon	24,000
Hanford	0.0037	0.02	from Columbia River	5.4
		0.07	per kg duck	19
INEL	0.0015	4	from max. duck	2,700
LBL	0.060	2.1	accelerator	35
LLNL	0.069 or 0.69	0.28	air, food, water	0.29 to 2.9
LANL	7.9	4.4	Accelerator only	-

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1992 RADIATION EXPOSURE TO THE MOST EXPOSED INDIVIDUAL (mrem) (Cont'd)

Site	WM PEIS	1992 Site Environmental Report		Ratio
Middlesex	0.009	0.3	gamma radiation	33
NTS	0.012	0.007	air, milk, veg., beef liver	3.5
ORR	1.4	4 to 17	air, water, fish, rad.	2.9 to 12
Pantex	<0.0001	0.000027		-
PGDP	0.0045	3.8	food, water, sediment, rad.	840
Portsmouth	0.26	0.03		0.12 typo?
RFETS	0.0002 or 0.000028	0.46	Plutonium monitoring	2,300 to 16,000
Sandia-NM	0.0034	0.0034		1.0
SRS	0.140	49	for hunter	350
		3.1	from fish	22
WVDP	0.0003	0.046	Fish	150

Failing to include data on exposure from other exposure pathways (including surface-water contamination, exposure to direct radiation, the ingestion of contaminated fish and game, etc.) results in a very misleading characterization of radiation and radionuclide exposure to the general public and associated human health impacts at DOE sites.

The summary table in Chapter 4 and Chapter 11 of the Draft PEIS shows different values for the exposure to the maximally exposed individual for LLNL and for RFETS. DOE needs to check the values in the WM PEIS.

The data in Site Environmental Reports clearly showed radiation and radionuclide exposures that were usually much higher (and, for many sites, more than 100 times higher) than the exposures reported in the Draft WM PEIS.

Risks to the most exposed individual above one in ten thousand are generally considered to be unacceptable under EPA CERCLA guidelines (which usually assume a maximum 30-year exposure) and EPA RCRA permit writer's guidelines (which usually assumes a 70-year exposure), unless they are due to pollutants complying with specific regulatory limits for the route of exposure causing the risk. Most of the actual exposures above 1 mrem are not covered by such route-of-exposure or source-specific EPA regulations.

Risks above one in one million indicate a need to evaluate better pollution control under CERCLA guidelines and the Clear Air Act of 1990 (which assumes a 70-year exposure), when applicable, along with some State regulations.

As described in 1992 Site Environmental Reports, the combined direct and indirect exposures associated with airborne radionuclides from DOE installations (excluding radon) to the hypothetical or actual most exposed members of the general public were well below the 10-mrem EPA standard (that also excludes radon). However, radon exposure was 24,000 times higher than the non-radon radionuclide exposure at FEMP and 40 times higher than non-radon exposure at ANL-E reported in the Draft WM PEIS. Radon was either not detected above background levels, not monitored at the site boundary, not modeled, or not discussed in the Site Environmental Reports for many of the other installations.

Based on available data on radionuclide levels measured in onsite animals (and background animal monitoring), potential exposure to the hypothetical maximally exposed individual from the ingestion of contaminated game could be much higher than the modeled direct and indirect exposure to airborne and liquid radionuclide releases because such game could conceivably be caught on or off the site.

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The general public has access to locations at the boundary of and within several DOE sites. At some of these locations, exposures exceeding 100 mrem from direct external exposure to radiation would have been possible in less than a year in the highly unlikely event that a person were to remain at such a location continuously. However, under plausible exposure assumptions (considering the land use) that were identified in Site Environmental Reports, exposure exceeding the 100 mrem limit did not occur.

Response
DOE has revised Table 4.2-2 to include radon doses related to site actions at FEMP and ANL-E. These estimates are also included in the cumulative impacts analysis presented in Chapter 11 in Volume I of the WM PEIS in the description of existing site conditions for those sites.

The commentor is correct in noting that many of the exposures listed in the Site Environmental Reports are higher than the exposures used in the PEIS analysis. All of the exposure information described in the comment is presented in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. However, this information was not listed in Chapter 4 (Affected Environment) or used in Chapter 11 (Cumulative Impacts) because the routes of exposure for these higher exposure estimates are not as relevant for most members of the offsite public as airborne exposure.

Consumption of contaminated wildlife and other multimedia exposure scenarios are best addressed as parts of site-specific analyses. These pathways would require additional information or assumptions about the dietary habits of these individuals who consume fish and wildlife. The WM PEIS attempted to estimate risks to the offsite population through pathways that are relevant for the general population (i.e., airborne releases from facilities, leading to inhalation exposure, and deposition of contaminants to soil, followed by uptake in crops and livestock and ingestion by receptors). The maximally exposed individual exposure and risk estimates for these pathways are more likely to be potentially applicable to most members of the general public. Consideration of hot-spot or contaminated wildlife exposures involves the use of site-specific characteristics that are better addressed in sitewide and project-level NEPA reviews.

The WM PEIS evaluates potential health risk impacts to offsite populations from waste treatment operations that are assumed to occur over a 10-year period. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. Impacts to offsite populations during the operations period are assumed to result mainly from airborne releases of radionuclides and hazardous chemicals from waste treatment facilities. During this 10-year operations period, institutional control of the sites is assumed to be maintained by DOE. Consequently, the offsite population should not come into contact with hot spots of contamination located inside the site boundary. The WM PEIS does not attempt to estimate future land-use scenarios at the sites. These decisions are better made on the basis of a sitewide analysis. Therefore, the airborne pathway is the only exposure route analyzed in the cumulative impacts section of the WM PEIS.

DOE has revised the Chapter 11 tables to list the correct maximally exposed individual doses for LLNL (6.9×10^{-1} mrem) and RFETS (2×10^{-4} mrem) for an offsite individual.

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Comment (4492)
The statement in Section 4.3.1 of the Draft WM PEIS that airborne radionuclide exposure is readily measured and that its potential impact can be immediately determined is highly misleading. Airborne radionuclide exposure is extremely difficult to measure directly and separate from background at the levels reported in the Draft WM PEIS, and the exposures included in the Draft WM PEIS were not, in fact, measured. Air pollution exposures (and associated exposure from ingestion of biota contaminated by the air pollution) in the Draft WM PEIS were determined by modeling, mostly using the CAP-88 model (which used the results of emission monitoring and modeling as data input). This is not measurement of exposure, but modeling of exposure.

The only potential airborne exposures that were directly measured in Site Environmental Reports were for radon, for radiation and for fugitive plutonium dust at RFETS, none of which was covered in the Draft WM PEIS.

The results of monitoring were used in Site Environmental Reports to determine potential radon exposure to the maximally exposed individual at FEMP, potential radiation exposure at the boundary of several sites, the amount of potential exposure to a hunter at SRS (from game that he caught), potential exposure from the ingestion of contaminated ducks at INEL, and potential exposure to plutonium at RFETS. The WM PEIS should include this information.

Response
DOE has revised the discussion in Section 4.3.1 of the WM PEIS to indicate that exposures of individuals in offsite populations would occur primarily through inhalation of airborne contaminants released from new waste treatment facilities. Except for the airborne exposures based on direct measurements at RFETS the commentor notes, estimates of these releases, as well as estimates of airborne releases from existing site activities, were developed using air dispersion models rather than measurements.

Comment (4494)
The statement in Section 4.3.1 of the Draft WM PEIS that, at DOE sites, the maximally exposed individual received a dose considerably less than 1 mrem per year does not agree with the following impacts reported in 1992 DOE Site Environmental Reports:

- The potential exposure in the game caught by a hunter at SRS was 49 mrem;
- The potential exposure from eating the most contaminated duck at INEL was 4 mrem;
- The exposure to a residence near the target of an accelerator at LBL was 2.1 mrem;
- The exposure to a residence near the target of an accelerator was estimated to be 4.4 mrem at LANL;
- Radon exposure at FEMP was estimated to be 51 mrem for the maximally exposed individual;
- PGDP had a potential multimedia exposure of 3.8 to 4 mrem to the maximally exposed individual;
- ORR had a potential multimedia exposure of 1.4 mrem from airborne radionuclides and 4 to 17 mrem from multimedia exposure.

Response
DOE has revised Section 4.3.1 of the WM PEIS to indicate that the estimated airborne maximally exposed individual dose at most sites is considerably less than 10 mrem per year, since the estimates for LANL and ORR exceed 1 mrem per year. Note that these are estimates of maximally exposed

individual exposure via the airborne pathway only. The source of these estimates is not the annual Site Environmental Reports, but rather the DOE report, *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992.*

The WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS, contains all the exposure information described in the comment. However, DOE did not carry this information into Chapters 4 (Affected Environment) and 11 (Cumulative Impacts) because those routes of exposure are not as relevant for most members of the offsite public as airborne exposures.

The consumption of contaminated wildlife and other multimedia exposure scenarios are best addressed in site-specific analyses. These pathways would require additional information or assumptions about the dietary habits of those populations who consume fish and wildlife. In addition, wildlife contamination data vary widely from year to year in site monitoring reports. The WM PEIS estimated risks to the offsite population through pathways that are relevant for the general population (i.e., airborne releases from facilities, leading to inhalation exposure, and deposition of contaminants to soil, followed by uptake in crops and livestock and ingestion by receptors). The maximally exposed individual exposure and risk estimates for these pathways are more likely to be applicable to most members of the general public. The consideration of hot-spot or contaminated wildlife exposures involves the use of site-specific characteristics that are better addressed in sitewide or project-level NEPA analyses.

The PEIS evaluates potential health risk impacts to offsite populations from waste treatment operations that would occur over an assumed 10-year period. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. Impacts to offsite populations during the operations period would result primarily from airborne releases of radionuclides and hazardous chemicals from waste treatment facilities. DOE would maintain institutional control of the sites during this period. As a consequence, the offsite population should not come in contact with hot spots of contamination inside the site boundary.

The PEIS does not attempt to estimate future land-use scenarios at the sites. DOE will make these decisions based on sitewide or project-level analyses. Therefore, the airborne pathway is the only exposure route analyzed in the cumulative impacts section of the WM PEIS.

Comment (4495)
The Draft WM PEIS misrepresents impacts of existing DOE sites during the baseline year and makes impacts of planned and alternative actions look much smaller than Site Environmental Reports and previous modeling.

Potential or actual radionuclide and radiation exposure to maximally exposed individuals in the general public from DOE sites in 1992 includes exposures that are at least 100 times higher than reported in the Draft WM PEIS because of contaminated wildlife at SRS, INEL, and WVDP, plausible multimedia exposure at PGDP, radioactivity at hot spots at the boundaries of ANL-E, LBL, ORR, and PGDP, and at the shoreline of the Columbia River at Hanford, plutonium impacts are RFETS, and radon from materials onsite at FEMP.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

The Draft PEIS did not include exposures to populations that were much higher than the exposures reported in the Draft WM PEIS at many sites due to routes of exposure whose impacts were quantified in DOE Site Environmental Reports and other internal documents.

Section 4.4.1 and Table 11-3 in the Draft WM PEIS reported that the radiation dose from airborne radionuclides from ANL-E to a maximally exposed individual was 0.0085 mrem. However, the 1992 ANL-E Site Environmental Report said that the exposure to airborne radionuclides excluding radon was 0.0091 mrem, and that, including radon, it was 0.34 mrem at an actual receptor 800 meters north of the site (40 times higher than the 0.0085 mrem reported in the Draft WM PEIS). Furthermore, the maximum reported potential multimedia exposure was 0.41 mrem from ingestion, inhalation, and radiation (48 times higher than the value in the WM PEIS). In addition, the Site Environmental Report provided data on a location at the ANL-E fenceline, near some transuranic waste where the maximum potential exposure from penetrating radiation was 82 mrem (and 0.01 mrem under more realistic exposure assumptions).

Section 4.4.2 of the Draft WM PEIS reports that the dose to the maximally exposed individual at BNL is 0.11 mrem from air emissions. However, the Site Environmental Report indicates that the dose to the maximally exposed individual from contaminated fish in the Peconic River is 0.64 mrem; the dose from contaminated water is 0.11 mrem; and the dose from airborne radionuclides is 0.17 mrem. This would make the maximum dose 0.92 mrem. The Draft WM PEIS reports that the collective radiological dose from airborne radionuclide emissions is 2.7 rem per year. However, the Site Environmental Report indicated that the dose is 3.6 rem per year, including 0.40 rem per year from fish, 0.07 rem per year from water, and 3.1 rem per year from airborne radionuclides.

The reported radiation dose in Section 4.4.3 and Table 11-7 of the Draft WM PEIS from airborne radionuclides to a maximally exposed individual of 0.0021 mrem impacted by FEMP is grossly misleading. It fails to include the 51 mrem potential exposure to airborne radon in the 1992 FEMP Site Environmental Report. This exposure is 24,285 times (24,000 to two significant figures) higher than that reported in the Draft WM PEIS, and represents a significant risk to public health. No analysis of the significance of deleting the radon data when characterizing human health impacts was provided in the WM PEIS. The fact that NESHAPS standards exclude radon is stated in the PEIS, but this is irrelevant to human health impact assessment, as such, in an EIS, under NEPA regulations. To try to use NESHAPS standards to justify excluding the radon data from the PEIS is to inappropriately mix regulatory compliance issues with human health impact issues.

Radon exposures from FEMP to the maximally exposed individual were reduced from 93 mrem per year (in 1991) to 51 mrem per year due to better containment of the radon from the uranium in a silo and waste pits on the site. DOE should be proud of this achievement, and it should be recognized in the Draft WM PEIS. However, more needs to be done, and plans existed in 1994 to do more at FEMP. Any plans for further mitigation of the impacts of the radon from this uranium and waste at FEMP and other sites (such as ANL-E) should be mentioned, and the most recent available information on radon exposure should be covered in the affected environment section of this WM PEIS. The impact of future reductions in radon impacts should be covered in the cumulative impacts section. Because radon exposure contributes to human health impacts from DOE sites and dominates those impacts at sites such as ANL-E and FEMP during the baseline year, it cannot be ignored just because there is no specific exposure limit for those impacts.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

The Draft WM PEIS provides a misleading characterization of radionuclide exposure to the general public from existing sites by basing the characterization on air emissions from stacks with exposure limits under NESHAPS, which do not include radon. This misses the most important routes of exposure at many sites (water pollution, bioaccumulation in fish and game, radiation, fugitive plutonium dust, etc.), as well as radon exposure. Exposure from the onsite waste at FEMP was reported in the Site Environmental Report to be substantial (51 mrem per year based on radon monitored at the fenceline in 1992). Mitigating measures for such radon exposure should also be covered, along with the latest information at FEMP (where dramatic reductions in radon impacts were reported).

The 1992 Site Environmental Report for Hanford reported an exposure of 0.0004 mrem at the Ringold Site near Hanford (consistent with the 0.0037 mrem reported in the Draft WM PEIS). However, this was based on the GENII model, and modeling using CAP-88 (the model specified in applicable regulations) showed the exposure to be 0.005 mrem. Monitoring at the Ringold Site showed a somewhat questionable value of 0.09 mrem.

Radionuclide exposure associated with contamination at the Columbia River (at Riverview) was reported to cause an estimated exposure of 0.02 mrem for the maximally exposed individual, according to the 1992 Site Environmental Report.

A location at the Columbia River near the 100N area has a potential exposure of 175 mrem in the unlikely event a member of the general public were to remain there for a year. Exposure was estimated to be 0.07 mrem per kilogram of contaminated duck on the site, 0.002 mrem per kilogram of contaminated pheasant, and 0.001 mrem per kilogram of contaminated deer, according to the 1992 Site Environmental Report.

The reported doses to the maximally exposed individual in the general public from airborne radionuclides at INEL are 0.0015 mrem for 1992 in Section 4.4.5, and 0.0029 mrem for 1994 in Table 11-11. DOE should explain how the dose changed so drastically.

Based on the 1992 INEL Site Environmental Report, the dose to the maximally exposed individual is 0.0018 mrem, based on modeling using CAP-88; and it was 0.0042 mrem at Atomic City, based on the MESODIF model.

However, a much more severe potential exposure from radionuclides is possible. The 1992 INEL Site Environmental Report showed that the most contaminated duck tested in 1992 could cause a dose of 4 mrem if eaten, and the most contaminated measured antelope, 0.2 mrem. The INEL Site Environmental Report estimated that two contaminated ducks from INEL are eaten annually (based on a rather detailed analysis of hunting and duck migration). The potential impact of ingestion of contaminated animals should be covered in the WM PEIS because contaminated ducks can travel far from the site, be shot and then eaten, and the INEL Site Environmental Report confirms that this is likely.

The reported airborne dose to the maximally exposed individual of 0.690 mrem and the collective dose of 1.7 mrem per year at LLNL in Section 4.4.6 of the Draft WM PEIS were higher than the doses reported in the 1992 Site Environmental Report (0.28 mrem to the maximally exposed individual and 0.28 rem per year to the population). However, the dose to the maximally exposed individual is

4.2 Existing Contamination/Historic Releases/Past DOE Practices

reported to be 0.069 mrem in Table 11-13 of the Draft PEIS, a value that is less than the 0.28 mrem summarized from the Site Environmental Report. The discrepancy indicates an error somewhere in the Draft WM PEIS.

The dose to the maximally exposed individual from radionuclides from the accelerator at LANL should be specifically delineated. It is unclear from the affected environment section of the Draft WM PEIS where the reported 7.9 mrem exposure comes from (it was reported to be 4.4 mrem in the 1992 Site Environmental Report). Mitigating measures for accelerator impacts should be covered in the WM PEIS.

Section 4.4.8 and Table 11-17 of the Draft WM PEIS reported airborne dose to the maximally exposed individual of 0.012 mrem for NTS is less than the 0.07 mrem exposure reported in the Site Environmental Report (which included exposure from air, milk, vegetables and beef liver). The most contaminated deer monitored onsite in 1992 would have caused a dose of 0.027 mrem (assuming 100 pounds of meat and 3 pounds of liver were eaten). The collective dose of 0.029 mrem per year for NTS was less than the 0.042 mrem exposure reported in the Site Environmental Report.

In addition to the 1.4 mrem exposure from airborne radionuclides at ORR, the 1992 Site Environmental Report showed a plausible multimedia exposure of 4 to 17 mrem from airborne radionuclides, drinking water from Gallagher Creek, eating contaminated fish from the Clinch River, and spending 250 hours at the radioactive areas of either the Clinch River (2 mrem) or Poplar Creek (15 mrem). In the unlikely event that someone were to spend all year in the contaminated area of Poplar Creek, potential exposure was reported to be 526 mrem in the Site Environmental Report. DOE should have included this information in the WM PEIS.

In addition to the 0.0045 mrem exposure from airborne radionuclides, the 1992 Site Environmental Report for PGDP showed a maximum multimedia exposure to the maximally exposed individual of 3.8 mrem from sediment, radiation from 30 minutes per day at the Little Bayou Creek, contaminated well water, and contaminated crops.

A hot spot was reported at the confluence of the K011 ditch and Little Bayou Creek, where the potential exposure was 187 mrem. This information should have been included in the Draft WM PEIS.

Table 11-23 in the Draft WM PEIS gives specific values for exposure for Pantex; these values should have been included in Section 4.4.11. A slight discrepancy exists between the exposure to the maximally exposed individual on Table 11-23 of 0.000036 mrem, and the 0.000027 mrem in the Site Environmental Report.

Exposure from airborne radionuclides reported in the 1992 Portsmouth Site Environmental Report (0.03) is an order of magnitude less than that in the Draft WM PEIS (0.26 mrem). The correct values for exposure should be verified and included in the WM PEIS.

Section 4.4.13 of the Draft WM PEIS shows a dose to the maximally exposed individual of 0.0002 mrem for RFETS in Chapter 4, and of 0.000028 mrem in Table 11-27, suggesting a typographical error somewhere. The Site Environmental Report also indicated a dose to the maximally exposed individual of 0.46 mrem based on plutonium monitoring between the source and the nearest actual housing and CAP-88 modeling. This plutonium exposure should be covered in the WM PEIS.

4.2 Existing Contamination/Historic Releases/Past DOE Practices

The doses in Section 4.4.14 of the Draft WM PEIS match those in the Site Environmental Report for SNL.

Section 4.4.15 and Table 11-31 of the Draft WM PEIS state the use of doses from airborne radionuclides to characterize exposure to the maximally exposed individual at SRS as 0.14 mrem; this is grossly misleading because it did not include exposure to hunters or fishermen. The maximally exposed individual at SRS is a hunter who eats contaminated game that he caught on the site (49 mrem). Potential exposure from the ingestion of contaminated fish was reported to be 3.1 mrem in 1992. The figures for the hunter were based on radiation monitoring for the game the hunter actually caught, and the only hypothetical issue was whether he would eat it himself, if others would eat it, or if he would discard it. In addition, fish were contaminated from the site. Ingestion of 42 pounds of bass were reported to result in a potential exposure of 3.1 mrem in the 1992 Site Environmental Report.

The 1992 SRS Site Environmental Report shows exposure data higher than the 6.40 person-rem for airborne exposure reported in Section 4.4.15 and Table 11-31 of the Draft WM PEIS. The collective radiological dose from all routes of exposure combined, based on the 1992 SRS Site Environmental Report was 17.5 person-rem per year, based on the CAP-88 (an EPA-approved airborne radionuclide model) and LAPTAPII. The 1992 Site Environmental Report also showed the collective radiological dose from all routes of exposure combined to be 8.9 person-rem per year, based on the POPGASP and LAPTAPII models (POPGASP was not approved by EPA at last report).

The Draft WM PEIS reports that the exposure to the maximally exposed individual from airborne radionuclides for WVDP was 0.0003 mrem in Section 4.4.17 and 0.00029 mrem in Table 11-35. However, the Site Environmental Report shows an exposure of 0.046 mrem from liquid effluents, assuming that the maximally exposed individual consumes 46 pounds of fish. This dose is 160 times higher than the dose in the Draft WM PEIS.

Response
With respect to the discrepancies noted by the commentor between the WM PEIS airborne doses and doses reported in Site Environmental Reports, the airborne radiation doses presented in Sections 4.4.1 through 4.4.17 in Volume I were taken from a DOE report entitled, *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992*. DOE used this report rather than Site Environmental Reports to provide consistent information for the 17 major sites. The report includes the same information for the same year for all major sites considered in the PEIS. Site environmental reports differ considerably in the information they include and the year on which they are based. However, radionuclide information from site reports is included in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

With respect to use of estimates of the dose from combined routes rather than airborne exposures at any of the sites, because they include more exposure pathways, multimedia maximally exposed individual e stimates will generally exceed airborne maximally exposed individual estimates. However, the WM PEIS health risk analysis considers airborne exposure to contaminants released from waste treatment facilities the most important exposure pathway for most members of the public living offsite in the vicinity of potential waste management sites. This assumption was also used in characterizing existing site conditions. The basis for this assumption is the 10-year treatment period analyzed, during which institutional controls would be maintained to limit access of the offsite population to many of the areas

4.2 Existing Contamination/Historic Releases/Past DOE Practices

considered in the multimedia pathway maximally exposed individual estimates. Therefore, only airborne maximally exposed individual estimates were used in Chapter 4 to characterize existing site conditions and in Chapter 11 to estimate cumulative impacts.

The maximally exposed individual multimedia dose estimates presented in the annual Site Environmental Reports are estimates that do not appear to be relevant to the potential exposure of most members of the offsite population living in the region of influence of the sites. These pathways would be relevant only for certain specialized populations (e.g., hunters and fishermen), and would require additional information or assumptions about the dietary habits of those populations. To be comprehensive, multimedia exposure is included in the WM PEIS Affected Environment Technical Report.

With respect to radon exposures at ANL-E and FEMP, Chapter 4 in Volume I of the WM PEIS summarizes the affected environments of the proposed waste management sites with information presented on potential exposure from existing site activities to offsite maximally exposed individuals from the airborne pathway, as well as from multimedia pathways, where available. The airborne pathway exposure estimates do not include background radiation. Radon accounts for about 200 mrem of the estimated 300 mrem average annual background radiation dose received in the U.S. These exposures are not associated with site activities. At certain DOE sites, storage of wastes containing uranium, thorium, and radium could serve as additional, diffuse sources of radon exposure, since radon is formed when these radionuclides decay. Estimates of this type of radionuclide exposure, which, for example, totaled 51 mrem at the fenceline at FEMP in 1992 and 0.3 mrem at ANL-E in 1993, are provided in the WM PEIS Affected Environment Technical Report supporting the WM PEIS. Airborne maximally exposed individual exposure estimates that include radon exposure, including that at ANL-E in 1993, are also presented in this technical report. The main radon emission at FEMP came from radium-bearing materials stored in the K-65 silos. Radon released from Building 200 at ANL-E was chiefly due to radioactive contamination from the "proof-of-breeding" program. These contaminated areas are undergoing remedial actions. Reduction or elimination of radon release is expected. DOE revised Table 4.2-2 to include radon doses related to site actions at FEMP and ANL-E. These estimates are also included in the cumulative impacts analysis presented in Chapter 11 under the description of existing conditions at these sites.

With respect to risks from exposures at site hot spots, the PEIS does not attempt to estimate future land-use scenarios and the potential for exposure at hot spots at the sites. DOE will make these decisions on the basis of site-level analyses. Therefore, the airborne pathway is the only exposure route analyzed in the cumulative impacts section of the PEIS. However, the WM PEIS Affected Environment Technical Report describes existing hot-spot contamination at the sites.

With respect to the accelerator at LANL, the WM PEIS includes the estimated effects of all existing activities, including the accelerator in the cumulative impacts analysis. LANL is currently preparing a sitewide EIS, which will evaluate the accelerator effects in greater detail and would address mitigation of those operations.

With respect to the maximally exposed individual dose at RFETS, DOE has revised Section 11.15.2 of the WM PEIS to incorporate the correct estimate of airborne maximally exposed individual exposure (0.0002 mrem), as presented in Section 4.4.13 in Volume I. Multimedia maximally exposed individual and hot-spot exposures are not applicable to most members of the offsite populations living in the

vicinity of the sites. However, this information is included in the WM PEIS Affected Environment Technical Report.

Comment (4506)
Exposure from airborne radionuclides reported in the 1992 Portsmouth Site Environmental Report (0.03) is an order of magnitude less than that in the Draft WM PEIS (0.26 mrem). The correct values for exposure should be verified and included in the WM PEIS.

Response
Sections 4.4.12 and 11.12 in Volume I present airborne maximally exposed individual dose estimates obtained from the DOE report, *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992*, rather than the Portsmouth Site Environmental Report. DOE used this report rather than Site Environmental Reports to provide consistent information among the sites. The report includes the same information for the same year for all major sites considered in the PEIS. Site Environmental Reports differ considerably in the information they include and the year on which they are based. However, radionuclide information from site reports is included in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (4512)
According to the 1992 Site Environmental Report for LBL, the exposure at a residence was 2.1 mrem from an accelerator. The 1992 Site Environmental Report also showed that a cobalt irradiator is estimated to cause a potential exposure of 17 mrem at the fencepost. The collective dose was reported to be less than 5 rem per year, including both the accelerator and conventional airborne radionuclide releases. Why was this information not included in the Draft WM PEIS?

Response
DOE summarized site doses only for the 17 major sites in Volume I, Chapter 4, of the Final WM PEIS and used the doses to estimate cumulative impacts at the 17 major sites in Volume I, Chapter 11. LBL is not one of the 17 sites, therefore, LBL data are not provided in Volume I of the PEIS. However, this information for LBL is included in the WM PEIS Affected Environmental Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (4513)
The gamma ray exposure reported in Section 4.5 of the Draft WM PEIS of 0.3 mrem to the nearest resident from pitchblende-contaminated soil should be mentioned for Middlesex Sampling Plant, along with the fact that the radon impact from the pitchblende has not been quantified.

Response
DOE summarized site doses only for the 17 major sites in Volume I, Chapter 4, of the Final WM PEIS and used the doses to estimate cumulative impacts at the 17 major sites in Volume I, Chapter 11. Middlesex is not one of the 17 sites, therefore, data on Middlesex were not provided in Volume I of the PEIS.

4.3 Existing or Planned Facilities and Activities

Comment (28)
Plan to use staff at LLNL to develop management and cleanup methods and plans.

Response
The mission of LLNL currently includes waste management and environmental restoration activities appropriate to the wastes and issues at the site. The WM PEIS analysis is based on information provided by the site, and is being closely coordinated with the site, including reviews by LLNL personnel before the Draft WM PEIS was released and before the Final WM PEIS was released. As the national decisions on waste management are made, they will be implemented at the individual sites based on additional environmental impact reviews. Implementation will include studies to identify the location, design and operating parameters of any necessary waste management facilities. DOE has programs in place to help retrain employees that had previously focused on the production of nuclear weapons to support the waste management mission.

Comment (40)
INEL is not considered as a Regionalized Alternative site for high-level waste storage because it has no existing or approved storage facilities. Aren't naval and commercial fuel rods high-level waste?

Response
No, they are spent nuclear fuel. The definition of spent nuclear fuel is nuclear reactor fuel elements (e.g., Naval and commercial fuel rods) and targets that have been irradiated in a nuclear reactor. A target is material that is placed in a nuclear reactor to be bombarded with neutrons to produce new, man-made materials, such as plutonium and tritium.

High-level waste is the highly reactive waste material that results from the chemical processing of spent nuclear fuel and irradiated targets, and includes liquid waste produced directly from reprocessing and any solid material derived from the liquid that contains fission products in concentrations sufficient to require permanent isolation. High-level waste might also contain toxic metals, organic materials, and corrosive characteristics that are considered hazardous under the Resource Conservation and Recovery Act. Therefore, high-level waste is sometimes considered mixed waste.

Although INEL has facilities for wet storage of spent nuclear fuel, it has no facilities capable of or approved for storing the immobilized high-level waste glass logs. The current and final physical form (calcine and glass-ceramic, respectively) of INEL's high-level waste is also different from the other three high-level waste storage sites (liquid high-level waste and vitrified borosilicate glass). Therefore, DOE does not consider INEL a reasonable regional site for high-level waste management.

Volume I, Section 9.3.6, describes the rationale for selecting high-level waste storage sites. The SNF/INEL EIS addresses programmatic decisions for the management of spent-nuclear fuel.

Comment (1177)
ANL-E currently stores its low-level nuclear waste until it can be transferred to long-term storage locations. Even this short-term storage concerns area residents.

Response
ANL-E currently stores low-level nuclear waste safely onsite. One of the reasons DOE prepared the WM PEIS was its concern about storage of waste in the DOE complex. Although storage is generally

a safe activity, DOE recognizes the need to work toward final disposition of its wastes. The PEIS impact assessment examined potential Waste Management Program effects on humans and the environment from the treatment, storage, and disposal of low-level waste at ANL-E. DOE found that risks to public health and the environment from low-level waste treatment, storage, and disposal would be low at ANL-E under all WM PEIS alternatives.

Comment (1560)
Impacts to cultural resources are site specific and DOE needs to understand that the presence of the existing facilities already impacts cultural resources.

Response
DOE agrees that a credible analysis of impacts to cultural resources cannot be conducted in the WM PEIS because the impacts would depend on the choice of specific locations for new waste management facilities on each site, which are not part of the PEIS decisionmaking and has revised the PEIS accordingly. Detailed examinations of site-specific cultural resources impacts that would include any effects from existing facilities would be conducted as part of sitewide or project-level NEPA reviews for sites selected for new waste management facilities.

Comment (1731)
Safety, the environment, and cleanup are very important considerations. The proper people are working at RFETS that care about these things.

Response
Thank you for your comment.

Comment (2029)
Any release of toxic or radioactive materials into the environment at LLNL is absolutely unacceptable.

Response
DOE strives to minimize or prevent releases of toxic or radioactive materials to the environment at all of its sites. DOE is strongly committed to pollution prevention. See Volume IV, Appendix G, of the WM PEIS for a description of DOE's Pollution Prevention Program, which applies to all activities at all DOE sites. Any release of toxic or radioactive materials into the environment would be in strict compliance with applicable regulatory requirements, for example, National Pollutant Discharge Elimination System (NPDES) permit limits for facility surface water effluents, and would pose low risk to the environment.

Comment (2129)
DOE should explain how often BNL low-level mixed waste is shipped offsite and whether storing it has been detrimental.

Response
BNL has the capacity to store 14 cubic meters of low-level mixed waste. At present, it stores approximately 9 cubic meters. BNL generally ships low-level mixed waste twice each year.

BNL currently manages its low-level mixed waste in a manner that prevents detrimental effects to the environment. BNL was founded in 1947 as a nondefense research laboratory. During these early

4.3 Existing or Planned Facilities and Activities

decades, environmental laws were much less stringent than they are today. Although BNL managed its wastes in accordance with these laws, some releases of contaminants to the environment did occur. The WM PEIS Affected Environment Technical Report, available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS, lists the contamination situations currently existing at BNL.

Comment (2201)
The PEIS used an assumption that there is no risk from waste in storage and ignored the issue of hydrogen in the high-level waste tanks.

Response
The WM PEIS analyzes the impacts of storage accidents in Appendix F in Volume IV. A review of recent DOE NEPA and safety documentation is provided in the sections on storage accidents for low-level waste, low-level mixed waste, and transuranic waste. The storage of vitrified high-level waste is discussed in Section F.3. Storage facility accidents for hazardous waste, which would vary by alternative, are discussed in Section D.3.3.5.2 in Volume III.

The WM PEIS is a national and programmatic study to assist DOE in formulating and implementing a strategy to manage its radioactive and hazardous wastes. The PEIS addresses only the storage of treated high-level waste prior to its ultimate disposal in a geologic repository. The issue of hydrogen storage in high-level waste tanks is addressed in sitewide or project-level NEPA documents and safety assessments, including the Hanford Tank Waste Remediation EIS.

Comment (2435)
INEL mixed waste container storage capacity is listed as 226,240 cubic meters in WM PEIS Volume I, Table 6.1-2. This capacity will be used to store transuranic waste currently on earth-covered pads at the Radioactive Waste Management Complex. This space will not be available until that waste is treated and shipped to WIPP. According to the recent settlement agreement between DOE and the State of Idaho, that activity will not be completed until 2018, 3 years beyond the scope of the WM PEIS.

Response
As explained in Section 6.1.3 in Volume I of the WM PEIS, DOE used existing storage capacity for all categories of waste as a starting point for analyzing facility requirements. The WM PEIS analysis compares this capacity with existing waste inventories and requirements for storing newly generated waste or waste that is transported from elsewhere. The analysis then estimates needed additional capacity, after which it estimates costs and impacts for the required new construction. If the need for additional capacity was projected, the use of new facilities was assumed.

Comment (2539)
Section 7.4.1.5 states that the plumes from the various disposal units are assumed to not intermingle? Why? At INEL's low-level waste disposal site, active disposal units cannot be distinguished from inactive units by the environmental monitoring system currently in place.

Response
Sections 5.4.1.2.2, 6.4.1.8, and 7.4.1.7 in Volume I of the WM PEIS have been revised to clarify this assumption. The hypothetical farm family risks represent individual receptors assumed to be exposed

through location of a drinking water well 300 meters (984 feet) from the center of a single disposal unit. Concentrations of groundwater contaminants at this location are assumed to be higher than those that could be expected at greater distances from the unit due to dispersion of contaminants. Construction of multiple units is expected to be required at certain sites under the various low-level mixed waste and low-level waste alternatives to dispose of the projected waste volumes. Although, the farm family scenario evaluates only a single receptor 300 meters from an individual unit, DOE assumes that each of these close-in receptors will be affected primarily by the contaminant plume from the facility closest to him/her. However, DOE recognizes that commingling of contaminant plumes from multiple disposal units could occur as distance from the units increases, but anticipates that at 300 meters the highest concentration of contaminants is likely to result from the single closest plume. At greater distances from the disposal units, where overlap of the plumes is more likely, the concentrations in any given plume should be lower as a result of dispersion and dilution than those estimated at the 300 meter well.

Comment (2541)
Why are there only five disposal units under low-level waste Regionalized Alternative 5 for INEL? This is the alternative that brings the most waste to INEL for disposal.

Response
Regionalized Alternative 5 for low-level waste involves treatment to reduce waste volumes, as described in Section 7.2.2 and illustrated in Figure 7.2-1 of the WM PEIS. Therefore, although this alternative involves shipment of the most offsite waste to INEL for treatment and disposal, waste-reduction treatment produces a smaller volume of low-level waste for disposal at INEL than do the alternatives that only involve minimum treatment of low-level waste. DOE calculated the number of disposal units that would be required at a site by dividing the volume of waste to be disposed of by the capacity of the disposal unit.

Comment (2889)
Land use at INEL will have to be in accordance with the INEL Land Use Plan.

Response
The WM PEIS used the INEL Land Use Plan to ascertain how much land was available for waste management activities. However, the WM PEIS did not attempt to address any of the other land-use issues.

Comment (2893)
Volume I, Table 4-10. The number of shipments of "other hazardous material" seems unbelievably small (much smaller than the number of radioactive material shipments). What is included in this category and, perhaps more important, what is left out?

Response
The term "other hazardous" refers to all hazardous material except radioactive materials and radioactive waste. The reason the number is small is that DOE sites ship very little other hazardous material from site to site. The Shipment Mobility/Accountability Collection data base, which was used in the WM PEIS analysis, only includes site-to-site shipment. Most, if not all DOE sites, ship their non-radioactive hazardous waste (referred to in the WM PEIS as "other hazardous") to offsite commercial disposal sites. These shipments are not reflected in the WM PEIS.

4.3 Existing or Planned Facilities and Activities

Comment (2896)
Volume I, Table 4-11. The table shows that the number of rail shipments coming in and going out was 0 for INEL, and for another 18 sites in FY 1993. But the data used in the table "represent most, but not all, of the DOE transportation activities related to the shipment of radioactive material." Are there additional unlisted shipments?

Response
The data reported in Table 4-11 of the Draft WM PEIS in the Draft WM PEIS were the data that were in the Shipment Mobility/Accountability Collection database for 1993. These data were the best data available at the time the Draft WM PEIS was prepared, although some sites did not report all shipments. In addition, the database only includes site-to-site shipments. Shipments to and from commercial facilities are not included. The truck and rail shipment data in Section 4.3.10 in Volume I were included to give some perspective regarding recent shipments of radioactive and hazardous wastes. These data were not used in the impacts analyses. Table 4-11 is now Table 4.3-7 in the Final WM PEIS.

Comment (3158)
The State of Washington and the U.S. EPA should not allow DOE or the U.S. Department of Defense to transfer to the Hanford Site any hazardous or radioactive waste unless the following criteria are met:

- Acceptance of offsite waste is contingent on existing facility capacity and on availability of funding to handle processing and storage needs, while having a neutral or positive impact on Hanford cleanup.

- A general condition of permit and plan approval and subsequent offsite waste acceptance in Washington State should be on-going substantive compliance with the Washington Dangerous Waste Law and the terms, conditions, and schedules of permits, consent orders and cleanup agreements (e.g., the Tri-Party Agreement) between DOE and the State.

- In all instances where DOE proposes to treat offsite wastes at Hanford, a written reciprocal agreement should be required between the State of Washington, the State of origin of the offsite waste and DOE.

- No pretreatment storage should be allowed at the receiving site unless it has been approved in the written reciprocal agreement between the shipping and receiving States.

- Plans and schedules to treat offsite wastes should be approved only in instances where there is a binding legal obligation on the part of DOE for primary and secondary offsite storage facilities designed to receive post-treatment residual before wastes are allowed to be shipped to Hanford. Plans and schedules should specify that, generally, no residuals will be stored or disposed of at Hanford. In the event of substantial noncompliance with Washington Dangerous Waste Law requirements, or failure to have offsite facilities available for return of post-treatment residuals, offsite waste will not be accepted at Hanford. Lacking specific agreement between the State, DOE, and the State of origin, waste residuals should be returned to the site of origin or other compliant facilities to be specified in plans and schedules.

- When reviewing requests from other sites/States to accept wastes for treatment at Hanford, the sending site's treatment plan should be scrutinized to determine whether there has been thorough consideration of onsite treatment and pre-shipment storage. Offsite wastes should not be accepted for treatment where such analysis is lacking or not compelling, unless it is otherwise approved in the reciprocal agreement between the sending and receiving States.

- Receipt of any offsite wastes for treatment should require submission by the shipping State of a schedule for shipment, treatment, and post-treatment residuals management, and prior written approval by the State of Washington.

- Hanford offsite waste acceptance criteria must include provisions for inspection and payment of appropriate permit fees to cover all State costs, including inspection of pre-treatment shipping procedures. Existing waste facilities at Hanford must be in substantial compliance with the Tri-Party Agreement milestone, other orders or agreements, and RCRA or State law requirements in order for permits to be issued or amended to allow offsite wastes to be treated, stored, or disposed of at Hanford.

Response
DOE acknowledges the principles advocated in this comment and will consider them in its decisionmaking process. These principles are the subject of continuing discussions between DOE and stakeholders and regulatory authorities, as well as within the broader National Dialogue initiative described in Section 1.8.2 in Volume I of the WM PEIS.

Comment (3533)
The affected environment description of NTS does not mention the five offsite plutonium dispersal sites and 10 underground nuclear explosion sites (e.g., the Faultless Site at the Central Nevada Test Area), all of which require extensive remediation work that would result in large quantities of hazardous waste.

The affected environment description of NTS does not mention other sites associated with the Nevada Operations Office, which include the Amador Valley Operations, Pleasanton, California; Kirtland Operations that include the Craddock Facility and facilities at Kirtland Air Force Base, Albuquerque, New Mexico; Las Vegas Area Operations that include the Remote Sensing Laboratory at Nellis Air Force Base and North Las Vegas Complex in North Las Vegas, Nevada; Los Alamos Operations, Los Alamos, New Mexico; Santa Barbara Operations that include the Robin Hill Road and Francis Botello Road Facilities, Goleta, California; Special Technologies Laboratory, Santa Barbara, California; Washington Aerial Measurement Department, Andrews Air Force Base, Maryland; and Woburn Cathode Ray Tube Operations, Woburn, Massachusetts.

Response
The summary description of the NTS affected environment in Volume I, Chapter 4, of the WM PEIS does not provide detail about contamination situations at NTS requiring remediation because environmental restoration has been removed from the scope of the PEIS. Sections 4.3.3 and 4.3.4 in Chapter 4 summarize contamination situations at the major DOE sites including NTS. The WM PEIS Affected Environment Technical Report section on NTS provides more detailed descriptions of contamination situations at NTS. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

4.3 Existing or Planned Facilities and Activities

The summary description of NTS's affected environment does not describe other sites associated with NTS because the PEIS focuses on the environmental characteristics of NTS, where waste management activities are proposed to occur under a number of alternatives. It is this physical location and the immediate vicinity that would experience impacts from waste management activities such as construction of treatment facilities or disposal of low-level waste. No such activities are proposed at the other sites mentioned.

Comment (3535)
The affected environment description of SNL-NM does not mention facilities such as the Tonopah Test Range, which is contaminated with dispersed plutonium, and the Kauai Test Facility.

Response
Section 1.6 in Volume I states that there are 54 sites for which DOE has some waste management responsibility and that are within the scope of the WM PEIS. There are additional sites for which DOE has some waste management responsibility. However, these sites generate little waste and are often affiliated or collocated with one of the 54 sites (with waste being co-managed). Regardless, waste from these sites is not expected to prejudice the analysis or programmatic decisions. Of the 54 sites, 17 have been designated "major" sites in this PEIS. See Volume I, Section 4.2.1, for a full explanation of how DOE determined the sites to be analyzed in the WM PEIS. For purposes of the WM PEIS analysis, SNL-NM is considered to be a major DOE site. The Tonopah Test Range and Kauai Test Facility are managed by SNL-NM, but are not considered to be major sites, and are not located close enough to SNL-NM to be considered part of the SNL-NM environment.

Comment (3603)
The dual purpose of waste management and environmental restoration is not addressed in Table 8.1-2; assumptions are made as to the capacity and viability of the facilities to serve the dual purpose. For INEL, what does it mean for the Stored Waste Examination Pilot Plant capabilities to include drum venting? For LANL, why is the controlled air incinerator listed? Realistically, this incinerator will not operate. Why is the Transuranic Storage Area Retrieval Enclosure not applicable to the WM PEIS analysis?

Response
The WM PEIS does not analyze environmental restoration alternatives. DOE has revised Table 8.1-2 to reflect the existing capacity at DOE sites. More specific information regarding existing facilities can be found in the references cited in the WM PEIS. The PEIS includes consideration of environmental restoration transuranic wastes (TRUW) in Appendix B (Volume III) and Section 8.15 (Volume I). The excess capacity of the waste management facilities would be available to the environmental restoration wastes that require processing. However, the Environmental Restoration Program is independently establishing cleanup plans, and might not use any waste management facilities.

"Drum venting" refers to the release of particulates during drum characterization. A number of TRUW drums have corroded during storage, with the potential for releases to occur during characterization activities.

The Stored Examination Pilot Plant (SWEPP) is designed to certify stored TRUW in preparation for its final disposition. Activities at the SWEPP include examination, characterization, sorting, reclassifying, and repackaging (as necessary) retrieved stored TRUW. The SWEPP is currently on operational

standby, and was not considered in the WM PEIS analysis. The treatment capacity at the INEL considered in the WM PEIS, however, includes the 200 cubic meters per year capacity of the Waste Characterization Facility, which would sort, reclassify, and repackage (as necessary) retrieved stored TRUW.

The Transuranic Storage Area Retrieval Enclosure provides capabilities to retrieve and restore wastes in new permitted storage buildings designed to meet requirements of RCRA, TSCA, and the Idaho Hazardous Waste Management Act. Its storage capacity of approximately 20,000 cubic meters of TRUW has been included in the WM PEIS analysis.

Further information on the above INEL facilities is provided in Appendix C in Volume 2, Part B, of the "Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement" (DOE/EIS-0203-F, April 1995).

The Controlled Air Incinerator at LANL is currently shut down and is being dismantled. Its thermal treatment capacity is not considered in the WM PEIS analysis.

DOE has added a footnote to Table 8.1-2 to indicate that the thermal treatment unit at LANL is currently unfunded and in shutdown mode.

4.3 Existing or Planned Facilities and Activities

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5. Environmental Impacts

Comment (499)
The WM PEIS needs to clarify the relationship between the 10-year exposure time frame and the 20-year implementation time frame for the alternatives.

Response
Potential risks of public exposure to radioactivity from waste treatment and storage activities were assumed to occur during the 10-year period of facility operations, which follows the 10-year facility construction period. Therefore, exposure was calculated for 10 years of operations with project implementation occurring over a 20-year period. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. The WM PEIS Summary document (Section 3.2.1) was clarified to reflect this relationship between time frames. Section 5.2.3 in Volume I describes the time frame of analysis assumptions in more detail.

Comment (3785)
DOE needs to consider criteria impact assessment such as socioeconomics, risk management, and environmental justice.

Response
The WM PEIS analyzes the impact parameters referenced by the commentor for all five waste types (Chapters 6, 7, 8, 9 and 10 in Volume I). Human health risk assessment plays a major role in this analysis.

5.1 Impact Analysis Assumptions, Methodologies, Uncertainties

Comment (543)
In the Final WM PEIS, discuss and detail the assumptions that could affect the outcomes of the evaluation.

Response
The WM PEIS describes in detail the assumptions used in the models in discussions that can be found in the appendices and in the supporting technical reports cited in Volume I or the appendices. The major assumptions are summarized in Chapter 5 in Volume I of the WM PEIS, which address the WM PEIS impact analysis methodologies.

Comment (724)
The WM PEIS must include the amount of radioactive leakage to the air, water, and land based on leakage rates from other facilities such as Hanford.

Response
Treatment, storage, and disposal are analyzed in the WM PEIS by routing the waste through a series of facilities that execute each of the major operations needed to fully treat and dispose of the waste. There are over 30 different facilities that are employed, considering the five waste types. Each facility operates to design specifications that allows computation of resources consumed, risks that are incurred during operation, and the resulting residuals that leave the facility enroute to the next facility and phase of waste management. For each facility, the input waste is fractioned into residuals (air release, waster release, and/or by-product solids) and product--the output waste stream. The analysis of impacts then takes into account the sum of all the releases from each facility.

The design specifications and assumed fractions for releases use historic emissions data for known and available technologies; fugitive emissions are based upon established EPA methods for similar processes. Thus, "leakage" to the air, water, and land--termed "releases" in this discussion--is based on release rates from other facilities and processes, as advocated in the comment. A complete discussion of the assumed release rates can be found in the technical reports listed in Section 15.2 in Volume I. These technical reports are available in the DOE reading rooms, listed in Section 1.9 in Volume I.

Comment (1159)
A commentor questioned the DOE characterization of potential releases of toxic substances into streams, soil, air and groundwater, and the size of the potentially affected population around the Paducah Gaseous Diffusion Plant (PGDP).

Response
DOE used generic treatment and disposal technologies and a number of conservative assumptions to develop its programmatic evaluations of the relative impacts of different waste management alternatives. The results of these impact analyses are screening-level estimates; more precise estimates of potential impacts would need to be developed.

For example, the WM PEIS analysis indicates that DOE should carefully control the disposal of low-level waste at PGDP to prevent potential groundwater contamination (Section 7.6.2, Volume I). DOE Order 5820.2A requires DOE to conduct a detailed performance assessment before it can develop a low-level waste facility. This assessment would require more detailed site-specific information to

identify the precise location and design of any proposed facility. The facility design, in turn, would require a number of mitigating factors to help limit potential groundwater contamination.

DOE used data from the 1990 U.S. Census to estimate that about 500,000 people live within 50 miles from the center of PGDP. The risk analyses in the PEIS suggest that adverse health effects, if any, from the operation of waste treatment facilities at PGDP would be small (Section 4.4.10, Volume 1).

Comment (2056)
In general, the choice of cut-points for detailed analysis of effects seems arbitrary. These range between 1% of a standard to 10% or 25%, depending on the impact being measured. A more comprehensive explanation would add clarity, since this apparent arbitrariness could be construed as making choices based on what the subsequent analysis shows, an inappropriate procedure.

Response
DOE has revised Section 5.4 in Volume I of the WM PEIS to more clearly explain the method DOE used to select these percentages. In summary, DOE used a three-step process to evaluate environmental impacts. First, DOE estimated environmental impacts at major DOE sites for each alternative and each waste type. The Site Data Tables in Volume II of the PEIS list the results of this comprehensive analysis without any screening for significance. Second, a screening level was selected for each impact area in order to focus the analysis on impacts with a greater potential to be significant. For example, air quality impacts used a screening level of 10% of standards. The screening levels are described by resource area in Section 5.4 in Volume I of the WM PEIS. Third, a summary listing and description of the impacts that exceed the screening level was prepared for each waste-type chapter (Chapters 6 through 10). Impacts that exceed 100% of the comparison criteria are described in more detail.

In assessing impacts on resources for which regulatory standards exist, specifically air quality, DOE evaluated the significance of estimated waste management facility pollutant emissions or ambient air concentrations by comparing these estimates to relevant Federal and State regulatory limits. For impacts on the environmental and socioeconomic resources that have no such comparable regulatory standards, DOE based its evaluations on significance criteria defined in CEQ regulations at 40 CFR 1508.26 and on the experience and judgment of the WM PEIS interdisciplinary team members in their fields of expertise.

The air quality impacts presentation first focused on sites and alternatives where air quality standards could be exceeded (that is, where air quality impacts could be significant). Thus, all cases where emissions or ambient air concentrations would be 100% of a standard or greater are included in the waste-type chapters. In addition, to allow for the cumulative air impacts analysis that includes emissions from other sources, and to show instances where concentrations might be approaching the comparison criteria, DOE chose a 10%-of-standard threshold. This threshold is used to highlight the sites where criteria air pollutant emissions from proposed waste management activities would not exceed standards, but where they could substantially contribute to overall criteria pollutant concentrations from all sources in the area, which could result in adverse cumulative air quality impacts.

For the water quality impacts analyses for low-level mixed waste and low-level waste, estimates of pollutant concentrations in downgradient well water caused by disposal facility leachate were compared

5.1 Impact Analysis Assumptions, Methodologies, Uncertainties

to relevant water quality comparison criteria, as described in Section 5.4.3.2 in Volume I. As was the case for air quality, all sites/alternatives where the comparison criteria would be met or exceeded are included in the waste type chapters because they represented a potential for significant impacts to persons consuming the groundwater. In addition, to account for some level of uncertainty in the modeling results for the disposal analysis, and to show instances where concentrations might be approaching the comparison criteria, water pollutant concentrations that would meet or exceed 25% of the comparison criteria are also included in the waste type chapters for discussion, even though they would be less likely to indicate instances where impacts would be significant.

For economic and population impacts, DOE used a 1% significance screening level because regional economic or population changes of 1% or more in the communities around DOE sites are likely to be considered by those communities as substantial; that is, economic benefits are likely to be important and population growth could substantially affect social and medical services, housing, and educational systems. This is particularly true if the economic or population changes occur only in one or a few specific localities within an affected region rather than uniformly across the region.

For ecological resources and land-use impacts, DOE used a screening level of 1%, principally to screen out sites under an alternative where DOE can reasonably conclude there would be no significant impacts. DOE based this percentage on the fact that it has not yet proposed facility locations and detailed impact evaluation would require location-specific information, and that, at sites where less than 1% of the available land would be required for waste management facility construction, DOE would have sufficient flexibility to locate the facility in a manner that would avoid significant impacts to critical habitats and site land use.

The analysis of infrastructure impacts was somewhat more complex. For the impacts analysis of the onsite water, power, and wastewater treatment infrastructure, DOE brought requirements that would exceed 5% of current capacities forward from Volume II to Chapters 6 through 10. DOE believes that, in general, infrastructure requirements below 5% could be accommodated by existing infrastructure because estimates of capacity would have some built-in margin for substantial peak loads. Capacities for onsite transportation infrastructure impacts were not known, so DOE keyed significance to estimated increases in site employment as an index of the potential increased stress to existing site transportation infrastructure. DOE brought potential site employment increases of 5% or more forward for discussions of instances in which transportation infrastructure impacts could be significant. Similarly, offsite infrastructure impacts were keyed to regional population growth, with potential growth greater than 5% considered to have the potential to cause substantial stress to the regional transportation infrastructure.

Comment (2197)
DOE should not use statements that conclude no impact without the benefit of up-to-date scientific knowledge.

Response
Best available data at the time of the analysis and accepted scientific methods were used to conduct the impact analyses. Chapter 5 in Volume I of the WM PEIS provides a summary of the underlying methodology. The WM PEIS has been peer reviewed and subjected to a 150-day public comment period. DOE incorporated appropriate changes recommended by the public and internal agency reviews to make this study the best document possible.

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Comment (2645)
Volume III, Table D.3.3-2: It would be helpful to know the percent composition ("relative proportions") of the hazardous waste source term. Why was analytical data (relative chemical proportion) not presented for all hazardous waste source term constituents?

Response
The chemical compositions of the hazardous waste streams evaluated in the WM PEIS are in the WM PEIS Hazardous Waste Technical Report. This report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS.

Comment (2914)
DOE must develop an inventory of processing and storage technologies that includes, at least, the admissible waste streams and estimated unit processing and development costs, as applicable. The inventory should include existing capabilities (DOE and private sector) and facilities to be developed.

Response
Because the WM PEIS compares the impacts of alternatives for waste management across sites, DOE used generic treatment, storage, and disposal technologies for the analysis. In this way, DOE can compare alternatives consistently, allowing only site environmental factors to be discriminators.

The WM PEIS evaluates the impacts of using offsite commercial facilities for nonwastewater hazardous waste that is treated and disposed of offsite at commercial facilities. The impacts associated with managing hazardous waste are provided in Chapter 10 in Volume I of the WM PEIS. DOE revised the Draft WM PEIS to add a discussion of the issue of privatization using commercial facilities to manage the other waste types. See Volume I, Section 1.7.4.

Section 1.8.1 in Volume I discusses the various levels of NEPA documentation. Sitewide or project-level NEPA reviews would provide more detailed analyses of specific treatment, storage, and disposal technologies including analysis, as appropriate, of commercial facilities.

DOE has developed a number of technical studies not related to the WM PEIS NEPA process that it can use to compare the costs and effectiveness of various treatment, storage, and disposal technologies. These studies are available to the public through the Office of Environmental Management, Office of Research and Development.

Comment (2929)
The WM PEIS does not emphasize sorting by applicable technologies.

Response
The WM PEIS does include significant sorting by waste stream and technology. To conduct the PEIS evaluation, DOE (1) identified existing and projected waste volumes, as discussed in Section 5.2 in Volume I; (2) sorted volumes according to treatment groups, as discussed in Section 5.2; and (3) generically routed wastes through treatment trains, as discussed for each waste type in Sections 6.2, 7.2, 8.2, 9.2, and 10.2 in Volume I. The resulting conceptual impacts are identified in Chapters 6 through 10.

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Because the WM PEIS provides a means to compare impacts across sites, the treatment, storage, and disposal technologies were, for the most part, held constant. In this way, DOE could compare "apples to apples," allowing only site environmental factors to be discriminators.

Comment (3027)
Air quality, as well as risks, can be treated with better procedures, enhanced designs, and/or more cost. This philosophy is not mentioned in the WM PEIS. It is better to compare costs for proposed alternatives based on equal risk. When both costs and risks are being compared, results are often inconclusive and subject to interpretation.

Response
The main purpose of an EIS is the evaluation of environmental impacts from the proposed action. NEPA does not require that costs be evaluated in an EIS. Costs are based to a large degree on the technology used. Since technologies will not be selected in the Record of Decision for the WM PEIS, it is not appropriate to base the PEIS decisions on cost alone. Cost and risk, in addition to other factors, will be considered by the decisionmakers in selecting alternatives. The decision factors and criteria are listed in Section 1.7.3 in Volume I of the WM PEIS. More detailed sitewide or project-level NEPA reviews would consider alternative technologies for waste management.

Comment (3033)
In Volume I, Section 1.7.3, of the Draft WM PEIS, the discussion of relocating facilities within a site is so general that it obscures several issues. First, the paragraph seems to imply that impacts on geology and soils, noise and visual/aesthetic impacts, habitat impacts, environmental justice, offsite land use, and cultural resources can be understood without specific information about specific sites. Second, the statement appears to imply that such impacts can be mitigated merely by moving a facility around within the perimeter of a (presumably large) site. The conclusion seems simplistic for several reasons. First, such factors as visual openness, distribution of populations on the perimeter of a site, and groundwater formations are likely to confound the simplistic linear notion stated here. Second, the assumption ignores existing commitments for future uses. For example, the Hanford Future Site Uses Working Group's scenarios would restrict all but the Central Plateau from new waste disposal facilities. Finally, it is not clear that this statement is consistent with the environmental impact criterion given in Section 1.8 of the Draft PEIS. The statement in Section 1.7.3 appears to say that these impacts can be mitigated, so they will not be used as a basis for decisions.

Response
Because some impacts are location-specific, they cannot be analyzed until a specific location is chosen. On the commentor's second point, DOE maintains that because the sites that would support major waste management facilities have extensive areas for such construction, selecting an appropriate location or locations within that area would serve to mitigate impacts. This is true for example, when the location selected for a waste management facility is on or near a cultural resource. Relocating the facility only a short distance could avoid or minimize its potential impact. This is not true for all such impacts at all sites, but in general, effects on adjacent land uses, auditory and aesthetic impacts, impacts to habitat, and environmental justice effects are substantially location-specific and could be dealt with by project location. The PEIS does not address impacts on soils or geology, noise or visual impacts, or effects on cultural resources because such analyses would require knowing the locations of the various waste management facilities. Again, DOE agrees that these impacts cannot be effectively analyzed using "simplistic linear notions." They can only be analyzed credibly at the site level when

locations are proposed. They PEIS does address habitat, land use, and environmental justice impacts to the extent possible without location-specific information. For all these impact parameters, detailed analyses at the site or project level would be conducted, if warranted, during sitewide or project-level NEPA reviews.

The PEIS land-use analysis does make use of information on areas, such as the Central Plateau at Hanford, that have been designated as waste management areas; however, the PEIS does not address any future uses issues at the sites so as not to preempt the sites' own planning activities with stakeholders.

On the commentor's final point, DOE maintains that the impacts can be mitigated. However, DOE recognizes that the type and severity of impact will dictate the effort and expense involved in mitigation. Thus, impacts will serve as an indicator of program costs for mitigation and, therefore, as a basis for decisionmaking.

Comment (3060)
Section 5.1.2 illustrates DOE's heavy reliance on assumptions, generic cases, and conceptual models, which leaves the reader wondering whether anything in this PEIS is real.

Response
For the WM PEIS, DOE evaluated the potential impact of 36 alternatives across five waste types at 17 "major" sites for air quality, water resources, ecological resources, human health risks, land use, infrastructure, economic, social, and environmental justice effects. Potential impacts to human health stemming from the requirement for transportation of wastes across a nationwide truck and rail network were also considered.

Any analysis covering such a broad scope as the WM PEIS must, of necessity, be very general in nature. To ensure a consistent analysis across alternatives and to present the analytical approach and corresponding results to the concerned public and decisionmakers in a succinct and direct manner, certain simplifying assumptions were required. As with any such general predictive analysis, certain assumptions had to be made regarding timing, context, duration, and level of waste management activity under consideration for each alternative. These assumptions and their limitations are noted as part of the methodology discussion for each impact parameter. Information about the generic design phase is provided in Section 5.2 in Volume I. Section 5.3 in Volume I describes the methodology and assumptions used to determine discharges, resources required or consumed, and costs. Section 5.4 in Volume I describes the methodologies and assumptions used for evaluating the environmental impacts.

The WM PEIS details the assumptions used in the analysis in discussions that can be found in the individual appendices and in the supporting technical reports that are cited in Volume I. Data for the analysis are derived from multiple sources, such as site development plans and environmental reports, DOE and national laboratory technical reports, and national databases such as that from the Bureau of the Census. Whenever possible, existing data were used in conducting the analysis; however, when addressing so many sites and corresponding regions of influence, some limitations on data availability and uniformity can be anticipated.

The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies, will be considered in making

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decisions. As part of implementing nationwide waste management strategy, additional studies will be necessary to analyze the impacts of the precise location, capacity, and design of facilities at the individual DOE sites.

Comment (3102)
Referring to Figure C.1-1, a commentor asked why facility discharges (outputs) were not analyzed against environmental justice, land use, and cultural resources.

Response
DOE did consider airborne facility discharges in the environmental justice analysis and found that only in a few cases (certain sites for specific waste type alternatives) would there be a potential for disproportionately high and adverse impacts to minority and low-income communities. There is an environmental justice discussion in each waste-type chapter describing the results of each waste-type analysis, Sections 6.10, 7.10, 8.10, 9.10, and 10.10. The land-use analysis did not consider facility discharges directly, but did evaluate the degree of flexibility DOE would have in locating waste management facilities to avoid such impacts. Discussions of land-use impacts are contained in each waste-type chapter in Sections 6.11, 7.11, 8.11, 9.11, and 10.11 in Volume I of the WM PEIS. DOE did not analyze cultural resources impacts in the PEIS, because the specific locations of proposed waste treatment, storage, or disposal facilities at any of the DOE sites are not yet selected.

Comment (3108)
At the Hanford Site, existing wastewater treatment facilities do not have the capacity to treat sanitary waste. Due to the large plumes of contaminated groundwater, the treatment of choice is evaporation lagoons, which are large (tens to hundreds of acres) and lead to the destruction of much habitat. These are impacts which should be considered.

Response
Sanitary wastewater treatment capability was not included in the waste management facilities that could be constructed at each site. Therefore, it was assumed that sanitary wastes would be discharged to existing treatment facilities. Impacts to sanitary wastewater treatment plants at the sites are evaluated in Sections 6.12, 7.12, 8.12, and 9.12 in Volume I of the WM PEIS. These sections note that Hanford has little excess wastewater treatment capacity. The secondary impacts of constructing additional sanitary wastewater treatment capacity are more appropriately evaluated in sitewide or project-level NEPA reviews.

Comment (3369)
Volume III, Section D.2.7.2. Where did DOE get the 10% of immediately dangerous to life and health (IDLH) values used in the absence of a threshold limit value?

Response
In the absence of threshold limit values, professional judgment was used to select surrogate values. The rationale for the recommended use of 10% of the IDLH values as a surrogate for threshold limit values was as follows. Threshold limit values (TLVs) address worker exposure to relatively low concentrations of hazardous chemicals under routine operation conditions over an 8-hour per day, 40 hour per week time period. In the absence of TLVs, the National Institutes of Occupational Safety and Health Recommended Exposure Limits (RELs) or Permissible Exposure Limits (PELs) were used. If more of these values were available for a hazardous chemical, DOE used 10% of the IDLH value.

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IDLH values address short-term (30-minute) exposures to relatively high concentrations of hazardous chemicals during workplace accidents. Based on professional judgment, 10% of IDLH values was considered to provide concentrations that would be similar to threshold limit value concentrations, given the differences in the exposure times.

Note that both threshold limit values and IDLH values pertain to worker exposure. The worker population is generally acknowledged to consist of healthy, relatively young people. Emergency Response Planning Guideline values also address accident conditions. They pertain to the general public, which includes children, senior citizens, pregnant women, and ill people. Therefore, modification of IDLH values was thought to be more appropriate than modification of Emergency Response Planning Guideline values.

Comment (3406)
There is an error in Volume I, Table 5.1-1. ISC2 was developed by EPA and/or EPA contractors, not by Oak Ridge National Laboratory.

Response
DOE corrected the table.

Comment (3618)
Under the transuranic waste No Action Alternative in Section 8.3.1, has any aspect of packaging or repackaging been assessed as to the health risks, environmental impacts, costs, etc.? If not, why? If so, what document(s) gives this analysis?

Response
Section 8.3.1 in Volume I of the WM PEIS describes the impacts that are included under the No Action Alternative analysis and those that are not (impacts associated with newly generated transuranic waste are included and impacts associated with handling retrievable transuranic waste are not). Because there is no disposal of transuranic waste under the No Action Alternative, there is no need to retrieve the waste. Under the No Action Alternative, it is assumed that stored transuranic waste would continue to be stored indefinitely and DOE would continue to characterize and package newly generated transuranic waste to meet the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria.

The results of the analysis for the transuranic waste alternatives are given in Chapter 8 of the WM PEIS. Further information is available in the WM PEIS Transuranic Waste Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3650)
Why was it assumed that the shipments would occur uniformly over a 10-year period, assuming a 10-year period to build treatment and storage facilities, when the operation and maintenance at WIPP is 25 years?

Response
DOE manages numerous different waste streams within the five major waste types. Each waste stream requires a unique management system. Recognizing the complexity of reporting construction and shipping and operations schedules for each waste-type stream, a generalization was made for the

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WM PEIS that would facilitate the estimation of impacts across sites and waste types and allow for the calculation of combined waste management impacts from all waste types. This type of generalization is not expected to impact the programmatic decisions that will result from the WM PEIS. A 10-year operations period was selected as an optimistic, but reasonable, assumption for waste shipments and associated treatment and disposal of all waste types. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable).

The WM PEIS considers current inventory plus 20 years of waste generation. It does not conclude that no further waste will be generated or that waste management facilities will be retired subsequent to the 20-year period. Proposed operations at WIPP are analyzed in the WIPP SEIS-II.

Comment (3804)
The public is concerned that without site-specific data incorporated into the WM PEIS, DOE could make decisions with incomplete data.

Response
Site-specific data are used in the WM PEIS impact analyses ,or the cumulative impacts analyses to inform the decisionmakers and public about potentially affected resources. Representative data points include site size, amount of land designated for waste management activities, population living within 50 miles of the site, site wind conditions, county of residence of site employees, 1990 Census data on counties near the site, sensitive plants and animals that occur at the site, distribution of minority and low-income populations in census tracts within 50 miles of the site, and cultural resources listed on the National Register of Historic Places. Before implementing WM PEIS decisions, DOE will perform additional analyses, as necessary, using site-specific and waste management facility location-specific data.

Comment (3956)
Table 4-3 in Volume I assumes that socioeconomic conditions and environmental justice only apply to counties in which 90% of the site's workforce resides or where the site is located. What is the basis for the DOE assumption that the presence of a major nuclear facility does not directly impact surrounding counties and populations by exposure to risk from normal site operations, accidents, and waste transports?

Response
Table 4.2-1 has been corrected to indicate that both the socioeconomic and human health regions of influence are encompassed in the analysis of environmental justice impacts.

Comment (4425)
DOE should provide in the WM PEIS quantitative estimates of uncertainties in key numbers and evaluate alternative research and monitoring programs to reduce these uncertainties to acceptable levels for making programmatic and final decisions. Criteria for defining and/or modifying decisions should be based on uncertainty considerations including:

- The costs and potential impacts of near-term decisions versus costs and potential impacts of making decisions later, and costs and impacts if early decisions turn out to have been wrong and corrective action is or is not taken;

- The potential interference of the alternatives selected on potential future recycling and waste treatment, storage, and disposal actions;

- How the impacts would compare if one assumes plausible values at estimated 95% confidence intervals that would imply maximum impacts at a site, versus plausible 95% confidence values that would imply minimum impacts at a site (considering uncertainties in the models and assumptions versus all uncertainties), and how that would change the relative and absolute impacts of alternatives;

- Criteria for triggering new decisions, reexamination of decisions already made, creating supplemental NEPA documents, or even writing a new PEIS as new and better information and methods of impact assessment become available. Timetables for such activities should also be provided. At a minimum, routine reevaluation of the need for new PEISs should be conducted every 5 years.

Response

Because of the programmatic nature of the document and the fact that waste management facility locations have not been selected, DOE did not conduct a detailed analysis of uncertainties and their potential effects on impacts estimates for the WM PEIS. DOE also did not attempt to factor estimates of uncertainty into the analysis to establish ranges of effects. DOE did conduct a qualitative analysis of uncertainties for the human health risk assessment (see Volume III, Section D.4). More importantly however, DOE structured the PEIS analyses of human health risks and environmental impacts to ensure both that the effects would not be underestimated and that they would be estimated consistently from alternative to alternative.

DOE accomplished this goal in three areas--use of site data, impacts estimation, and risk assessment--with a variety of techniques. Consistency and accuracy of site data were ensured by:

- Relying on more recent DOE databases for important variables, such as waste volumes at sites where the more recent data affected the comparison of alternatives;

- Relying on DOE summary reports and individual site reports for environmental data and operational information;

- Ensuring that individual sites reviewed these data to double-check their accuracy.

Consistency and conservatism in environmental impacts estimates were ensured by:

- Applying the same impacts estimation method across all sites and alternatives;

- Using conservative estimators of the potential for effects to highlight impacts estimates for review by the decisionmakers and public;

- Deferring to site-level analysis those impacts assessments that could not be reliably conducted in the PEIS.

5.1 Impact Analysis Assumptions, Methodologies, Uncertainties

In particular, DOE established percentage change levels for impacts such as population, land use, and infrastructure, and included in the PEIS text all effects that met minimal criteria; e.g., at sites where 1% or more of available land area would be required for construction of waste management facilities, the site and alternative were highlighted as a potential concern for land-use impacts even though 1% is a minimal use requirement. DOE also checked site development plans for any potential conflicts with the type of proposed use.

Consistency and conservatism in the human health risk assessment were ensured by:

- Using the best available data on toxicity, accident frequencies, contaminant-specific environmental characteristics, and other important parameters;
- Using environmental-setting data on site meteorology and geohydrology developed by Pacific Northwest Laboratories specifically for risk assessment purposes;
- Using conservatively structured risk scenarios to estimate maximally exposed individual and population doses.

Section D.2.15 in Volume III summarizes the uncertainties in the PEIS health risk analysis. Risk estimate uncertainty is also qualitatively differentiated in Section 5.4.1 in Volume I.

In the notice entitled "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," the CEQ indicates that, as a rule of thumb, if the proposal has not yet been implemented or if the EIS concerns an ongoing program, an EIS that is more than 5 years old should be carefully reexamined to determine if the criteria in Section 1502.9 compels preparation of an EIS supplement (46 Fed. Reg. 18026 (1981)).

In accordance with the CEQ regulations and DOE's NEPA regulations, DOE would prepare a supplemental NEPA analysis for the WM PEIS where appropriate. DOE cannot determine at this time whether a supplemental analysis would be necessary for the WM PEIS.

Comment (4514)
The Draft WM PEIS lacks adequate information on biases in modeling, uncertainties, water pollution and other nonairborne routes of exposure, and cumulative impacts; therefore, the results of the modeling are inadequate to meet NEPA requirements or to be taken seriously for deciding the placement of waste management facilities. The WM PEIS should address how the GENII model (used to calculate radioactive unit doses for atmospheric releases) compares to CAP-88, the model used to characterize radionuclide transport and exposure for the reported impacts of airborne radionuclides in the affected environment and cumulative impacts sections of the WM PEIS, in most Site Environmental Reports, and in EPA regulations. The conservatism of these models should also be compared to that of ISC-2, ALOHA, RADTRAN4, RISKIND, MEPAS and other models used for human health impact assessment in the WM PEIS, along with the models and assumptions used to estimate impacts to workers.

It is not uncommon for air pollution models to differ in conservatism by a factor of 2 or more, since some models target most likely impacts, and others target 90% upper limits to risks.

5.1 Impact Analysis Assumptions, Methodologies, Uncertainties

Without adequate information on the relative biases in the models and assumptions used to compute impacts, associated uncertainties, and the results of this on the modeled results, it is not possible to:

- Combine the estimated human health impacts from different models to determine overall cumulative impacts in a scientifically defensible manner;
- Adequately evaluate the limitations of available information and modeling for making programmatic decisions;
- Know how seriously to take the modeled impacts when using such results for decisionmaking;
- Objectively evaluate which waste management siting decisions can be made with confidence concerning their relative impacts on human health now, which should be reevaluated when better information becomes available, and which should be deferred until adequate information on impacts becomes available;
- Evaluate the need for existing and alternative future monitoring, modeling, and impact assessment work to improve the decisionmaking process and to avoid unnecessary adverse impacts on human health and the environment.

In addition, the assessment of human health impacts of the alternatives (except for waste disposal) and of existing sites in the Draft WM PEIS focuses exclusively on the effects of airborne pollution and, in some cases (mainly CAP-88 modeling of site impacts in Chapter 4 and 11), associated deposition on soil and biota. Other pathways of exposure dominate the impacts of many DOE sites. Furthermore, most waste storage and treatment systems and associated activities result in some discharges to surface water, if only from sludge thickening, final cleaning of contaminated equipment and personnel, etc. DOE should consider the facts that aqueous emissions and associated contamination of surface water and fish are expected to dominate the impacts of the high-level waste treatment at West Valley Demonstration Project (WVDP), according to the site safety report.

The Draft WM PEIS fails to document that the waste treatment alternatives will *not* result in discharges to surface water and other pathways of exposure that would cause much higher impacts than the impacts modeled. Without such an analysis, or a commitment to true zero discharge to surface-water pathways from DOE sites (which would involve a lot of evaporators and associated air emissions not analyzed in the WM PEIS), the modeling in the WM PEIS is incomplete and the missing information could be very significant.

Response

Appendix D in Volume III, and Appendices E and F in Volume IV of the WM PEIS describe the models used in the assessment of stationary source and transportation risks, and the rationales for the selection of these models. For example, DOE used GENII to model airborne releases in the WM PEIS because it enables the assessment of both acute and chronic exposures. CAP-88 is used to model only chronic exposures.

The WM PEIS used different types of models to estimate potential risks from stationary sources, such as waste management facilities, versus those from wastes transported under the Regionalized and Centralized Alternatives. The risk analyses for waste management workers considered the effects of

5.1 Impact Analysis Assumptions, Methodologies, Uncertainties

shielding on limiting exposures to direct radiation from stationary sources. However, the transportation assessment could not use shielding as a factor in reducing exposures because of uncertainties about potential locations of the receptors (e.g., the offsite population) in relation to the shipments. As a result, the transportation radiological risk estimates are conservative, i.e., higher than would be likely to occur on the implementation of the alternatives. This difference in conservatism does not complicate the risk management decisionmaking process because transportation radiological risk estimates are routinely lower than transportation physical trauma risks. Therefore, the risk manager must balance potential risks associated with exposure to radionuclides and radiation released from waste management facilities under the various alternatives against potential transportation risks associated with physical trauma from accidents.

Given the variety of data sources, models, and assumptions used in the WM PEIS, detailed explanations of individual model code biases are not warranted. Uncertainties introduced by such biases were systematically applied across sites and waste management alternatives. Therefore, they are not likely to influence the comparison of risks among the alternatives. Additional information about uncertainties involved in the health risk and transportation assessments is presented in Appendix D (Volume III) and Appendix E (Volume IV).

DOE has added text to Section 5.4.3.3 in Volume I and Section C.4.3.4.10 in Volume III to discuss the vulnerability of the various sites, including WVDP, to surface water quality impacts. Since the WM PEIS does not propose specific locations for waste management facilities on sites, DOE believes that impacts to surface-water quality would be more appropriately analyzed in sitewide or project-level NEPA reviews.

5.2 Human Health Risk Assessment

Comment (14)
Commentors are concerned about radiation exposure to the general public and workers, with and without accidents.

Response
DOE performed detailed analyses using conservative assumptions to estimate health risks to the general public and workers that could result from potential radiation exposures from both routine waste treatment and storage facility operations and facility accidents. The results of the detailed analysis for each waste type are presented in Chapters 6 through 10 in Volume I. Cumulative impacts are presented in Chapter 11. The WM PEIS Summary document provides an overview of the risks involved for all alternatives for each waste type, and for each site.

Comment (16)
Commentors are concerned about the health and safety impacts of waste treatment, storage, and disposal activities at Lawrence Livermore National Laboratory (LLNL) because of the proximity of homes and apartments to the site.

Response
The WM PEIS evaluates health risks to the maximally exposed individual at each site, including LLNL. The maximally exposed individual is a hypothetical person who would receive the largest dose from waste management activities. In addition, the PEIS evaluates risks to persons living within a 50-mile radius from the geographic center of the site (for smaller DOE sites and from an existing waste management location at each of the larger DOE sites). Section 5.4.1.2 in Volume I contains a discussion of the populations and individuals at risk.

For each candidate site, the WM PEIS evaluates the potential for environmental impacts resulting from programmatic waste management activities (see Volume I, Chapters 6 through 10). The evaluation considers potential impacts from routine treatment and storage facility operations, facility accidents, incident-free transportation, and transportation accidents. In addition, the PEIS estimates cumulative impacts from existing site conditions, the proposed waste management actions, and other reasonably foreseeable future actions (see Volume I, Chapter 11). In general, the environmental impacts associated with waste management activities under all alternatives considered in the PEIS would be small. For impacts that would not be small, DOE would implement mitigation measures to reduce or eliminate the impacts, and, where applicable, comply within regulatory requirements. Therefore, there is no reason to believe that waste management activities at LLNL would have a significant negative impact on public health and safety in the communities around the site.

Comment (17)
Commentors believe there is a need for national baseline health data to determine health effects.

Response
The WM PEIS does not attempt to establish the baseline health risks resulting from past and current exposures at each site or from non-DOE sources. Dose reconstruction estimates have been prepared for the Hanford Site and similar efforts are ongoing at a number of other DOE sites. However, information on historic site-specific radiation doses is limited and, at this time, DOE does not have sufficient data to address existing baseline health effects from activities at all sites across the complex.

5.2 Human Health Risk Assessment

The estimated health risks in the WM PEIS from the implementation of the proposed waste management actions are generally quite small. Therefore, they would present little additional incremental risk to the existing baseline risks at the various sites.

Comment (34)
A commentor questioned the usefulness of estimating impacts to the maximally exposed individual.

Response
The maximally exposed individual is the individual member of the receptor population who is estimated to receive the highest total chemical intake and/or radiation dose from the airborne pathway over the individual's lifetime. Estimates of maximally exposed individual exposure and risk are useful because they are assumed to include the potential risk for other members of the population; i.e., the risks for most members of the population should be less than those estimated for the maximally exposed individual. Chapter 5 in Volume I and Appendix D in Volume III of the WM PEIS contain more details on the risk analysis methodology and human health risk estimates.

Comment (156)
A commentor is opposed to toxic waste impacts on health and safety in any and all communities.

Response
Minimization of potential health and safety risks and impacts will be a critical consideration for the DOE decisionmakers when selecting the alternatives for implementing waste management activities. In the WM PEIS, DOE determined potential health risks by detailed analyses, including (1) the risk to local residents from ongoing activities at the site; (2) the risk to workers from chemical, radiological, and physical hazards on the site; (3) the risk associated with transportation off the site; and (4) the risk to future individual receptors from disposal. In general, the health and safety impacts for all sites under all alternatives would be small. For impacts that would not be small, DOE would implement mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements. During further selection, design, and implementation stages of waste management projects, DOE would take steps to minimize any impacts for alternatives or sites that could have unacceptable health and safety impacts.

Comment (180)
The City of Tracy is downwind from LLNL and Site 300 for most of the year and would be impacted by escaping radioactive and hazardous waste. This raises questions about the safety of City residents. One commentor was specifically concerned about risks from nuclear weapons production at LLNL and its resulting waste.

Response
While the potential risks of weapons research activities are outside the scope of the WM PEIS, the *wastes* from LLNL activities are addressed. (It should be noted that LLNL is not a nuclear weapons production facility; it is a research facility, and in that facility, nuclear weapons design research, not production is conducted.) DOE determined potential health risks to the general public from both normal waste management facility operations and accidents by taking into account local meteorology, hydrogeology, and population distribution when assessing the potential impacts of managing low-level mixed waste, low-level waste, and transuranic waste at LLNL. Chapters 6, 7, and 8 in Volume I provide the results of the detailed analyses for each of these waste types, respectively. Chapter 11

discusses cumulative impacts. The analyses indicate that air quality and water quality impacts from waste management activities at LLNL would not exceed regulatory limits. If DOE decides to site a new waste management facility at LLNL, it would establish design and operational limitations to ensure that releases from the facility would be maintained below regulatory limits.

Comment (384)
Commentors are concerned about family safety and requested that DOE clarify whether ANL-E residents would face potentially negative health impacts as a result of the alternatives considered in the WM PEIS.

Response
The WM PEIS evaluated the potential health risks from the treatment and disposal of low-level mixed waste and low-level waste and the treatment of transuranic waste at ANL-E. The results of these analyses are presented in Sections 6.4, 7.4, and 8.4 in Volume I. The health of the offsite public at ANL-E is not expected to be adversely affected as a result of the proposed waste management actions.

Comment (481)
I am alarmed by the recent proposal to make LLNL a site for treating mixed wastes. The proposed thermal treatment seems risky and dangerous, and transportation risks seem worth a second analysis.

Response
The WM PEIS does not propose a specific waste treatment technology for LLNL or for any other DOE site. Rather, DOE analyzed treatment technologies at many candidate sites, including LLNL. Thermal treatment technologies were evaluated at each candidate site to enable a comparison of potential impacts between sites. Thermal treatment is a currently available technology that can be an effective treatment process. DOE is aggressively seeking to develop other technologies to treat its wastes. DOE will not select a treatment technology as a result of analyses conducted in this PEIS, i.e., further studies, and NEPA reviews, as appropriate, would be prepared before such a decision is made. Refer to Section 3.7 in Volume I of the WM PEIS for a discussion of DOE's preferred alternatives for low-level mixed-waste treatment.

Transportation risks due to the properties of the cargo would generally be low, and risks from vehicle accidents would result in a maximum of one potential fatality for all options considered. When a specific technology is proposed for a specific site, human health impacts will be among the factors considered.

Comment (494)
The toxicity standards data used to determine risks and hazards are under review and might be changed. If these input parameters change, the magnitude of the risk problem described in the WM PEIS results would also change.

Response
The inhalation dose conversion factors (DCFs) used in the WM PEIS for both the worker and public radiological risk estimates come from the International Commission on Radiological Protection's Report (ICRP) 30 (1979-1988). Since the completion of the PEIS, there have been revisions made to ICRP 30 concerning the tissue weighting factors, biokinetic models, and additional dosimetric data. The current publications include ICRP 68 for workers and ICRP 72 for the public. Comparisons of ICRP 30 and 68, and ICRP 30 and 72, were made to assess possible effects on the PEIS risk estimates

for workers and the public, respectively. Since the GENII computer model used to assess risk to the public incorporates 250 radionuclides, only the radionuclides which typically drive risks were compared. These included isotopes of cesium, plutonium, technetium, thorium, and uranium. Since the differences between ICRP 68 (worker) and 72 (public) were negligible, the comparisons for the worker and public using current DCFs versus ICRP 30 are nearly identical. The DCFs for most of the plutonium isotopes changed by one-half to one order of magnitude. For thorium-229 and thorium-230 the DCFs changed by slightly more than one-half an order of magnitude; thorium-232 was the only radionuclide that changed by more than one order of magnitude. For uranium, only uranium-232 changed by slightly more than one-half an order of magnitude. Therefore, use of the updated DCFs might cause some risk estimates to change by, at most, a factor of ten. Any such changes would be systematically applied across all alternatives and to all sites, so the relative differences among the waste management alternatives would not be expected to change.

Comment (562)
Why were the models selected for the risk evaluation chosen, and how do they differ from other accepted codes such as RESRAD and PRESTO-EPA? How are the MEPAS/GENII codes different from DOE/ANL's RESRAD code?

Response
WM PEIS analysts selected the models for their ability to address specific situations (e.g., atmospheric emissions, radiological dose assessment, groundwater transport, etc.). No two models were used for the same purpose. The selected models were used to estimate future concentrations of contaminants and subsequent risks.

For example, DOE updated the PRESTO-EPA code to include the toxicity values needed to evaluate the cancer and noncancer effects of exposures to hazardous chemicals. The MEPAS/GENII codes were used rather than RESRAD to enable the evaluation of chemicals in groundwater scenarios and far-field transport scenarios. Additional descriptions of the models used to estimate health risks from waste management facilities and transportation can be found in Appendices D, E, and F in Volume III and IV and the technical reports that support these appendices.

Comment (583)
A commentor is concerned about the potential for disasters during the transport and storage process, and the environmental risks to life, water, and air for future generations.

Response
DOE used conservative assumptions to estimate the potential health risks to the maximally exposed individual and to general public within a 50-mile radius either from an existing waste management facility or the geographic center of the site for both normal operations and accidents. The results of the detailed analyses for each waste type are presented in Volume I, Chapters 6 through 10. Cumulative impacts are presented in Chapter 11. The analyses show that the health risks to the maximally exposed individual and the offsite public generally would be small. For impacts that would not be small, DOE would implement mitigation measures to reduce or eliminate the impacts and, where applicable, comply with regulatory requirements.

The WM PEIS includes a detailed assessment of the risks of a complete range of credible transportation accidents for both rail and truck transportation, including low-probability/high-consequence and high-

probability/low-consequence accidents. Emergency plans and equipment are in place at DOE sites to respond to these types of accidents and other emergencies. Emergency response plans are required by State and local authorities to deal with any emergency situation. DOE, the U.S. Department of Transportation, and the Federal Emergency Management Agency assist in review and modification of these plans, if requested. In addition, DOE provides for Radiological Assistance Program Teams consisting of trained experts equipped and prepared to quickly respond to an accident and assist local emergency response personnel, if requested.

Comment (619)
Commentors are concerned about the health and safety impacts of importing wastes to LLNL.

Response
Under the Decentralized Alternative and some of the Regionalized Alternatives, LLNL is a candidate to receive wastes from other sites for treatment and disposal. In general, the WM PEIS analysis finds that human health and safety and environmental impacts under all alternatives for all sites would be small. For impacts that would not be small, DOE would implement mitigation measures to reduce or eliminate the impacts and, where applicable, to maintain compliance with regulatory requirements. There are no notable national trends for offsite population risks from treatment; however, some sites, such as LLNL, might require different technologies to minimize treatment risks. Before waste management decisions can be implemented, studies will be necessary to identify the precise location, capacity, and design of facilities at the individual DOE sites. As a part of that process, DOE will consider the results of existing relevant or required new sitewide or project-level NEPA reviews, which would consider the potential for health and safety impacts based on site-specific conditions.

Comment (727)
A commentor stated that the WM PEIS must include the increase in disease and death due to leakage.

Response
The commentor is concerned about "leakage," which DOE assumes refers to releases of hazardous materials during both routine operations and accidents at waste management facilities. Human health risks resulting from routine operations and accidents at conceptual waste management facilities are addressed in the WM PEIS. Volume I, Chapter 5, describes the approach and analytical methods used to evaluate human health impacts. Chapters 6 through 10 address the impacts of managing the five WM PEIS waste types, and Chapter 11 describes cumulative impacts. Additional details about the methodologies and assumptions used to assess health impacts can be found in Appendices D, E, and F.

Comment (881)
A commentor stated that cancer is already raging in western Kentucky (without Paducah being a waste management facility).

Response
Human health risks (e.g., cancer) constitute a site-specific impact parameter analyzed in the WM PEIS. Offsite population human health risks and offsite maximally exposed individual health risks are cumulative impact parameters addressed in the WM PEIS (See Volume I, Section 11.12). The health risk analysis suggests that adverse health effects from the operation of waste treatment facilities located at Paducah would be small. Public health impacts from disposal would similarly be small after implementation of mitigation measures necessary to ensure that DOE would not exceed radionuclide

and/or chemical-specific limits. Volume III, Appendix D, describes in more detail waste management facility human health risk estimates.

The information on existing conditions addresses *only* exposures that currently can be attributed to site activities, and not baseline health risks from non-DOE sources. The WM PEIS does not attempt to establish the baseline health risks resulting from past and current exposures at each site or from non-DOE sources. Dose reconstruction estimates have been prepared for the Hanford Site and similar efforts are ongoing at a number of other sites. However, information on historic site-specific radiation doses is limited and, at this time, DOE does not have sufficient data to address existing baseline health effects from activities at all sites across the complex.

Comment (892)
A commentor stated that the WM PEIS sections dealing with potential adverse human health effects (Chapter 5 in Volume I and Appendix D in Volume III) appear to be well developed and comprehensive, and risks to public health from transportation and storage of DOE waste materials, as expressed in the WM PEIS, are reasonable.

Response
Thank you for your comment.

Comment (1168)
A commentor stated that the most important consideration in the decision to locate a waste management facility at PGDP is the potential adverse affects on future generations.

Response
A key objective of the WM PEIS is to help protect the health and safety of the current population and of future generations. Minimization of potential future health risks will be a primary consideration for the DOE decisionmakers when selecting the alternatives for implementing waste management activities.

Comment (1255)
If waste is not handled properly, cities within a 50-mile radius of PGDP could be affected by radiation.

Response
DOE performed a number of risk assessments during the preparation of the WM PEIS, among them an examination of potential effects on human health and the environment around PGDP. DOE chose a 50-mile radius to represent the offsite population which could be affected. Using this very conservative radius, these studies concluded that risks to public health and the environment at PGDP would be small under any of the alternatives described in the PEIS (see Section 11.12.2, Volume I.)

Comment (1505)
A commentor stated that under two of the Regionalized Alternatives, low-level wastes and low-level mixed wastes, would be brought to the LLNL Main Site first for treatment, and that there has been inadequate attention to what it would mean to put these very hazardous wastes in areas with earthquake faults and 6 million people within a 50-mile radius.

Response
Sixteen candidate disposal sites were selected for evaluation based on screening performed by DOE in coordination with the States under the Federal Facility Compliance Act. Three exclusionary criteria were applied, including that sites could not be located within 200 feet of a seismic fault.

DOE performed detailed analyses using conservative assumptions to determine the potential health risks to the general public living within a 50-mile radius from an existing waste management facility at LLNL, for both routine facility operations and accidents, including seismic events (earthquakes). The analyses were designed to include the potential impacts from all reasonably foreseeable conditions. In addition, the PEIS assumes the use of generic or conceptual facilities. Actual facility design would include safety and security measures. Waste management facilities constructed by DOE would be designed to the appropriate local seismic standard.

The results of the detailed analyses for each waste type are presented in WM PEIS Volume I, Chapters 6 through 10, and in the cumulative impacts discussion presented in Chapter 11. The analyses show that the health risks to the population from the proposed waste management actions generally would be low.

Comment (1514)
DOE has failed to present an adequate public health case for the proposal supported by the WM PEIS. DOE has not adequately characterized or assessed the risk of existing inventory and ongoing operations at the contaminated sites. We don't know why we are being asked to spend $40 billion to move wastes around.

Response
For each of the alternatives being considered, the impacts to the general public that could result from both normal operations and accidents were determined by detailed analyses of potential health risks, including (1) the risk to local residents from ongoing activities at the site; (2) the risk to workers from chemical, radiological, and physical hazards onsite; (3) the risk associated with transportation offsite; and (4) the risk to current and future generations associated with disposal. These analyses used conservative assumptions. The results of the detailed analyses for each alternative are presented in the WM PEIS Volume I, Chapters 6 through 10, and the cumulative impacts presented in Chapter 11. The analyses show that for all alternatives health risks would generally be small.

As required by NEPA, DOE has also evaluated a No Action Alternative, which represents the continuation of current operations. DOE also evaluated alternatives that minimize waste transportation (Decentralized Alternatives) and that maximize waste transportation (Centralized Alternatives). Thus, DOE believes that the impacts of transporting wastes were considered. Transportation costs would be highest for the Centralized Alternatives, but are still a small percentage of the total costs.

Comment (1613)
The risk numbers in the WM PEIS are disturbing and should be reevaluated, since they show significant health effects over 20 years, and appear to be much higher than any other study; for example, the percentage of fatalities due to radioactivity is much higher.

Response
The approach taken in the WM PEIS was first to identify the groups potentially at risk and then to compare the risks to these groups and individuals if the different alternatives were implemented. The risk

5.2 Human Health Risk Assessment

assessments conducted for the WM PEIS used conservative assumptions and best estimates when data were only generally known or where processes have not been demonstrated fully.

A more conservative approach enables the WM PEIS to include a larger number of scenarios and causes the risk estimates to be higher. Mitigation measures such as tighter waste acceptance criteria, better air pollution control equipment and containment structures, safer packaging for transportation, etc., would be evaluated, as appropriate, when actual facilities are proposed for construction.

Comment (1728)
DOE needs to consider how close Rocky Flats Environmental Technology Site (RFETS) is to public residences and the uses of the potentially contaminated water in these communities.

Response
The health risk analyses conducted for the WM PEIS include assessment of potential risks to members of the offsite population from the proposed treatment of low-level mixed waste, low-level waste, and transuranic waste at RFETS. Members of the offsite population living within 80 kilometers (50 miles) from the center of RFETS are assumed to be exposed to radionuclide and hazardous chemical contaminants released from conceptual thermal treatment facilities. As explained in the description of the air dispersion modeling used to estimate risk (see Appendix D in Volume III of the WM PEIS) site-specific data were used as inputs to the environmental fate models. For RFETS, information on the distribution of the population living within 50 miles from the center of the site was used, along with data on prevailing meteorological conditions at the site. The results of the health risk analyses, presented in Chapters 6, 7, and 8, and in the Volume II Site Data Tables, suggest that adverse health effects in the offsite population living in the vicinity of RFETS resulting from the treatment of low-level mixed waste, low level waste, and transuranic waste should be small.

DOE also evaluated the potential health risks resulting from the proposed disposal of low-level mixed waste and low-level waste at RFETS. Risks from consumption of contaminated groundwater were evaluated using a very conservative analysis. The analysis assumed that a future hypothetical farm family living on the site established a well located 300 meters (984 feet) from the center of a disposal unit. The farm family is assumed to be located so that they receive the highest possible exposure to contaminants leached to groundwater from disposal units. A series of families is assumed to live at this location for 10,000 years. Each family is assumed to have a lifetime of 70 years; therefore, 143 lifetimes were evaluated.

The results of the analysis, presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I, are risk estimates for an individual member of the farm family lifetime expected to receive the highest potential exposure. The chemical constituents of low-level mixed waste were estimated to result in higher groundwater contamination and potential health risk than the radionuclide constituents. However, these risks can be mitigated by the use of more effective waste treatment processes than those modeled for the WM PEIS.

Sections 6.4.1.9 and 7.4.1.8 of the Final WM PEIS also present the results of the risk vulnerability analysis for potential collective or population risk from waste disposal. The results of the analysis suggest that RFETS is intermediate among the 16 proposed DOE disposal sites in its potential for adverse risks to offsite populations from waste disposal.

5.2 Human Health Risk Assessment

Comment (1735)
Although it is true that uncertainties resulting from assumptions concerning toxicological effects and exposure scenarios are systematic in nature, uncertainties resulting from inadequate estimates of exposure concentrations may vary by orders of magnitude from site to site. The application of generic fate and transport models to sites with very different geologic and hydrologic characteristics will yield very different degrees of uncertainty.

Response
Volume I, Section 5.4.1.1, of the WM PEIS discusses the uncertainty in the risk estimates. The environmental fate and transport models used in the risk assessment are described in Appendix D in Volume III. These models were applied consistently to all sites in order to have comparable results. Where possible, actual site-specific hydrogeological and meteorological data were used as inputs to these models to develop the exposure and risk estimates. Generic data were substituted if site-specific data were not unavailable.

The WM PEIS risk assessment assumptions were intended to yield reasonably conservative risk estimates (i.e., estimates that tend to overestimate rather than underestimate risk) using the best available data at the time of the analysis and state-of-the-art models. Additional site-specific and facility-specific analyses might be needed prior to site-specific project implementation.

Comment (1752)
DOE needs to include additional discussion about the long-term health impacts from low levels of radiation exposure. DOE needs to consider exposure and impacts over several decades.

Response
DOE analyzed the potential chronic or long-term health effects in offsite populations resulting from airborne releases of radionuclides and hazardous chemicals during waste treatment and storage operations, as described in Volume I, Chapter 5, of the WM PEIS. The waste management operations are generally assumed to occur over a 10-year period. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. The resulting health impacts are evaluated over the assumed 70-year lifetime of the offsite populations potentially exposed.

In addition, the potential risks to future individuals resulting from the disposal of low-level mixed waste and low-level waste are assessed for a 10,000-year period. The results of these analyses are presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I.

Comment (2072)
Section 5.4 states that no calculation of secondary pollution resulting from disposal was made because the effects would be small compared to treatment, storage, and disposal. This is a misplaced comparison. Relevant here are the effects of this secondary pollution compared to the overall effects of DOE's waste management effort. Since the WM PEIS shows zero offsite impacts on the population, even a small secondary effect could significantly change this picture.

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Response
Section 5.4 of the WM PEIS states that "secondary pollutant" discharges resulting from the burning of fuel for waste treatment are analyzed in the air quality sections of the waste-type chapters. The air quality impacts analysis considered emissions of criteria pollutants from waste incineration and from combustion processes used to provide heat for buildings. Emissions of these pollutants were compared to applicable standards to determine compliance. The standards are set, in part, through consideration of adverse health effects. Therefore, the health impacts of "secondary pollutants" were indirectly considered in the air quality impact analysis. Secondary pollutants discharged from waste treatment facilities were not considered in the health risk assessments conducted for most waste types because the potential impacts from exposure to these contaminants are expected to be minor in comparison to impacts from releases of radionuclides and hazardous chemicals. However, emissions of dioxin from hazardous waste treatment facilities were considered in the health risk analysis conducted for that waste type, the results of which are presented in Section 10.4 in Volume I of the WM PEIS. The estimated population risks from the routine operation of treatment facilities were generally small for most sites and most waste types, but not zero.

The health risk analysis also included evaluation of potential impacts of waste transportation. Impacts from transportation included estimation of excess latent cancer fatalities resulting from exposure to diesel exhaust (see Appendix E in Volume IV for additional details). DOE has revised Section 5.4 in Volume I to include these clarifications.

Comment (2095)
A commentor from the Brookhaven National Laboratory (BNL) area stated that DOE should avoid the possible incidence of cancer due to hosting a disposal site or acceptance of offsite DOE waste, since long-term low-dose exposure to radiation has *not* been shown to be safe.

Response
DOE assumes the commentor is referring to BNL hosting a disposal facility. As explained in the alternatives, BNL would manage only its own low-level mixed waste and low-level waste. BNL would dispose of such wastes only under the Decentralized Alternative. It would not dispose of any offsite wastes. The results of the health risk analyses for BNL-relevant waste streams of low-level mixed waste and low-level waste are presented in Volume I, Sections 6.4 and 7.4, respectively, of the WM PEIS. The WM PEIS health risk analysis includes consideration of adverse health effects potentially resulting from long-term exposures to low doses of radiation, including both cancer and non-cancer effects. The PEIS estimates that the health risks associated with the proposed future waste management activities at BNL may, in general, be considered small. The WM PEIS assesses potential health risk impacts on a programmatic scale. Locations for actual disposal facilities will be selected based on sitewide or project-level NEPA reviews. Prior to disposal, DOE would conduct performance assessments to ensure protection of human health and the environment.

Comment (2135)
The risk assessment analysis considered radioactive exposure. There is also volatile organic compound exposure, and often one multiplies the effect of the other. DOE needs to consider the additional risk to the population.

Response
Risks from exposure to hazardous chemicals, including volatile organic compounds, are considered in the WM PEIS for the waste types that contain these compounds (i.e., low-level mixed waste, transuranic

waste, and hazardous waste). Appendix D in Volume III of the PEIS contains a detailed description of the methodology used to evaluate health risks from radiation and hazardous chemicals. Section D.2.6.3 describes the differences in radionuclide and chemicals exposures. DOE added this information to Section 5.4.1.4 in Volume I. As described in Section D.2.5.1, the methodology did not address the potential interaction of exposure to radiation and hazardous chemicals, since little is known about synergistic and antagonistic effects.

Comment (2161)
The WM PEIS health risk estimates are way too low and undermine the credibility of the PEIS.

Response
The WM PEIS health risk estimates are based on the use of various assumptions, the best available data at the time of the analysis, and state-of-the-art models. A summary description of the environmental fate and dose conversion models used in the analysis is presented in Volume I, Table 5.1-1. The assumptions made in performing the program-level screening analyses were intended to yield reasonably conservative risk estimates (i.e., estimates that tend to overestimate rather than underestimate risk). The methods used to estimate health risk, described in summary form in Section 5.4.1 in Volume I and in detail in Appendix D in Volume III, have been found to be reasonable by a peer review panel, EPA, and the Centers for Disease Control. Note that the WM PEIS health risk estimates address only the risks resulting from exposure to contaminants released from waste treatment, storage, and disposal facilities. Sitewide or project-level NEPA analyses would contain more detailed assessments of worker and public health risks.

Comment (2163)
DOE needs to look at the epidemiology associated with sites such as RFETS and the Oak Ridge Reservation (ORR), including the Piketon Site, that had a high incidence of stomach cancers, to help them better understand the risk of cancer at this site.

Response
The WM PEIS examines the potential exposure of offsite populations to radionuclides and hazardous chemicals released from waste treatment facilities. In addition, in the evaluation of cumulative impacts, modeling estimates of annual radiation doses are considered from existing site activities and other potential future actions. Historical site-specific radiation doses have not been addressed because the availability of this information is limited. The estimated offsite population risks from the proposed waste management actions generally would be small; therefore, they would present little additional incremental risk to whatever the historical radiation exposures from natural background and previous practices might be at the various sites.

Comment (2168)
Workers need to be informed when they have been exposed.

Response
DOE maintains a comprehensive safety program for controlling, monitoring, and recording the exposure of workers to radiation and radioactive materials in accordance with Federally mandated standards and regulations. These standards are established in DOE Order 5480.11, which addresses worker radiation protection. As part of this monitoring program, workers are provided information on the exposures that they could receive on the job, as well as reports on any previous exposure that they might have received. Details of the safety programs are available from DOE officials at each site. DOE must also comply with

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the DOE occupational radiation protection regulations (10 CFR 835). Subpart I of these regulations contains reporting requirements to individuals.

Comment (2191)
DOE dose calculations are based on current site boundaries and land uses and ignore the fact that more and more people will be on the sites. For example, the WM PEIS ignores the fact that people using the Columbia River are far closer and receive more radiation than the hypothetical maximally exposed individual at the boundary of the Hanford Site.

Response
The health risk analysis in the WM PEIS assumed that current site boundaries will remain the same throughout the 20-year period of analysis of the proposed waste management actions. As described in Section 5.4.1.2 in Volume I of the PEIS, three potential groups of receptors were evaluated: (1) the offsite public, (2) waste management workers, and (3) onsite workers not involved in waste management actions. The health risks estimated for the latter group can be indicative of those that could be expected for individuals located inside existing site boundaries. As noted in Section 4.3.8, future land-use issues will be considered in sitewide and project-level NEPA analyses.

Comment (2290)
I don't think that the exposure risks that you put forth in this PEIS, which come to about 70 years, are enough when you consider the long half lives of many of the elements and radionuclides that you are talking about. I think we have to look ahead to seven generations.

Response
As described in Section 5.4.1.2.2 in Volume I of the WM PEIS, the hypothetical farm family is assumed to move directly onto a site 300 meters (984 feet) downgradient from the center of an underground disposal facility. A series of families is assumed to live there for 10,000 years. Each family lifetime is assumed to be of 70 years duration; therefore, 143 lifetimes were evaluated, which is much more than seven generations. This hypothetical farm family was assumed to be exposed to radiation at a time when there had been a leak from the disposal facility and when institutional controls (fences, warning signs, land records, etc.) no longer existed. This hypothetical farm family is assumed to be located so that they receive the highest possible exposure to contaminants in groundwater.

Comment (2293)
I don't hear anything about autoimmune systems health risks, which is something that is coming out more and more in a lot of studies, and is devastating the health of the community.

Response
The health effects endpoints evaluated in the WM PEIS health risk analyses included cancer incidence, cancer fatality, and genetic effects resulting from radiation exposure, and cancer incidence and noncancer effects resulting from exposure to hazardous chemicals. Immunotoxic effects were included in the evaluation of noncancer effects for chemical contaminants that have reference doses or reference concentrations based on immune system effects, as described in Section D.2.5 in Volume III.

Comment (2300)
DOE must protect worker and public health and safety, first and foremost.

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Response
Worker and public health and safety are important concerns for DOE. The WM PEIS estimates potential health risks for workers and the public for the proposed waste treatment, storage, and disposal actions. As stated in Volume I, Section 2.2, DOE will manage its current and anticipated volumes of the five WM PEIS waste types in compliance with all applicable Federal and State laws, to protect public health and safety, and to enhance protection of the environment.

Comment (2315)
The WM PEIS cancer rate assumptions leave out pregnant women, fetal exposure risks, and genetic resistance or susceptibility to cancer and exposures.

Response
Section D.2.2.1 in Volume III of the WM PEIS states that while the human health risk analysis did not explicitly include risks to sensitive subpopulations (e.g., pregnant women), sensitive subpopulations were considered in the development of the toxicity values used in the analysis.

For radiological exposures, the risk factors used to estimate the risk of cancer and adverse genetic effects were taken from International Commission on Radiological Protection Publication 60. These factors differ for workers and the general population. The general population includes the more sensitive younger age groups and pregnant women not included in the worker population.

For chemical exposures, DOE used EPA slope factors and reference doses or reference concentrations. EPA used uncertainty factors to derive these toxicity benchmark values from animal toxicity tests. The uncertainty factors used to develop slope factors and reference doses and concentrations ensure that the values are valid for a wide range of potential receptor groups, including sensitive subpopulations such as children, pregnant women, and the elderly.

Comment (2327)
A commentor requested that the Illinois Department of Health conduct a study of pediatric cancer rates in the ANL-E area before any decision is made, because there is a higher than expected incidence of cancer.

Response
The WM PEIS health risk impact assessment examined potential Waste Management Program effects on workers and the public as a result of the proposed waste management actions at ANL-E. DOE estimated that worker and public health risks would be small at ANL-E under all waste management alternatives. Sitewide or project-level NEPA reviews would be better able to address site-level epidemiology or public health studies.

In response to requests from the residents of Lemont, Illinois, the Illinois Department of Public Health initiated a study of the cancer incidence among children in the Township. The Division of Epidemiologic Studies prepared a study based on hospital reports found in the Illinois State Cancer Registry for the years 1986 through 1993 (Illinois Department of Health, 1995). Seventeen cases of childhood cancer were observed in the study area, four cases more than the 13 that would be statistically expected. The most frequently reported childhood cancer type was leukemia, with six cases observed and three cases statistically expected. The report finds that those differences are not statistically significant. More details on the survey can be obtained from the study.

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Comment (2386)
DOE should present health effects in context, especially health effects below what is probably a *de minimis* level (not defined, but probably less than one excess health effect in number). DOE should provide data with a clear explanation of health effects so as to not mislead or create undue anxiety among members of the public.

It is essential that narratives be provided to give readers perspective on the risk data. It is essential that before indicating (by word or number) that there is a substantial increase in effect or risk, that the level of risk associated with past or background levels be very clearly explained and delineated. It is important that before developing any total risk estimate, that the WM PEIS provide an explanation of how that total might be associated with some actual or at least specified potential impact.

If, for example, an alternative considered by DOE would create additional exposures, but these exposures are some small fraction of either background or allowable exposures, it is misleading not to explain that fact. Similarly, if an alternative results in a small increment in exposure, but the resulting level does cross over into a known or suspected danger zone, that too needs to be highlighted. We believe all citizens will want to know when there are only *de minimis* health differences between alternatives (which could vary dramatically in cost) and when differences in projected exposures really do create significant differences in risk.

Response
The WM PEIS human health risk analysis provides estimates of risks to workers and the offsite population resulting from releases of radionuclides and hazardous chemicals from waste treatment and storage facilities. The health risk endpoints focused on in the analysis are numbers of radiation cancer fatalities for workers and the offsite population, and numbers of physical trauma fatalities for workers. For maximally exposed individuals, the health risk endpoint focus was the probability of cancer fatality.

There are no regulatory *de minimis* levels for the health risk endpoints described above. Evaluation of population impacts requires consideration of the overall size of the population. For example, an estimated single radiation cancer fatality in a population of millions of individuals could be considered to be less significant than the same effect in a population of hundreds of individuals. Cancer probability estimates for single individuals resulting from exposure to hazardous chemicals in DOE mixed wastes can be crudely compared to EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance of 1 in 1 million to 1 in 10,000 levels of acceptable risk.

Section 5.4.1 in Volume I of the WM PEIS contains a discussion intended to aid the reader in interpreting risk values. To assist the reader in understanding the risk values, DOE has modified the PEIS by adding a footnote to the tables containing risk data for the maximally exposed individual to direct the reader to Section 5.4.1 for an explanation and methods for interpreting the risk values.

Cumulative impacts due to exposure to radionuclides are described in Chapter 11 in Volume I. Potential impacts from proposed waste management activities are added to impacts from existing site conditions and impacts from other reasonably foreseeable activities to develop estimates of cumulative impacts. These cumulative impacts are compared to applicable limits and standards.

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Comment (2388)
Provide more detail and a better discussion of worker risks for the different treatment alternatives. The WM PEIS lacks data about worker risks, an area in which DOE has invested significant resources in both real time monitoring and dose reconstruction. Members of affected communities, who often work at DOE sites, are concerned about exposures and risks on the site as well as at its borders.

Response
The WM PEIS attempts to estimate future risks to workers from exposure to radiation and hazardous chemicals and from physical trauma resulting from facility construction and operation accidents. The commentor stated that DOE has invested significant resources in worker exposure monitoring and dose reconstruction studies. These studies address past exposure, from which risk can be calculated. Therefore, they cannot be directly applied to estimate *future* risk at new facilities designed to meet stringent safety standards. However, to the extent that historical worker exposure information is available, it can be used to baseline the models used to estimate future worker risk.

Section 5.4.1 in Volume I of the WM PEIS summarizes the methodology DOE used to estimate future worker risk. The worker risk estimates created for the purpose of comparing alternatives are presented in detail in Chapters 6 through 11 in Volume I of the WM PEIS.

Comment (2398)
One of the issues important to understanding the impacts of the Nation's nuclear waste sites is the impact of stress--of concern to DOE sites because of the stress and anxiety created by radionuclides. Given the scientific community's consensus that stress is a real health danger and plays a role in both acute and chronic disease promotion, it is essential that it be included in the effects that are assessed in this PEIS.

Response
DOE has attempted to estimate reasonably foreseeable, quantifiable environmental impacts due to the actions analyzed in the WM PEIS, including operations and accident consequences. In the absence of a sufficient connection to a physical impact, other potential concerns such as moral, emotional, and psychological (including fear, dread, mental anguish, etc.) issues are beyond the scope of required NEPA evaluations. (*Metropolitan Edison v. People Against Nuclear Energy*, 103 S. Ct. 1556 (1983))

Comment (2400)
The current 365-page effort to explain the human health risks (Volume III, Appendix D) is one part of the WM PEIS that needs the most reworking. The reader encounters hundreds of page-length tables that focus inordinately on the cancer endpoint, using formulas that the average reader cannot begin to decipher, and which are based on risk models that are the subject of a strenuous debate within the scientific community. The PEIS does little to alert the reader to the nature of this debate. Hence, the use of numbers derived from these models obscure the uncertainty about them. The real problem is that these tables divert attention from what is really needed--an effective narrative to help the reader (particularly the lay reader) understand how the alternatives being considered by DOE will actually affect the health of anyone, but particularly how they will affect the reader and his or her neighbors.

Response
Appendix D contains a detailed description of the health risk analysis methodology and results, and was written for a technical audience. The summary narrative for the lay reader is presented in Volume I,

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Chapter 5, for the methodology, and Chapters 6 through 10 in Volume I for the results. Section 5.4.1.4 also contains a discussion intended to aid the reader in the interpretation of the results of the risk analyses.

The WM PEIS risk analysis used currently accepted state-of-the-art models and conservative assumptions to produce conservative risk estimates (i.e., the analysis tends to overestimate rather than underestimate risks). The health risk methods were subjected to peer review before being used in the WM PEIS.

Comment (2480)
Volume I, Section 4.3.1, states, "For DOE sites, the MEI [maximally exposed individual] received a dose considerably less than 1 mrem per year..." Obviously, this is not true, since the MEIs at LANL and ORR both receive more than 1 mrem.

Response
DOE revised the WM PEIS in response to this comment. The end of the last paragraph of Section 4.3.1 now reads: "More than 70% of the sites reported doses to the MEI that were less than 1% of the standard. Los Alamos National Laboratory reported the highest estimated dose, about 80% of the standard."

Comment (2503)
Volume I, Section 5.4.1, states that risks to onsite and offsite populations were estimated for 70 years. This statement needs to be revised to include the transportation risks, which were estimated for 50 years for accident conditions.

Response
The WM PEIS health risk analysis evaluated impacts to members of the public living within a 50-mile radius of DOE sites, to waste management workers, and to onsite workers not directly involved in the proposed waste management actions. For each of these groups of receptors, the standard risk assessment assumption of 70 years was used for the length of an average lifetime.

For offsite population receptors, health risks were primarily from exposure to contaminants released from waste treatment facilities. Both radionuclide and hazardous chemical contaminants are potentially released. Exposure to radionuclides and hazardous chemicals is assumed to occur over the 10-year period of facility operation. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. Exposure to radionuclides that are inhaled or ingested is expected to continue for up to 50 years, since these contaminants, once incorporated into the body, will irradiate tissues even after the 10-year operations period has ended. This 50-year exposure period (also known as a commitment period) is assumed for radionuclide releases from both treatment facilities and from trucks or railcars following transportation accidents.

Waste management workers are also subject to physical hazard injuries and fatalities resulting from industrial accidents occurring during the assumed 10-year facility construction period and 10-year facility operation period.

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Comment (2505)
Referring to the Volume I, Section 5.4.1, statement that offsite population and onsite uninvolved workers were assumed to be exposed to radionuclides through inhalation of airborne vapor and dust and ingestion of contaminated groundwater, a commentor asked, "What about the ingestion of contaminated food?"

Response
DOE has revised Section 5.4.1.3 in Volume I of the WM PEIS to state that exposure of the offsite population was analyzed to determine upper-bound exposures by ingestion of radioactively contaminated food and groundwater as well as inhalation of airborne vapor and dust. Section D.2.4.1 in Volume III provides additional information about the exposure pathways used to estimate health risks for the offsite population and noninvolved worker population.

Comment (2506)
Is the statement in Section 5.4.1 that workers are assumed to be wearing the proper industrial safety and health equipment representative of the worst case, or is this a conservative estimate?

Response
Section 5.4.1 in Volume I of the WM PEIS states that the WM PEIS health risk analysis assumes that workers wear the proper industrial safety and health protection equipment for the tasks being performed. This is not a conservative assumption, but, rather, indicates expected current practices. DOE believes that, on the bases of all of the assumptions used to model worker risk, these analyses, like the offsite population risk analyses, produce conservative estimates of exposure and risk.

Comment (2507)
Even if the skin is considered a much lower exposure pathway, skin and ingestion would still contribute to the cumulative impact of chemical exposure. The overall dose would increase if other routes of exposure were considered. The public could also be exposed to plumes from site releases of hazardous chemicals.

Response
The WM PEIS health risk transportation accident analysis assumes that, under accident conditions, exposure to hazardous chemicals occurs only by inhalation of vapors and dust. The analysis evaluates the potential release of gaseous or low-boiling liquid hazardous chemicals from trucks or railcars and their downwind dispersion in plumes. Individuals would be exposed to these contaminants for only a short period of time as the plume passes by. Given this scenario, dermal absorption is possible, but ingestion is not likely. Inhalation of gaseous contaminants in a passing plume is expected to produce much higher exposures than skin contact, especially under the short-term acute exposure scenario used for the transportation accident risk analysis.

The WM PEIS health risk analysis does consider some dermal exposure to contaminants. As noted in Figure 5.4-1 in Volume I of the WM PEIS for the routine operation of waste treatment and storage facilities, the offsite and noninvolved worker population exposure pathways include dermal absorption of tritium. The tritium is derived from tritiated water released to the atmosphere from the waste management facilities. Both absorption of tritium through the skin and in the lungs are taken into account. The combined rate of absorption is assumed to be 150% of the inhalation intake rate alone.

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Comment (2508)
DOE states that it did not calculate genetic toxicity from chemicals because it is more difficult to assess than radionuclides. Please explain.

Response
Genetic toxicity includes a number of different kinds of effects or endpoints, including gene mutations, which alter the makeup of genes, and gross chromosomal aberrations, which alter the structure or number of the chromosomes. The type of genetic toxicity resulting from exposure to hazardous chemicals depends on the mechanism of action by which the compound interacts with the genetic material of the cell. Since different compounds can produce different types of effects, chemical-derived genetic toxicity must be considered on a compound-specific basis. This kind of analysis is more difficult and requires more assumptions than are appropriate for a programmatic study.

By contrast, potential genetic effects resulting from radiation exposure are more easily analyzed, since the mechanism of radiation effects on genetic material is similar for all radionuclides. Potential exposure is estimated using the environmental fate models identified in Appendix D in Volume III of the WM PEIS. These models sum potential exposure from all different types of radionuclides as person-rem (population) or rem (individual) estimates. The estimated doses are converted to risks by applying International Commission on Radiological Protection (ICRP) risk factors. For example, the ICRP risk factor for genetic effects (which is treated as a single endpoint) for public receptors is 0.0001 genetic effects per rem-lifetime. This value is multiplied by the estimated population exposure (person-rems per lifetime) to obtain an estimate of the number of genetic effects that could occur in the population. Note that this analysis does not require tracking exposure to individual radionuclides.

Comment (2509)
Volume I, Section 5.4.1, states that assumptions about fatalities from chemically-induced cancers are not possible because of the diverse nature of chemically-induced cancer. Is this reasonable? It would seem that chemically-induced cancers would be just as easy to determine as radiation-induced cancers.

Response
A more detailed explanation is provided in Section D.2.6.3 in Volume III of the WM PEIS. In summary, research and epidemiological studies have provided enough information to develop risk factors for radionuclide-induced cancer incidence and cancer fatalities. However, the current practice in chemical cancer risk assessment is limited to estimating potential cancer incidence resulting from exposure to chemical carcinogens. Therefore, the WM PEIS presents total cancer incidence for both chemicals and radionuclides, but presents potential cancer fatalities only for radionuclides.

Comment (2510)
Volume I, Section 5.4.1, states that noncancer toxicity is the health impact discussed for hazardous waste. Chemical carcinogenesis would seem to be important also, since chemical carcinogenicity is not directly proportional to toxicity for all chemical species.

Response
DOE deleted the referenced statement from Section 5.4.1 in Volume I of the WM PEIS. Section 10.4 in Volume I states that both cancer incidence and non-cancer effects resulting from chemical exposure were evaluated for hazardous waste alternatives.

Comment (2511)
If total cancer incidence includes nonradionuclide-induced cancers, how does one derive nonfatal cancer incidence *due to radionuclide exposure* by subtracting fatal from total? Wouldn't this instead represent nonfatal cancer incidence due to *radionuclide plus chemical* exposure? Is there an assumption missing from the WM PEIS text?

Response
The discussion under the heading of "Cancer Incidence" in Section 5.4.1.4 in Volume I of the WM PEIS mentions that total cancer incidence was calculated for both chemicals and radionuclides. However, as shown in the health risk sections of Chapters 6 and 8, radiation cancer incidence and chemical cancer incidence are evaluated and reported separately. DOE revised the PEIS to clarify this.

The discussion cited in the comment refers only to radiation-induced cancers. Nonfatal radiation cancers can be derived from estimates of total radiation cancer incidence by subtracting the estimated number of fatal radiation cancers. This discussion does not apply to chemically-induced cancers, because available methods allow only estimation of total chemical cancer incidence, but not chemical cancer fatalities. Therefore, DOE did not attempt to calculate chemically-induced cancer fatalities. See Volume III, Section D.2.6.3, for more on this subject.

Comment (2512)
Volume I, Section 5.4.1. DOE should provide better explanation of why the total cancer incidence and the nonfatal cancer incidence values lead to an overestimation of skin cancer incidence.

Response
DOE has revised Section 5.4.1.4 in Volume I of the WM PEIS to clarify this discussion. The ICRP dose conversion factors used in the PEIS to convert radiation exposure to estimates of total cancer incidences contain a relatively large component of skin cancers. Such cancers generally result from external exposures to radiation. However, the exposure pathways evaluated in the PEIS (e.g., inhalation or ingestion of radionuclides) are largely internal pathways. These internal exposures to radionuclides are not likely to induce large numbers of skin cancers.

Comment (2513)
The Hazard Quotient actually measures the risk of noncancer health effects (i.e., the NOEL/LOAEL effect measured), not chemical effects.

Response
DOE has revised Section 5.4.1.4 in Volume I of the WM PEIS to describe the Hazard Quotient as a measure of the risk of noncancer health effects.

Comment (2514)
A conservative estimate would use the worst accident year since records were available, not just one or two specific years, such as indicated in this document.

Response
The most recently available information from the Bureau of Labor Statistics was used because this information was thought to be representative of *current* industrial conditions and safety practices.

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Conservative values were used in the absence of better information. Current practices were assumed to be in place during the construction and operation of new waste management facilities.

The values used were conservative, although not necessarily the most conservative. Use of the worst accident year would not provide the most realistic estimates of future worker injuries and potential fatalities. Moreover, NEPA does not require analysis of a worst-case scenario, but rather, reasonably foreseeable consequences. Therefore, current Bureau of Labor Statistics information was considered to be the most appropriate for use in the WM PEIS.

Comment (2515)
Volume I, Section 5.4.1, states that each health risk endpoint should be considered independently; values for different endpoints should not be added to obtain overall estimates for a given group of receptors. This is a valid statement. However, this caveat could make it more difficult to compare risks between alternatives if different endpoints dominate different alternatives.

Response
Exposure-related impacts are evaluated as a number of different health effect endpoints (e.g., cancer fatality, cancer incidence, genetic effects, noncancer effects). However, the PEIS generally uses one endpoint, excess latent cancer fatalities from radiation exposure, to characterize public health risk in the comparison of alternatives summaries in Chapters 6 through 10 in Volume I. DOE used this endpoint as an indicator of the variability in exposure-related health effects among the waste management alternatives evaluated because it is a standard of measurement commonly used and recognized in radiation health effects assessments conducted by DOE and other organizations. In addition, the trends in the other exposure-related endpoints among the alternatives generally followed the trend in the cancer fatality estimates. For workers, DOE used both excess cancer fatality and potential physical hazard fatality to characterize the variability in the routine facility operation health risk impacts among the waste management alternatives evaluated.

Comment (2530)
Noise is not considered for workers.

Response
The WM PEIS health risk analysis did not analyze the impacts of noise on workers, since hearing protection would be provided to all waste management workers as required by Occupational Safety and Health Administration regulations, and because noise impacts would depend on the specific waste management technologies selected. Because the WM PEIS does not select technologies, noise impacts cannot be evaluated at this time.

Comment (2628)
Volume I, Section 12.2, under "Health Risk to Workers and the Public." The "risks" talked about on line 7 of this paragraph are individual risks and assume exposure. The key element missing from the statement is the size of the population being exposed. It would be helpful to present the total health risk for each of the alternatives and compare them.

Response
Section 12.2 of the WM PEIS discusses unavoidable adverse environmental effects, including health risks to workers and the public. The health risks evaluated in the WM PEIS include population as well

as individual risks for members of the offsite population, noninvolved workers, and waste management workers. The results of the health risk analyses are presented in Chapters 6 through 10. Alternative-by-alternative comparisons are presented by chapter in the "Health Risk Impacts" discussion of the "Comparison of Alternatives Summary" sections of each waste-type chapter. Population risks are presented as number of incidences of adverse health effects (e.g., excess latent cancer fatalities) in the population of receptors. Individual risks are presented as the probability of occurrence of an adverse health effect over the lifetime of an individual.

Comment (2630)
The actual chemical constituents analyzed in the various waste streams are not presented in Appendix D. Where are the chemicals of potential concern characterized and the source term defined for hazardous waste? Much of the detailed risk assessment methodology (e.g., the remote shielding scenario on Page D-63, Paragraph 5) is not in Appendix D; rather, readers are referred to Oak Ridge National Laboratory publications (e.g., ORNL, 1995c).

Response
The WM PEIS Hazardous Waste Technical Report contains the chemical constituent composition of the waste stream treatment categories evaluated for hazardous waste. The WM PEIS lists this report, along with the Oak Ridge National Laboratory technical reports referenced in Section D.3.2.2 in Volume III. These documents are available for review in the DOE public reading rooms identified in Volume I, Section 1.9, of the Final WM PEIS.

Comment (2633)
Volume III, Section D.2.7.2. One full-time equivalent (FTE) could also underestimate exposure for workers who work more than or are exposed more than 2,000 hours per year.

Response
An FTE is not necessarily a single individual, but is assumed to be equivalent to one individual working full-time in a waste management facility. Risks to actual individual workers might be overestimated because exposures could be shared by more than one worker working less than full time. Therefore, an FTE could represent the cumulative work time totals of several individuals who are not involved full time in waste management activities. The actual exposures for any individual worker are expected to be within occupational safety and DOE Order guidelines because standard radiation protection and industrial hygiene programs are assumed to be in place.

Comment (2635)
Volume III, Section D.2.7.2. How can a conservative estimate use 5.6 work hours per day as an exposure time?

Response
The value of 5.6 hours per day represents the assumed 70% facility availability for each 8-hour day, which is a realistic and not a conservative estimate. Other elements of the worker exposure scenario do use values and assumptions that provide overall conservative estimates of exposure and risk.

Comment (2637)
Volume III, Section D.2.9. Did DOE use maximum acceptable levels other than EPA reference doses? If so, where are they presented in the PEIS and how were they derived?

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Response
Volume III, Section D.2.9, states that EPA reference doses and reference concentrations were the only sources used as the maximum acceptable concentrations for the Hazard Index calculations.

Comment (2638)
Volume III, Section D.2.10. Are 8-hour time-weighted averages appropriate for the workers at these facilities? Do any sites use shift lengths of a different duration? This could affect the maximally exposed individual's exposure duration.

Response
Standard 8-hour time-weighted average threshold limit values were used to estimate potential worker noncancer health risks resulting from occupational exposures to hazardous chemicals. Although actual shift lengths may differ, for analytical purposes, workers were assumed to be potentially exposed for 8 hours per day, 40 hours per week. This assumption was made in order to provide a consistent framework for risk comparison in this programmatic document.

For hazardous chemical exposure, note that for actual worker exposure to hazardous chemicals, DOE complies with exposure levels established by the Occupational Safety and Health Administration. Waste management worker chemical exposures also are expected to be limited by the workplace practices implemented to ensure safe conditions for workers potentially exposed to radiation or radionuclides. DOE Order 5480.11 specifies the maximum allowable worker exposure for radiation. DOE sites institute their own additional waste operation procedures and worker exposure limits.

Comment (2639)
Where are the Hazard Index calculations?

Response
The Hazard Index calculations are in WM PEIS Volume III, Tables D.3.3-5 through D.3.3-8 for hazardous waste; Tables D.3.4-5 through D.3.4-11 and D.3.4-25 through D.3.4-29 for transuranic waste; and in Tables D.3.5-5 and D.3.5-7 through D.3.5-14 for low-level mixed waste. Additional details about the noncancer health risk analyses are provided in the technical reports cited in Appendix D. Hazard Index analyses are also summarized in the health risk sections of Chapters 6, 8, and 10 in Volume I.

Comment (2641)
In Volume III, Section D.2.15, the WM PEIS provides a poor example for a variable that would be influenced by uncertainty. The consumption of agricultural food products by the offsite population depends on site variables such as geology (soil) and geography, climate (growth parameters) and irrigation, population distribution, and demographics (income). It is not necessarily true that an overestimation of consumption of contaminated agricultural food under one alternative would translate to a similar overestimation for all alternatives.

Response
The WM PEIS risk analysis uses an approach that involves similarities among the alternative scenarios. For example, the variables cited in the comment (e.g., geology, geography, climate, population distribution, and demographics) are site specific, but for a given site are not expected to vary by waste management alternative. The only parameter that varies significantly from alternative to alternative is

the amount of waste that needs to be processed. Although the *actual* consumption of agricultural food products by the offsite population might vary as stated in the comment, for analysis purposes, the *modeled* consumption is similar, except for the influence of the amount of waste processed. This systematic application of modeling and scenario assumptions provides a consistent framework for risk comparison. Therefore, the example given in Section D.2.15 in Volume I of the WM PEIS is correct as stated.

Comment (2642)
For Table D.3.1-13, where is the "risk per year" calculation (for cancer incidence/fatalities) explained?

Response
See Sections D.3.1.1 through D.3.1.3 in Volume III.

Comment (2643)
Volume III, Section D.3.3.2. Why were the 1992 threshold limit values used instead of the 1994 or 1995 versions? How can it be assumed that full-time equivalents are not exposed to chemical concentrations exceeding the time-weighted average threshold limit values?

Response
The 1992 Threshold Limit Values (TLVs) for all 126 chemicals used in the WM PEIS to estimate worker noncancer risks from exposure to hazardous chemicals for low-level mixed waste, transuranic waste, and hazardous waste were compared to the 1996 values published by the American Conference of Governmental Industrial Hygienists. Only arsenic changed significantly, decreasing by slightly greater than one order of magnitude. Four other chemicals had TLV values that changed somewhat, but all four changed by less than half an order of magnitude.

TLV Comparison

Chemical	PEIS Worker TLV	1996 Worker TLV	TLV Ratio (New/Old)
Arsenic	2.00E-01	1.00E-02	0.05
Cyclohexne	0.00E+00	3.00E-02	N/A
Manganese	5.00E+00	2.00E+00	0.4
Mercury	5.00E+02	2.50E-02	0.5
Tetrachloroethylene	3.39E+02	1.70E+02	0.5
Toluene	1.47E+02	1.88E+02	1.3

These TLV changes are all fairly small. In addition, as discussed in Sections 6.4.1.7 and 8.4.1.5 in Volume I of the WM PEIS, no worker noncancer health effects are expected as a result of low-level mixed waste and transuranic waste management. Although worker noncancer health effects are estimated as a result of hazardous waste management, as discussed in Section 10.4.1.4 in Volume I the estimated Worker Exposure Index values are similar among all alternatives (Table 10.4-5). Any adjustments to these values by use of the updated TLVs would be small. These adjustments would be systematically applied across the hazardous waste alternatives and to all sites, so the relative differences among the alternatives would not be expected to change.

Waste management workers are assumed to comply with all standard worker protection and good industrial hygiene practices, including the use of personal protective equipment and appropriate process

engineering controls. American Conference of Governmental Industrial Hygienists TLVs are industry-recognized benchmarks of acceptable exposure levels.

Comment (2777)
Consider that a group at ANL-E called "Looking Inside the National Laboratory Center," is in the process of constructing an onsite museum open to the general public. It would bring the general public in very close proximity to the waste storage areas.

Response
A number of DOE sites that have waste management facilities, such as Los Alamos National Laboratory (LANL) and Sandia National Laboratory-New Mexico (SNL-NM), have museums open to the public. This could also occur at ANL-E. The WM PEIS analysis showed that impacts to noninvolved workers (i.e., onsite workers not directly involved in waste management actions) at ANL-E would be low under all alternatives. A member of the general public who periodically visited the museum presumably would be on the site less than a noninvolved worker and, therefore, their risk should be less.

Comment (2816)
In Section 4.3.1 of the WM PEIS Summary document, it might be misleading to indicate that risks generally decrease with time. This applies to short-lived radionuclides like cesium-137 and cobalt-60, but not to low-level transuranic wastes and not to nonradioactive metals. Under Superfund, for example, a carcinogenic risk of 1 in 100 or 1 in 1,000 are both unacceptable risks. Please clarify.

Response
Section 4.3.1 of the Draft WM PEIS Summary document described the potential health risk resulting from low-level mixed waste treatment and disposal. The statement cited in the comment about risks decreasing with time refers only to the risks presented by the radionuclide component of low-level mixed waste. DOE has provided a discussion in Section 5.4.1.2.1 on risks from radiation exposure for the hypothetical intruder and hypothetical farm family to demonstrate risk as described in the Summary.

Section 6.4.1.10 in Volume I presents details about low-level mixed waste disposal risks for intruders. The cancer fatality probabilities presented in Table 6.4-16 are generally lower at 300 years after disposal than at 100 years. Strontium-90 (half-life 29 years) was the main radionuclide risk driver at 100 years, whereas longer-lived radionuclides, such as thorium-232 (half-life 1E-10 years), nickel-63 (half-life 96 years), and americium-241 (half-life 432 years) were the main risk drivers at 300 years.

Comment (2817)
Because no estimate was provided for BNL's production of low-level waste, no applicable risk factor could have been computed for BNL. Therefore, any analysis of BNL is fatally flawed.

Response
The Final WM PEIS has been revised to incorporate information from the 1996 Integrated Data Base. This database contains an estimate of 254 cubic meters of low-level waste at BNL (see Chapter 7 in Volume I and Appendix I in Volume IV of the WM PEIS). Therefore, the impact areas, including health risks, were reanalyzed for BNL. Thus, the health risk estimates for management of low-level waste at BNL, which are presented in Section 7.4 in Volume I and in the Volume II Site Data Tables of the Final WM PEIS, are based on this updated waste-volume information.

Comment (2827)
Volume I, Section 4.3.1, states that maximally exposed individual doses from 40 CFR 61 National Emission Standards for Hazardous Air Pollutants (NESHAP) emissions are used to define the baseline for analyzing impacts of proposed actions. NESHAP maximally exposed individual doses only address the effects from airborne emissions. The baseline should include effects from all pathways.

Response
The WM PEIS health risk analysis evaluates a number of potential exposure pathways for different receptor groups, as described in Section 5.4.1 in Volume I of the WM PEIS. For the offsite population receptor group, inhalation of contaminants released to the atmosphere from waste treatment and storage facilities is considered to be the most important exposure pathway (see Figure 5.4-1). Multimedia pathways are considered to be of less importance than the airborne pathway for most members of the general public. The maximally exposed individual airborne doses presented in Table 4.2-2 in Volume I are taken from the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992*. To ensure a common basis for the cumulative impacts analysis, DOE also used maximally exposed individual airborne dose estimates to define the baseline risk conditions at the sites.

Comment (2831)
Volume I, Section 5.4.1. National Pollutant Discharge Elimination System (NPDES) permits might not address radionuclide contamination. The WM PEIS should include a description of the types of permits applicable to radionuclide liquid discharges.

Response
The comment correctly states that NPDES permits might not address radionuclide contamination. Liquid effluent discharges from DOE facilities to the environment would be subject to applicable requirements of Federal and State NPDES and industrial wastewater discharge regulations. These requirements may include limits for non-radiological parameters including hazardous constituents, temperature, and flow. Releases of radionuclides must meet the limits specified in the DOE Orders. Effluent discharges to municipal sewers must meet applicable State and local requirements, including any requirements of the service provider.

DOE intended the reference to NPDES permit compliance to refer only to applicable discharges under the NPDES program. Accordingly, DOE revised Section 5.4.1.3 in Volume I of the WM PEIS to delete the word "permit."

Comment (2833)
Volume I, Section 5.4.1, compares average individual risk to CERCLA risk range guidance (1 in 10,000 to 1 in 10,000,000). As noted in the text, the CERCLA risk range is based on maximally exposed individual risks, not on average risks. Despite the disclaimer, the comparison is not appropriate and should be deleted.

Response
DOE deleted the comparison of "average" individual risk to CERCLA risk range guidance.

Comment (2834)
The discussion in Volume I, Section 5.4.1, regarding population risk does not accurately reflect the EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) (*Federal Register*,

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54 FR 51654, December 15, 1989). The NESHAP describes a two-step process. The first step is determining "acceptable" risk based on maximally exposed individual risk. This risk level is 1 in 10,000. The second step is determining "ample margin of safety" below the 1 in 10,0000 level. This second determination might involve population risk. The example given in Section 5.4.1 is not accurate. A risk of 1 in 100 would not be acceptable compared to the 1 in 10,000 presumptive "acceptable" risk level. The point of including population risk is that even a risk of 1 in 10,000 might not be acceptable if the population exposed at the maximally exposed individual level were too large.

Response
DOE deleted the cited example, and the Final WM PEIS explains that all measures of risk, including population risk, need to be examined to determine if the maximally exposed individual risk should be allowed to exceed the NESHAP "acceptable" risk level. Appendix D, Section D.2.14, of the WM PEIS also was revised to reflect this clarification.

Comment (2836)
Individual risk goals in drinking water standards are set at 1/10,000 or lower for carcinogens. Volume I, Section 5.4.1, of the PEIS should further substantiate and document the claim regarding risk goals of 1 in 100 in drinking water standards.

Response
DOE corrected the WM PEIS to state that drinking water standards have individual risk goals of 1 in 10,000 or lower for carcinogens. See Section 5.4.1.4 in Volume I of the WM PEIS.

Comment (2838)
The radon standard referred to in Volume I, Section 5.4.1, is probably the EPA guidance for residential radon levels. This is guidance, not a standard. In addition, the residential radon guidance (4 picocuries per liter) is not risk based, but was determined based on cost and practicality. Comparing it with risk-based criteria is not appropriate.

Response
DOE deleted the reference to the radon standard identified in the comment.

Comment (2862)
The basis for the computation in Volume I, Section 4.3.1, must be clearly stated, because it is not clear whether the measurements are made on the basis of possible releases or predicted releases. DOE must account for worst-case scenarios, considering the history of DOE operations at sites such as BNL.

Response
DOE revised Section 4.3.1 in Volume I of the WM PEIS to note that predicted releases are used to characterize the affected environment, not measured/monitored results. Additional information is contained in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS.

Waste management risk values are estimates based on modeled releases, not measurements. The assumptions used in the health risk analysis are intended to yield reasonably conservative risk estimates that would overestimate rather than underestimate risk. The best available data at the time of the analysis and state-of-the-art models were used.

NEPA does not require analysis of worst-case scenarios, but rather requires analysis of reasonably foreseeable consequences in EISs. Note that the WM PEIS health risk analysis includes consideration of very conservative exposures from waste management. As described in Section 5.4.1 in Volume I, these include risks to the offsite population maximally exposed individual from waste treatment, maximum consequence facility accident scenarios, and the hypothetical intruder scenario for waste disposal.

Comment (2900)
It is difficult to understand the nature of the risk posed by the various waste streams.

Response
The WM PEIS analyzes the potential health risks to workers and the public resulting from DOE's management of high-level waste, low-level mixed waste, low-level waste, transuranic waste, and hazardous waste. Health risks result from exposures to radionuclides released from waste treatment, storage, and disposal facilities, from exposure to direct radiation, and from physical hazards associated with facility construction and operation accidents. Members of offsite populations are assumed to be exposed primarily to radionuclides released to the atmosphere from waste treatment facilities. Workers are assumed to be exposed to direct radiation and to experience physical hazard injuries and fatalities.

Details of the health risk analysis methodology are provided in Appendix D in Volume III. A summary of the methodology is presented in Section 5.4.1 in Volume I. Results of the analyses for each waste are presented in summary form in the health risk sections of Chapters 6 through 10 in Volume I. Detailed results for each site and alternative are presented by site and waste type in Volume II Site Data Tables. Chapter 11 in Volume I presents the health risk results for each site from the combined waste management actions across all waste types, and cumulatively, inclusive of existing site conditions and other proposed actions. Guidance on the interpretation of the results of the health risk analysis is provided in Appendix D in Volume III and in Section 5.4.1 in Volume I.

Comment (2921)
Some common measure of hazard reduction must be created for each waste stream. It is not practical to compute a quantitative health risk; at the least, a common measure based on environmental release rates in reasonable scenarios must be established.

Response
The WM PEIS evaluates five waste types: low-level waste, low-level mixed waste, transuranic waste, high-level waste, and hazardous waste. As discussed in Section 5.2 in Volume I of the WM PEIS, for each waste type, DOE combined waste streams into treatment groups based on physical properties to enable the development of generic waste treatment systems. The waste volumes were then "processed" through these conceptual treatment facilities, as discussed in Sections 6.2, 7.2, 8.2, 9.2, and 10.2 in Volume I. As discussed in Section 5.4.1 in Volume I, health risks were quantitatively evaluated both for the public and for waste management workers. These evaluations revealed that risks to members of the offsite public would result from airborne releases of radionuclide and chemical contaminants from the treatment facilities; and risks to workers would result from direct exposure to radiation during facility operation and from physical hazards resulting from facility construction and operation.

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Comment (2924)
In calculating radiation and chemical exposures for workers handling waste and the 50-mile radius population, why estimate for 10 years if 20 years is the time frame covered in document?

Response
As stated in Volume I, Section 5.2.3, of the WM PEIS, the first 10 years of the 20-year time frame used in the waste management analysis was assumed to be a construction phase, during which the treatment, storage, and disposal facilities for a waste type would be built. All inventory and newly generated wastes were assumed to be shipped, treated, stored, and disposed of, as appropriate for the waste type in question, during the succeeding 10-year operational phase. Yearly throughput volumes were based on this 10-year "workoff" assumption. Exceptions to this assumption would include a full 20-year operational phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS.

Comment (2938)
Section 5.4.1 (under *Health Risks*) must address the high rate of breast cancer on Long Island and the potential risks associated with alternatives proposed for BNL. A commentor does not want DOE to add to the incidence of breast cancer on Long Island.

Response
The WM PEIS health risk analysis addresses the potential risks only from the construction and operation of new waste treatment, storage, and disposal facilities. Section 5.4.1 in Volume I of the WM PEIS provides a description of the methods used to assess health risks. The results for each waste type are presented in Chapters 6 through 10. Chapter 11 also addresses, by site, the cumulative health impacts of the management of the combined waste types, the existing conditions at the site, and other proposed actions at the site.

Note that the WM PEIS health risk analysis considers site baseline risk only as a component of cumulative impacts. In Chapter 11, baseline risk is considered as the potential effect of existing site-related actions on population exposure and risk. The analysis does not include regional epidemiological or health statistics information, such as the rate of cancer incidence on Long Island. The estimated risks of the proposed waste management actions at BNL must be considered as excess latent cancer incidence or fatality risks that would be added to the existing baseline.

BNL continually monitors for impacts to public health, safety, and the environment. Air and water emissions from BNL are permitted and regulated by EPA, NYSDEC, and DOE. When these agencies assign standards to environmental releases, they consider risks to public health, safety, and the environment. The amount of radiation exposure received by BNL's maximally exposed individual (a hypothetical person who receives the largest dose as a result of actions at BNL) is 100 times less than the DOE standard. The potential relationship between cancer incidence rates on Long Island and BNL site activities is currently under independent investigation by a number of local organizations through funding provided by the National Cancer Institute. In addition, Suffolk County has named an independent group to analyze the influence of BNL actions on public health in communities surrounding the site.

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Comment (3016)
Volume I, Section 5.4.1, states that actual data are used where available, but generic assumptions are substituted where needed. It is entirely unclear where the specific versus the generic data were used. Of substantially more concern is the fact that the degree of site characterization across the complex is quite variable. Inclusion of some, but not complete, site-specific data are more likely to bias the results than to meaningfully add to the strength of the analysis.

Response
The WM PEIS health risk analysis is based on the use of state-of-the-art models and the best available data at the time of the analysis. Site-specific environmental data were developed for each site for use in the environmental fate models. This information included meteorological, hydrogeological, and population distribution data. A number of models were used to estimate releases of contaminants from waste treatment, storage, and disposal facilities and their distribution in the environment. Standard assumptions were made regarding the contact of workers and the public with the contaminants through various exposure pathways. All assumptions were consistently applied across all sites and waste management alternatives.

The WM PEIS health risk analysis results are screening-level estimates that are influenced to a large extent by the assumptions and models used in the analysis. Chapter 5 in Volume I describes the methodologies used to evaluate potential impacts. Section 5.4.1 in Volume I includes a discussion of the uncertainty involved in the risk estimates. The consistent application of available data and assumptions throughout the analysis produced estimates that are adequate and useful in comparing the differences among waste management alternatives.

Comment (3026)
There are many uncertainties and arbitrary assumptions used for risk assessment. The risk assessment applied degrees of conservatism for each alternative in an arbitrary fashion. Thus, it is difficult to compare alternatives according to their potential risk. Unless "degree of conservatism" can be handled on an equitable basis (i.e., best estimate, or 95/95 approach for fair comparison), risk comparison of alternatives should not be attempted.

Response
Section 5.4.1.1 in Volume I of the WM PEIS describes the types of uncertainties associated with the risk estimates. As described in this section, for purposes of programmatic analysis, many assumptions were used in the risk assessment. However, they were not arbitrarily selected or applied. For example, standard assumptions were used for a range of exposure assessment parameters, such as length of lifetime, average body weight, amount of air inhaled, etc. The assumptions used were intended to provide reasonably conservative risk estimates. The best available data at the time of the analysis and state-of-the-art models were used in the analysis. The modeling and scenario assumptions were consistently applied throughout the analysis for all alternatives. Therefore, many of the uncertainties are systematic, and should not affect the relative differences in risk estimates among programmatic waste management alternatives.

Comment (3029)
It is not logical to attempt to discriminate between alternatives when the same assumptions are made for each site. If the exact same assumptions are used, the risk is always the same and the analysis is

useless. The correct method is to make site-specific assumptions, then use the same analysis method to determine relative risk.

Response
Section 5.1.2 in Volume I of the WM PEIS contains a listing of the computer models used in the risk analysis. Although several exposure parameter values were assumed to have the same values at every site (e.g., average body weight, inhalation rate, period of exposure, length of lifetime), many of the models required the use of site-specific hydrogeological, meteorological, and population distribution data. The use of site-specific data in the models produced site-specific estimates of risk.

Comment (3073)
Section 5.4.11 seems to be summarized too briefly, because it does not mention seismic characteristics at Hanford, which were supposed to be accounted for in the health risk assessment.

Response
Information about seismic conditions at Hanford are summarized in Section 4.4.4 in Volume I, and described in more detail in the WM PEIS Affected Environment Technical Report. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The potential health risks resulting from waste management facility accidents, including those from earthquakes, are addressed in Volume I in Sections 6.4.3 for low-level mixed waste, 7.4.3 for low-level waste, and 8.4.3 for transuranic waste. Tables 6.4-19, 7.4-16, and 8.4-10 contain summary information on maximum consequence treatment facility accidents, including those caused by earthquakes at Hanford. Additional details about the facility accident analyses are presented in Appendix F (Volume IV).

Comment (3229)
The WM PEIS analysis method does not appear to consider the proposed reduction in the allowable standard for exposure to radiation for the general public from 100 mrem per year to 25 mrem per year.

Response
The WM PEIS is intended to show, on a relative basis, the potential impacts of implementing the proposed alternatives. The relative relationship of these impacts would not change, even with a change in standards. Although the WM PEIS mentions the 100 mrem standard for context, the analyses in the WM PEIS do not determine the acceptability of impacts by comparison to this standard. Therefore, the analyses in the WM PEIS are not dependent on this dose standard.

Comment (3231)
Because of the long half-life and bioaccumulation potential of the wastes under consideration, the arbitrary 50-mile radius for pathway examination should be extended to include all potentially exposed persons using the Columbia River downstream of Hanford.

Response
The general population living within the 50-mile radius of the region of influence is assumed to be exposed to contaminants released to the atmosphere from treatment facilities. Section 5.4.1 in Volume I indicates that direct releases of contaminants to surface water from waste management

facilities are expected to be limited. Dilution of contaminants in surface-water bodies could further limit the importance of this potential route of exposure. Section D.2.3.1 in Volume III states that deposition of airborne contaminants to surface water is expected to result in potential exposures many times lower than those from inhalation. In addition, recharge to surface water of groundwater contaminated as a result of waste disposal is also expected to produce relatively lower concentrations of contaminants because of dilution. Therefore, populations that are potentially exposed primarily by contact with Columbia River water or aquatic organisms downstream of the Hanford Site and outside the 50-mile radius are expected to receive lower exposures to contaminants released from waste management facilities at Hanford than the population living within the region of influence exposed primarily via the airborne pathway.

The WM PEIS health risk analysis described in Section 5.4.1 is a screening-level evaluation. The analysis uses several generic assumptions that are considered to be acceptable given the programmatic nature of the document. Sitewide or project-level NEPA reviews are better able to consider more detailed, site-specific information, such as potential concentrations of bioaccumulative contaminants in Columbia River sediment or aquatic organisms.

Comment (3248)
The Final PEIS should explain how transport and waste facility risk assessments take into consideration uncertainties and inaccuracies in waste characterization data. The WM PEIS should also explain how potential human errors during waste handling and packaging will be minimized, e.g., errors in labeling whereby wastes may be incorrectly classified as not transuranic or not regulated under the Resource Conservation and Recovery Act (a possibility identified in the Tiger Team Report of 1990).

Response
Section 5.4.1 in Volume I and Sections D.2.15 and D.4 in Volume III contain discussions of the uncertainties inherent in the WM PEIS health risk estimates. In addition, Appendix I in Volume IV contains a discussion of the significance of updating waste-volume estimates for low-level mixed waste, low-level waste and transuranic waste.

DOE recognizes the importance of more effective and cost-effective waste characterization approaches and identifies waste characterization technology as a focus area for technology development in Volume IV, Appendix H. The potential for human errors during waste handling and packaging will be minimized by facility design, standard operating practices, and employee training.

Comment (3252)
The WM PEIS risk assessments for transport and offsite health impacts from waste treatment and disposal facilities should use more accurate California population densities, which exceed the 10,000 people per square mile used in the WM PEIS for average population densities.

Response
The population densities for each population zone are identified in Section E.6.3 in Volume 1 of the PEIS. The commentor is correct in stating that some California population densities exceed 10,000 people per square mile. It should be noted, however, that urban transportation of waste shipments is the smallest fraction of travel. In addition, the majority of most urban areas are approximately 10% lower than the 10,000 people per square mile. Thus, DOE believes that impacts from transportation are conservatively estimated.

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In addition, Section E.8.4 in Volume IV of the PEIS describes the uncertainties in the calculation of radiation dose. Uncertainties associated with computational models are recognized but are difficult to quantify. Therefore, assumptions are made at each step of the risk assessment process that are intended to produce conservative results (that is, overestimate the calculated dose and radiological risk). Note that the single largest contributor to the collective population doses calculated with RADTRAN were found to be the dose to members of the public at truck stops. For trucks approximately 80% of the estimated public dose was incurred at stops. Thus, DOE believes the population densities yield conservative results.

Comment (3257)
The Final WM EIS should consider estimated impacts to an offsite maximally exposed individual for *all* relevant pathways, including potential public exposure from radioactive releases into sewer systems and storm drain runoff into streams that leave the site, not just airborne emissions.

Response
Section 5.4.1.2.3 in Volume I of the WM PEIS states that the potential exists for human exposure to radiological and chemical contaminants in the surface water. Receptors can be exposed through use of contaminated surface water for drinking water, bathing, swimming, or irrigation. In addition, ingestion of fish or shellfish taken from contaminated surface waters can be another source of contaminants through bioaccumulation of the contaminants in the tissues of these organisms. Potential pathways for surface-water contamination from waste management practices include deposition of contaminants released to the atmosphere to surface-water bodies, overland runoff to surface waters, releases of contaminants in aqueous effluents from treatment and storage facilities, and recharge of surface waters by groundwaters potentially contaminated through waste management disposal practices.

Of the potential surface-water contamination pathways, only deposition of airborne contaminants is amenable to quantitative analysis without information about the exact location of the facility or technology employed for waste treatment, storage, or disposal on a given site. Preliminary estimates described in Appendix D in Volume III for the Columbia and Clinch Rivers, indicated that the potential dose received from ingestion of surface water contaminated by deposition of airborne contaminants was a thousand to millions of times lower than that received from inhalation in a gaseous plume of hazardous or radioactive material.

Other potential pathways of surface-water contamination can be controlled or are more affected by the technical design and relative location of the waste management facilities with respect to the location of surface-water bodies. Releases of contaminants in aqueous effluents from treatment and storage facilities are expected to be small because process wastewaters from these facilities would discharge to aqueous waste treatment facilities. After treatment, wastewaters would be recycled or discharged from these plants. All wastewaters, including stormwaters, would be discharged in compliance with site-specific DOE, National Pollutant Discharge Elimination System, or industrial wastewater discharge limits, which are established based on consideration of the potential health and environmental effects of contamination of the receiving body. Disposal facilities might eventually degrade and release contaminants to the groundwater. Resultant contamination of surface water from the groundwater depends on the specific location of the disposal facility with respect to the surface water; however, dilution of the contaminants in "clean" surface waters is likely to result in surface-water concentrations that are much lower than the concentrations in the groundwater.

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Since the WM PEIS does not attempt to make waste management facility technology or location decisions, there would be a high degree of uncertainty associated with any quantitative surface-water pathway exposure estimates. Consequently, DOE did not conduct a detailed evaluation of this pathway. Surface-water pathway analyses would be presented in sitewide or project-level NEPA reviews, as appropriate.

As stated in Section 5.4.3 in Volume I, the aqueous wastewaters that are currently being managed at the sites are not part of the WM PEIS. The WM PEIS includes only those aqueous wastes generated by the hypothetical facilities analyzed as part of the WM PEIS alternatives. These waste management facilities were assumed to be very efficient in water use. Process wastewater would be treated per regulatory and permit requirements and recycled to the extent practicable with little liquid effluent discharge. Therefore, there is little process wastewater that would be discharged to surface waters after treatment. Since process wastewater treatment would continue at the sites where it presently occurs, and the volumes of process wastewater treated at each site would vary only slightly between alternatives, the effects of process wastewater treatment on surface water and groundwater quality are already accounted for in the affected environment section. These impacts would be evaluated in sitewide or project-level NEPA reviews.

Comment (3287)
The zone of potential impact is a 50-mile radius from the site center, because this radius is judged to encompass virtually all of the human health risks and environmental impacts that might occur. First, this zone of impact assumption would seem to result in misleading assessments across sites, particularly at larger sites such as NTS, that have waste management activities several miles from the center of the site and closer to the perimeter. The true impact zone should be set from the perimeter and should definitely include Pahrump.

Response
Section 5.4.1.2 in Volume I and Section D.2.2 in Volume III discuss the population and individual receptors used in the WM PEIS health risk analysis. The offsite population or general public receptor group was assumed to be the population living within an 80-kilometer (50-mile) radius of either an existing waste management location for the largest DOE sites (the Hanford Site, INEL, LANL, NTS, ORR, and SRS) or the geographic center for the 11 smaller DOE sites.

The WM PEIS does not attempt to place any of the programmatic waste management activities at a particular location on a DOE site. As necessary, sitewide or project-level NEPA reviews will evaluate in greater detail the potential impacts at sites selected for programmatic waste management activities.

Comment (3329)
Referring to the WM PEIS evaluation of health risks to waste management workers and a hypothetical farm family, a commentor stated, "I can't even believe this equation [of an educated, technically schooled radiological worker to a hypothetical farm family]." DOE's own data shows that the primary risk to workers is physical injury, not exposure-related injury.

Response
The WM PEIS health risk analysis estimated potential impacts to several receptors from disposal of low-level mixed waste and low-level waste. Waste management worker risks from disposal include radiation exposure during waste handling prior to burial and physical hazard trauma from facility

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construction and operations accidents. Section 6.4.1.3 in Volume I summarizes the estimated worker fatalities from disposal of low-level mixed waste. The estimated number of radiation-induced latent cancer fatalities was slightly greater than the estimated number of potential physical hazard fatalities for most of the alternatives evaluated (Table 6.4-4). For low-level waste disposal, potential worker physical hazard fatalities were slightly greater than latent radiation-induced cancer fatalities under all but the Centralized Alternatives (Section 7.4.1.3 in Volume I, Table 7.4-4).

Potential health risks from disposal were also estimated for a hypothetical farm family and a hypothetical intruder. The farm family scenario involves exposure of a future public receptor group to radionuclide and chemical contaminants released to groundwater over time from a disposal facility. The intruder is a single individual exposed to constituents of buried waste through accidental incursion into a disposal facility. The summary results of these analyses are presented in Sections 6.4.1.8, 6.4.1.9, 7.4.1.7, and 7.4.1.8 in Volume I. Note that the PEIS health risk analysis presents the potential impacts to these different receptors as discrete risks; risks to workers are not compared to the farm family or intruder.

Comment (3357)
The risk analysis charts are so subjective that they are not useful. In addition, they are conclusory, as they are not supported by credible scientific studies or objective data.

Response
The scatter diagrams presented in the health risk sections of the waste type chapters on low-level mixed waste (Section 6.4, Volume I) and low-level waste (Section 7.4, Volume I) (e.g., Figures 6.4-1, 6.4-2, 6.4-3, 6.4-4, 7.4-1, 7.4-2, and 7.4-3) are not subjective. Rather, they are graphical representations of the health risk analyses results presented in the various tables contained in Sections 6.4.1 and 7.4.1 in Volume I. The values presented in these tables are the outputs of the state-of-the-art health risk models used in the analyses, as described in Chapter 5 in Volume I and in Appendix D in Volume III. The models used the best available data at the time of the analysis and conservative assumptions in order to yield reasonably conservative estimates of risk for this screening-level evaluation.

Comment (3362)
There is no doubt that incineration of dioxin and dioxin-like compounds like polychlorinated biphenyls result in the emission of dioxins. Yet, there is no mention of any impacts associated with such emissions. EPA has already stated in its dioxin reassessment that humans are at near their effect level in terms of dioxin exposure. What is the synergistic effect of dioxin and radioactivity on the genetics, reproductive systems, and cancer and non-cancer for humans? If there is insufficient information or scientific uncertainty regarding this issue, then DOE needs to disclose this in full compliance with NEPA.

Response
As described in the WM PEIS supporting technical reports, dioxins and furans were included in the source terms for low-level mixed waste, transuranic waste, and hazardous waste because these waste types include hazardous constituents. Therefore, dioxins and furans are included in the health risk estimates for these waste types. Because specific molecular forms of the contaminants were not known, hexachlorodibenzo p-dioxin was used as a surrogate for all dioxins.

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Section D.2.5.1 in Volume III states that the risks from enhanced or diminished toxicity from interactions among components of a contaminant mixture (termed "synergy" and "antagonism," respectively), or the effects of multiple chemical forms for the same atom ("speciation") or combination of atoms ("complexing") were not evaluated because not enough information exists on these effects. If synergism or antagonism is occurring at a particular site, the risks there will be accordingly under- or overestimated. Similarly, since complexing and speciation can affect a contaminant's physicochemical and health-related properties, including its toxicity, carcinogenicity, reactivity, and water solubility (hence, transportability), the lack of toxicity information on waste complexing and speciation might introduce some additional uncertainty to the risk analysis.

Comment (3363)
The WM PEIS is deficient in its long-term analysis of the atmospheric deposition of radionuclides and chemical compounds on farm crops and its concomitant effects of biomagnification through the food chain. EPA has already admitted that this is perhaps the most serious threat from toxic emissions. This effect could be very important if there is significant agriculture being locally marketed in a region of influence.

Response
As described in Section 5.4.1.3 in Volume I, the WM PEIS health risk analysis does include evaluation of an agricultural exposure pathway for offsite population receptors. This pathway results from releases of radionuclide and chemical contaminants to the atmosphere from waste management treatment and storage facilities. Airborne contaminants are assumed to be deposited onto surface soils, where they are taken up by plants. The plants are consumed by the local population and are fed to livestock, which is also consumed by the local population. Offsite population receptors, therefore, are assumed to be exposed to contaminants released from treatment and storage facilities through inhalation of airborne contaminants as well as by ingestion of contaminated locally produced plants and livestock.

Comment (3365)
DOE performed the radiological dose assessment modeling of the air transport pathways using models (such as GENII) not approved by EPA for regulatory purposes. CAP-88 is an example of an EPA-approved air dispersion model for determining radiological dose assessments. Therefore, the models used do not appear to be adequate to demonstrate that radiation doses are within regulatory limits.

Response
DOE selected the GENII model for the WM PEIS analysis because of its versatility and documented use in the field of risk assessment. The GENII model is able to simulate both acute and chronic release scenarios and has an exposure pathway component capable of assessing food-chain exposures. The programmatic purpose of this study is to evaluate various waste treatment, storage, and disposal configurations. The GENII model is adequate for this purpose.

Predicted doses due to releases of radionuclides to the air are compared to the 10 mrem per year dose standard in the NESHAPs as an indicator of potential impacts. Comparison to this standard is not intended to demonstrate compliance for permitting purposes. Subsequent permitting documents would utilize EPA approved models to demonstrate compliance with the NESHAPs for radionuclides.

DOE will comply with all applicable air quality regulations when conducting its waste management activities.

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Comment (3370)
Does Appendix D list the EPA reference doses, cancer potency factors, and threshold limit values used in the analysis?

Response
Appendix D does not list these toxicity parameter values. However, DOE revised Section D.2.6.1 in Volume III to include references for the sources of the reference doses, reference concentrations, cancer potency, and threshold limit values used in the analysis.

Comment (3373)
The summation (dose additivity) of noncancer hazard quotients to derive the hazard index is inappropriate unless the toxicological endpoints and mechanisms of action are the same for each substance. (See Volume III, Section D.2.13.) Was this considered? Section D.2.14 mentioned this only in a brief explanation that the risk estimates provide no indication of severity.

Response
The WM PEIS methodology followed the *Risk Assessment Guidelines for Superfund*, which describes the procedure for adding hazard quotients of various contaminants to obtain an overall hazard index. This approach produces conservative estimates of noncancer risk. This level of detail is considered to be sufficient for a programmatic analysis.

Comment (3377)
There is a feeling among the public living around PGDP that cancer rates are already high in the area. For example, there are more cancers on one road [Bedford Road] near PGDP than in any other area in the surrounding region. Residents are concerned that fallout is causing health problems. The U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry is beginning to look at the possibility of existing health problems around PGDP. These problems need to be part of any environmental baselines when considering the wisdom of planning new facilities in such a populated area.

Response
The WM PEIS health risk analysis estimates that there would be no significant health impacts in the offsite population surrounding PGDP resulting from the proposed waste management actions. The analysis addresses only the potential future incremental risk of new waste management actions. This risk would be additive to the baseline cancer risk in the region, some of which could be related to past and current site activities. The PEIS does not attempt to characterize the existing baseline health risk at PGDP through the use of regional epidemiological or health statistics information. That kind of site-specific detail would be addressed in sitewide or project-level NEPA reviews. The cumulative impacts analysis did consider existing environmental conditions at DOE sites combined with potential impacts of the WM PEIS alternatives.

DOE is committed to operating its facilities and managing its wastes safely and in compliance with all applicable laws and regulations. It is DOE policy to maintain releases at levels that are as low as reasonably achievable. In 1992, DOE reported a radiation dose of 0.26 mrem to the maximally exposed individual at PGDP from airborne radionuclides. The maximally exposed individual is a hypothetical person in the offsite population who receives the largest dose from site activities. This is a very small

fraction of the annual radiation dose of 10 mrem that EPA has established as a regulatory level for the protection of public health and safety.

Comment (3380)
Volume III, Section D.2.11. What is the reference for the immediately dangerous to life and health (IDLH) indices?

Response
The source of the IDLHs was the National Institute of Occupational Safety and Health. The specific document cited was *Registry of Toxic Effects of Chemical Substances,* which DOE has added to the References section at the end of Appendix D. Section D.2.11 in Volume III of the WM PEIS was revised to include this information.

Comment (3381)
Volume III, Section D.3.1.7: High-efficiency particulate air filtration would not be effective at all for filtering iodine-129. If some filtration was considered in the risk estimates, the estimates would be incorrect.

Response
It is true that high-efficiency particulate air filtration would not be effective in removing iodine-129. Therefore, no allowance was made for removal of iodine-129. DOE has revised the referenced text in Appendix D (Volume III) to indicate that filtration is lost in these risk analyses.

Comment (3384)
Why were hexachlorodibenzo-p-dioxin and hexachlorodibenzofuran used as surrogates for chlorinated dioxins and furans? (See Volume III, Section D.3.3.2) A more conservative assumption would have been 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin and 2, 3, 7, 8-tetrachlorodibenzofuran as surrogates, since the tetra- forms are more carcinogenic that the hexa- forms.

Response
Tetrachlorodibenzo-p-dioxin and tetrachlorodibenzofuran can be used as surrogates for chlorinated dioxins and furans if the isomer of the chemical and corresponding toxicity equivalent factor are known. The source term evaluated in the WM PEIS did not specify specific isomers. In this case, it is appropriate to use the toxicity values for hexachlorodibenzo-p-dioxin mixtures and hexachlorobenzofuran mixtures.

Comment (3385)
What is the rationale behind using the chemical surrogates in Table D.3.3-14? Why weren't components of the established hazardous waste source term used (i.e., Table D.3.3-2)? A better explanation is needed.

Response
The Final WM PEIS, Section D.3.3.6 in Volume III, has been revised to indicate that more toxic chemical components were used as a conservative representation of the wastes if the exact or actual components were unknown for a particular category.

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Comment (3390)
Volume III, Section D.3.4. One of the additional treatment standards for transuranic waste evaluated by this analysis involves the incineration of wastes to destroy *most* of the hazardous organic components. What does "most" mean in this context? What happens to the inorganic components (e.g., metals)? Were incineration wastes and emissions considered in the human health risk assessment, and if so where? Since cadmium drove the risk analysis in the hazardous waste accident scenarios, since 50 to 60% of the DOE inventory of transuranic waste is mixed waste, and since cadmium was considered a component of mixed-waste, where does cadmium end up in the environment after the incineration treatment referred to? It would be helpful to include a table of estimated WIPP waste acceptance criteria level incinerator release rates from the WM PEIS Transuranic Waste Technical Report. Chapters 3 and 8 of the PEIS do not relate this information in detail, although the reader is referred to them.

Response
DOE has revised the text in Volume III, Section D.3.4, to state that inorganic components remain after incineration, and that small quantities of radioactive or hazardous constituents would be released from treatment facilities. Human health risks were evaluated based on these releases. Health risk impacts are presented in detail in Appendix D and in summary form in Section 8.4.1 in Volume I.

Cadmium is included in the transuranic waste treatment source term. The WM PEIS Transuranic Waste Technical Report presents the air release fractions used in the air dispersion modeling for radionuclide and chemical constituents in transuranic waste streams. Some cadmium would remain in the residual material following incineration, which will ultimately be shipped to WIPP for disposal. The fraction of cadmium in the source term released to the atmosphere would eventually deposit into surface soils.

Comment (3391)
Volume III, Section D.3.5.2. It might be overly conservative to use benzene, a "confirmed human carcinogen," to represent all water soluble organic compounds. No other soluble organic compounds are likely to be present in the waste stream that are confirmed human carcinogens (benzidine, β-naphthylamine, etc.). Unless benzene is a major constituent of the waste stream, this assumption could lead to overly conservative risk estimates. The use of 1,1,1-trichloroethane as a surrogate for compounds with three chlorine atoms is not necessarily conservative; trichloroethylene would have been a more conservative choice.

Response
Because of the lack of DOE incinerator stack release data needed to develop emission factors for establishing the hazardous waste treatment facility source-term, a representative surrogate was used. Data that could be used to support emission factors are available for facilities required to conducted "trial-burns" for obtaining operating permits under RCRA, Part B. Commercial facilities used by DOE for organic hazardous waste treatment were contacted to obtain available data. The hazardous waste incinerator in Deer Park, Texas, was selected based on its use by DOE facilities for commercial offsite incineration. Data from a series of Deer Park trial-burns were collected. The waste stream characteristics from these burns were carefully reviewed to select data with characteristics most similar to the DOE hazardous waste streams.

It is conservative to use benzene to represent all water soluble organic compounds, however, benzene was one of the compounds with this characteristic identified in the source term for the Deer Park trial-burn. 1,1,1-trichloroethane, rather than trichloroethylene, was used because it was also found in the source term for the burn.

Comment (3407)
Volume I, Section 5.4.1. Please change "accident-free" to "incident-free."

Response
DOE revised Section 5.4.1 in Volume I of the WM PEIS as requested.

Comment (3574)
It seems that DOE has made an assumption that the dispersion of regulated releases as well as unregulated releases through air, water, land, or some combination of medias, results in concentric and uniformly radiated exposure routes through the environment. This is a faulty assumption and/or portrayal of current as well as potential regulated and unregulated releases. Such an analysis cannot be confined or bound within concentric zones, but must accurately reflect and consider such factors as the influence of surface-water currents, groundwater flow, air currents, and/or geologic formations. All of these factors play an important role in the route of a release and *concentration* of exposures through releases.

Response
The exposure analysis does not assume that exposures to the public occur in concentric, uniformly radiated exposure routes at the sites; rather, the analysis assumes that airborne emissions from waste management facilities would disperse in accordance with local wind patterns. Exposures to these emissions are estimated for the public living within a 50-mile radius either from an existing waste management facility or the geographic center of the site.

Surface-water and groundwater exposure pathways were not evaluated for waste storage and treatment facilities, although the groundwater pathway was evaluated for waste disposal. This pathway accounts for the local hydrogeology at each site.

Comment (3577)
It is unclear what time frame is being considered in conjunction with the 50-mile zone. Only the 20-year period commonly referred to throughout this document? Or 50 years, 100 years, or perhaps the 10,000-year period from guidelines on land disposal in 10 CFR 61? And what of climatic changes over longer periods of time?

Response
The 50-mile zone was used to evaluate human health risks from waste treatment facility emissions. Potential risks of public exposure to radioactivity from waste treatment and storage activities were assumed to occur during the 10-year period of facility operations, which follows the 10-year facility construction period. Therefore, exposure was calculated for 10 years of operations, and project implementation was calculated for 20 years. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. Health impacts in the offsite population are evaluated assuming a 50-year

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period of committed effective dose, since radionuclides absorbed into the body after inhalation will continue to irradiate surrounding tissue over the lifetime of the individual. The 10,000-year time period was the current standard for disposal risk analysis at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A. Prediction of climatic changes would be speculative and therefore was not analyzed. Section D.2.6 in Volume III of the WM PEIS provides additional details regarding the assumptions used in estimating health risks from radionuclide exposure.

Comment (3584)
We feel that more sensitive populations, such as elders and children should be included in DOE's analysis of the impacts of the WM PEIS alternatives, since these populations are more severely impacted by environmental degradation of any sort. Also, mapping of children crosses over with Native issues/populations (as well as other minority issues/populations), since statistically, most members of Native populations are below the age 14. Thus, the risks and potential impacts to Native populations increases. We do not have accurate figures to reflect the percentage of children, collectively or by Nation, within Native populations or other minority groups. We will forward figures for Native populations and, hopefully other minority groups, at a later date. It is incumbent on DOE to assess these factors/statistics in formulating a waste management scheme due to the sensitivity and greater impact potential on children, as well as elders. We suggest the DOE consult with the Bureau of Indian Affairs to obtain these figures on Native Peoples. We do not suggest that the Bureau answer in any way for the needs, concerns, impacts, Treaty Rights, etc., for any Native Nation. The Nations themselves must be cooperated with.

Response
Section D.2.2.1 in Volume III of the WM PEIS states that while the human health risk analysis did not explicitly include risks to sensitive subpopulations (e.g., children or pregnant women), it did consider sensitive subpopulations in the development of the toxicity values used in the analysis. In addition, Section C.4.7.2.3 in Volume III describes the methodology used for evaluating risk and the potential environmental justice impacts to minority populations.

For radiological exposures, the risk factors used to estimate the risk of cancer and adverse genetic effects were taken from International Commission on Radiological Protection Publication 60. These factors differ for workers and the general population. The general population includes the more sensitive younger age groups and pregnant women not included in the worker population.

For chemical exposures, EPA slope factors and reference doses or reference concentrations were used. "Uncertainty factors" are used to derive these toxicity benchmark values from animal toxicity tests. The uncertainty factors used to develop slope factors, reference doses, and reference concentrations ensure that the values are valid for a wide range of potential receptor groups, including sensitive subpopulations such as children, pregnant women, and the elderly.

It is DOE policy to consult with Tribal Governments to ensure Tribal rights and interests are considered and that potential impacts of proposed DOE actions on cultural and religious resources are disclosed. DOE is committed to incorporating this policy into its ongoing and long-term planning and management processes, including the NEPA process, and has worked through its site representatives to notify the

Tribes of the WM PEIS scope and the availability of the document for comment. The WM PEIS has been revised to include a general discussion of the consultation obligations and activities, as well as DOE's treaty obligations in Section 1.4.5 in Volume I. Section 5.4.10 in Volume I was revised to discuss the unique nature of Native American cultural and religious resources.

Comment (3596)
It is necessary to include in the description of transuranic waste that the body can be severely damaged if alpha radiation particles are ingested as well as inhaled.

Response
Volume I, Section 8.1.1, of the WM PEIS has been revised in response to this comment. It now states that human tissue can be severely damaged if alpha particle emitting radionuclides are taken into the body by inhalation, ingestion, or other means such as severe cuts. Section D.2.2 in Volume III states that the scenarios for the maximally exposed individual include radiation dose for inhalation and ingestion.

Comment (3635)
If effects within a certain radius is the method of analysis used, in order to more accurately reflect the impacts of the radiation over time, the center of the circle should not be at the center of the site, but begin at the perimeter of the site because the health risks for the waste management workers and noninvolved workers have already been (insufficiently) assessed. In reality, if we really want to understand the past, present and future health risks, concentric circles from the perimeters of all the sites, final destinations of waste and transportation routes should cover the globe. The bi-lateral convergence of these circles would give a realistic picture of the cumulative impacts/risks as well as the past, present and future health risks.

Response
DOE estimated health risks from airborne releases from treatment and storage facilities to offsite populations living within 50 miles of an existing waste management facility or the geographic center of each major DOE site and within 0.5 miles of the road and rail shipment routes. Population and individual risks would generally be low, so evaluation of impacts outside these limits was considered to be unnecessarily detailed for a programmatic analysis.

Comment (3636)
We would like to include as part of our comments and to be part of the record the book, *Dead Reckoning: A Critical Review of the Department of Energy's Epidemiological Research*, written by Physicians for Social Responsibility's Physicians Task Force on the Health Risks of Nuclear Weapons Production to be included. We make particular reference to the discussion on the low-dose ionizing radiation controversy; the BEIR V Report; and Chapters III, VI, and VII.

Response
It should be noted that the book referenced by the commentor was published in 1992, prior to recent developments within DOE such as the environmental dose reconstruction studies currently underway at many DOE sites. For example, the States of Colorado and Tennessee are reconstructing doses at RFETS and ORR, respectively. Dose reconstruction involves determining potential radiation exposure and doses from past releases to people who lived near nuclear facilities where these releases occurred. The results of these studies can be used as a basis for deciding if epidemiological studies should be

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undertaken. Further information on dose reconstruction projects is provided in the October 1966 issue *Health Physics*, which is devoted to this subject.

In living organisms, the chemical changes induced by high doses of radiation can lead to serious illness or death. At lower doses, radiation can damage DNA, sometimes leading to cancer or genetic mutations. The reference cited in the comment indicates that genetic effects may be of concern from ionizing radiation. Ionizing radiation can produce submicroscopic changes in individual genes (gene mutations) and damage the chromosome structure. Damage to the genes in the germ cell of the testes or ovaries may result in the transmittal of heritable mutations. Little experimental study data exists on humans. Most of the available data are based on experimentation with animals. However, as described in the Hanford Tank Waste Remediation System EIS, a study of 38,000 offspring who had a least one parent exposed to radiation at Hiroshima or Nagasaki showed no statistically substantial effects resulting from the exposure. Based on human and animal genetic data, the number of genetic effects in an average population exposed to 1 rem per 30-year generation was calculated to be 15 to 40 additional cases of genetic disorders per million live birth offspring. Assuming the conservative end of the range, 40 additional cases per million results in a dose-to-risk conversion factor of 4×10^{-5} for genetic effects. For radiological doses, DOE calculated estimates of potential genetic effects within the PEIS using the conversion factors of 1×10^{-4} genetic effects per rem for public receptors and 6×10^{-5} genetic effects per rem for worker exposure (see Section D.2.8.2 Appendix D). Thus, the dose-to-risk conversion factors used in the WM PEIS analysis were more conservative than that used in the study cited in the reference.

The primary source of judgments on the effects of low-dose radiation has been the National Academy of Science's succession of reports on the Biological Effects of Ionizing Radiation (BEIR). The National Academy of Sciences BEIR V report asserted in 1990 that radiation is almost nine times as damaging as estimated in BEIR I and that annual doses should no longer exceed 5 rem per year. The Federal Government established its own radiation protection standard to be 5 rem per year in 1968.

Chapter III of the BEIR V report of the above-cited reference addresses the DOE epidemiologic studies conducted prior to 1992. The reference indicates that there was a lack of information at that time concerning past human exposures. However, it should be noted that the DOE recently has undertaken "dose reconstruction" studies around several of its facilities to gain a clearer understanding of potential health effects through epidemiological research. As an example, one of the earliest and more thorough research efforts concerned the Hanford Site in Washington State, where historical data are being identified, reviewed, and analyzed in order to understand atmospheric, river, and groundwater conditions that affected the transport of radioactivity. Dose reconstruction studies at Hanford and other sites will help build the informational foundations for sound risk assessment and will be invaluable in a wide range of environmental projects.

Chapters VI and VII of the BEIR V report imply that secrecy concerning epidemiological data for DOE workers has "plagued the entire AEC/ERDA/DOE operation and is totally inappropriate in investigations of health and safety." Note that Energy Secretary Hazel O'Leary's "openness initiative" has identified many types of information that no longer need to be kept secret to protect National security. Since December 1993, the DOE has opened its files on various information concerning issues such as health and safety, experiments with human beings, and hundred of other subjects. In addition, DOE's leadership in the recent past has made a substantial effort to expand its existing mechanisms for informing the public of potential risks and benefits of the DOE's proposed actions. Citizen advisory

boards at 11 of the major sites in the weapons complex have been established. Several of the DOE's external advisory groups have been restructured and strengthened to further support and encourage public involvement.

Comment (3637)
Are you assuming that the hypothetical farm family is incestuous? or they mate with aliens to create the next generation! We are concerned that the hypothetical farm family is not an accurate representation of a farm family that would live on the same land for 10,000 years. The analysis does not take into account the genetic exchange and accumulated genetic damage with outside populations living around the same DOE site (the girl next door?), thus being a member of another hypothetical farm family. The accumulated genetic damages (from regulated and/or unregulated radiological and chemical releases) throughout the generations is obviously not taken into account.

Response
The WM PEIS does not make the assumptions referenced in the first part of the comment. Volume II Site Data Tables present estimates of the probability of the farm family maximally exposed individual from the most exposed lifetime experiencing genetic effects. Tables D.3.2-33 through D.3.2-46 and D.3.5-23 through D.3.5-29 in Appendix D (Volume III) present the estimated numbers of genetic effects summed across all 143 lifetimes of the hypothetical farm family. Note that these estimates are simply totals of the discrete estimates for each lifetime. Potential genetic damage is *not* accumulated across generations.

Comment (3639)
Table 8.4-2, Transuranic Waste Health Risk Analysis Components. We are not clear as to why for the column "endpoints" under the rows for "number of genetic effects" and "probability of genetic effects," chemicals are not listed in the "source" column. Especially in light of the fact that all transuranic waste is being analyzed as if it were mixed waste.

Response
Table 8.4-2 in Volume I is intended to be used as an overview of the health risk end points, receptor groups, hazard sources, pathways, and exposure periods evaluated for transuranic waste treatment. The number of potential genetic effects and probability of genetic effects resulting from exposure to chemicals are not included in the table because none of the hazard or exposure indices estimated for the alternatives or evaluated in transuranic waste treatment exceed 1.0. Therefore, no non-cancer risks of concern are expected.

Comment (3642)
In Tables 8.4-4 and 8.4-7, we are not clear as to why in the rows labeled "Number of Genetic Effects" and "Probability of Genetic Effects" there is no analysis of chemical genetic effects for the offsite population, noninvolved workers, and waste management workers. Please explain.

Response
Genetic effects from chemicals are included in the hazard index, but were not analyzed separately as were radionuclide effects.

As described in Section D.2.9, Appendix D in Volume III, the hazard index is an indicator of the total *additive*, non-cancer toxicity from exposure to mixtures of hazardous chemicals. It is calculated for the

offsite and noninvolved worker maximally exposed individuals at each site, by alternative, for both routine waste management operations and potential accidents. The highest offsite and noninvolved worker hazard indices for a particular alternative represent the estimated highest noncarcinogenic chemical exposure that an offsite individual and individual noninvolved worker, respectively, would receive at any site under that alternative.

Comment (3645)
What does "the number in this table are the estimated probabilities that the MEI will die of cancer from radiation exposure" mean for Table 8.4-5? Will the person die immediately upon exposure, or some other alternative? What time-frame are we talking about? This analysis is unclear and needs to be clarified.

Response
Table 8.4.5 in Volume I of the WM PEIS presents estimates of the probability of cancer fatality for the maximally exposed individuals (MEIs) in the offsite population. The MEI risk estimates are the probability that the individual will die from cancer that developed from exposure to the released radionuclides. The probability estimates are for latent cancer fatalities; that is, for disease that develops over a period of decades following the exposure. The PEIS estimates represent the probability of a cancer fatality over the lifetime (assumed to be 70 years) of the MEI as a result of the exposure.

The MEIs are assumed to be exposed to radionuclides released to the atmosphere from waste treatment and storage facilities. The facilities are assumed to operate for 10 years, except under the No Action Alternative, where the impacts of only the first 20 years of an indefinite storage period are evaluated. However, radionuclides that are inhaled or ingested are assumed to be deposited in the body and remain radioactive for a period of 50 years. Section D.2.6.3 in Appendix D, Volume III, contains additional information about the assumed 50-year period of accumulated internal radiation dose.

Section 5.4.1 was revised to incorporate information on the average risk of death from cancer in the U.S. The reader can, therefore, compare this risk to the estimated probabilities that the MEI in the WM PEIS analysis will die of cancer from radiation exposure.

Comment (3646)
Table 8.4-6 does not include analysis for offsite maximally exposed individual cancer fatality probabilities at WVDP. Why?

Response
Table 8.4-6 in Volume I has been revised in the Final WM PEIS. A footnote was added to the table to indicate that offsite maximally exposed individual cancer fatality probabilities were not estimated at WVDP due to the low inventory of transuranic waste at the site.

Comment (3647)
What does it mean to be "protective" of human health?

Response
Concentrations "protective of human health" are concentrations of hazardous chemicals that are not expected to cause adverse health effects following continuous exposure. These concentrations, which are derived only for hazardous chemicals that are *not* known or suspected carcinogens

(i.e., cancer-causing agents), are based on long-term studies using laboratory animals. Sections D.2.6.1 and D.2.9, Appendix D, in Volume III contain additional details about the calculation of these chemical-specific reference doses for ingestion exposures and reference concentrations for inhalation exposures.

Comment (3648)
Is the "Hazard Index" based on a child's exposure? If no, then why not?

Response
The Hazard Index is the ratio of the estimated concentration of a noncarcinogenic hazardous chemical in an exposure medium to the concentration presumed to be protective of human health. The latter are chemical-specific reference doses and reference concentrations. The exposure levels estimated in the WM PEIS are for an adult. However, the reference doses/reference concentrations include uncertainty factors for variability in human sensitivity to chemical exposures, which account for sensitive subpopulations, such as children and the elderly.

Comment (3649)
Why are workers generally assumed to be in better health than the general population?

Response
Besides using protective gear, populations of workers generally are healthier than the population at large, for several reasons. The general population includes many more people who are too sick to work, who have some sort of disability, who lack good medical care, or who have lower socioeconomic status. In addition, the general population includes sensitive subpopulations, such as children and the elderly.

Comment (3682)
Where and what group is used for the OK exposure standard for human health.

Response
There are a number of exposure standards proposed by EPA and DOE. These standards are developed, using all relevant available laboratory bioassay and epidemiology information, to be broadly applicable to the public in general rather than to specific populations or individuals living or working in specific locations. For example, national standards have been proposed for workers and for the general public.

Section 5.4.1.4 in Volume I contains a discussion to guide the reader in interpreting the results of the health risk analyses. Relevant risk management exposure benchmarks noted in this section include the National Emission Standards for Hazardous Air Pollutants (NESHAP) for radionuclides of 10 mrem per year, the Safe Drinking Water Act drinking water standard of 4 mrem per year, the worker radiation protection standard of 5 rem per year, and DOE's maximum allowable annual radiation dose to members of the public from DOE-operated nuclear facilities of 100 mrem per year. These standards and guidelines have been developed to be protective of human health following long-term exposure to radiation and radionuclides. Section 5.4.1.4 in Volume I also includes information about background radiation exposure and risk.

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Comment (3755)
DOE needs to be conservative and not take chances. Any radioactive exposures to the public are dangerous.

Response
The assumptions made in performing the program-level screening analyses were intended to yield reasonably conservative risk estimates (i.e., estimates that tend to overestimate rather than underestimate risk). The methods used to estimate health risk, summarized in Section 5.4.1 in Volume I and detailed in Appendix D in Volume III, have been found to be reasonable by a peer review panel, EPA, and the Centers for Disease Control. Sitewide or project-level NEPA analyses will contain more detailed assessments of worker and public health risks.

DOE is cognizant of the potential health risks posed by exposure to radioactivity. It has, therefore, adopted a policy known as ALARA (as low as reasonably achievable). ALARA is an approach to control or manage radiation exposure (both individual and collective to the workforce and the public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. This is a process that has as its objective the attainment of dose levels as far below applicable limits as possible.

Comment (3758)
From an economic perspective, it is understandable that to use an existing facility would be cheaper than to build a new one. How can DOE measure in dollars the value of human health. One child dying is too many.

Response
DOE does not attempt to trade-off the potential risks versus the costs of waste management actions. Rather, the WM PEIS addresses health risks and costs as separate impact parameters. Each is independently considered in the decisionmaking process.

Comment (3776)
The deposition of nuclear waste, perhaps even small flakes, could cause 93 people to die. Even over the long-range, this is too many people.

Response
DOE cannot respond precisely to this comment without further information about the commentor's concern. DOE's approach to its management of radioactive waste is known as ALARA--as low as reasonably achievable. This is an approach to control or manage radiation exposure and release of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. ALARA is a process that has as its objective the attainment of dose levels as far below applicable limits as possible.

Comment (3802)
Predictions for cancer fatalities should be based on actual data. Get actual or real data.

Response
Toxicity and exposure values used in the WM PEIS are based largely on actual human and animal data. Cancer fatalities are considered in the development of the toxicity and exposure values that were used in the analysis, hence, are indirectly included.

Any prediction into the future involves assumptions and uncertainties. The human health risks analysis, including potential cancer fatalities, used a conservative approach to be as protective as possible. In radiation-induced cancer, the PEIS assumed that there is no threshold below which there is no cancer risk. In addition, the risk of cancer from multiple exposures to different sources was assumed to be additive, and a certain percentage of radiologically-induced cancers were assumed to be fatal. Similar assumptions regarding potential fatalities from chemically-induced cancers are not possible because of the diverse nature of chemically induced cancer. More details about the methodologies and assumptions used to assess human health impacts can be found in Section 5.4.1 in Volume I, Appendix D in Volume III, and Appendices E, and F in Volume IV of the WM PEIS.

Comment (3880)
The PEIS projects essentially zero deaths to the ANL-E offsite population based on a 10-year exposure and a 70-year life expectancy. DOE needs to look at using a 90-year life and 60-year exposure in the cancer fatalities estimates.

Response
The WM PEIS health risk impacts analysis estimates less than one latent cancer fatality in the offsite population at ANL-E as a result of exposure to radionuclides released from waste treatment facilities. The treatment facilities are assumed to operate over a 10-year period. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. Once radionuclide contaminants are inhaled or ingested, they are assumed to continue irradiating body tissues for a period of 50 years. This assumption, known as committed effective dose equivalent, is commonly used in assessing potential risks from radionuclide exposure. Section D.2.6.3 in Volume III provides additional details of the radionuclide exposure assessment. The assumed 70-year average lifetime is also a standard factor used in health risk assessments. The health risk analyses are based on a number of conservative assumptions which likely account for differences due to longer exposure periods.

Comment (3881)
DOE needs to explain how they measure illness from radiation exposure.

Response
The health endpoints used in analyzing radiation risk were cancer incidence, cancer fatality, and adverse genetic effects which, for members of the public, were assumed to be directly proportional to the amount of absorbed radiation and to occur in a fixed ratio of 15:7:1. See Section D.2.5 in Volume III for details of the WM PEIS.

Comment (3884)
All radiation causes genetic changes.

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Response
As described in Section D.2.6.2 in Volume III of the WM PEIS, all radiation is not equal in terms of causing genetic damage or other effects to human cells. The same dose (absorbed by the human body) of different types of radiation (e.g., alpha, beta, gamma) can produce different health risk outcomes and different effects on living cells. To standardize for these effects, a unit of radiation measure called a "rem" is used as a way of measuring the biological effects of a given dose of any type of radiation. The rem has built-in factors that weight the dose according to each type of radiation's capacity for causing biological damage (this capacity is called the "biological effectiveness" of the radiation). This unit of measure allows comparison of the biological effects (on a given type tissue) of radionuclides that emit different types of radiation. See *DOE Worker Health Risk Evaluation Methodology for Assessing Risks Associated with Environmental Restoration and Waste Management* (ORNL, 1995b) for a more detailed description of the different types of radiation.

The various organs of the body have different susceptibilities to harm from radiation. For example, the gonads tend to be more sensitive to radiation damage than the cornea of the eye. The unit of measure that takes these different susceptibilities into account to provide a broad indicator of the total effective radiation dose is called an "effective dose equivalent." It is obtained by multiplying the dose (or "dose equivalent") in rems in each major organ or tissue by a weighting factor associated with the risk susceptibility of the tissue or organ, then summing the totals. This unit of measure allows comparison of the general adverse consequences to people who are exposed to radiation, regardless of the different susceptibilities of individual types of tissue in different organs to such exposure.

Comment (3905)
DOE needs to look into whether any studies have been done on ANL-E employees for cancer. DOE needs to use actual data and not projected or expected data.

Response
DOE has undertaken "dose reconstruction" studies around several of its facilities to gain a clearer understanding of potential health effects through epidemiological research. As an example, one of the earliest and more thorough research efforts concerned the Hanford Site in Washington State, where historical data are being identified, reviewed, and analyzed in order to understand atmospheric, river, and groundwater conditions that affected the transport of radioactivity. Dose reconstruction studies at Hanford and other sites will help build the informational foundations for sound risk assessment and will be invaluable in a wide range of environmental projects. Discussions with Argonne National Laboratory-East (ANL-E) site personnel indicated that cancer incidence studies had, however, not been performed on ANL-E employees.

Any prediction into the future involves assumptions and uncertainties. The human health risks analysis, including potential cancer fatalities, used a conservative approach to be as protective as possible. In radiation-induced cancer, the PEIS assumed that there is no threshold below which there is no cancer risk. In addition, the risk of cancer from multiple exposures to different sources was assumed to be additive, and a certain percentage of radiologically induced cancers was assumed to be fatal. Similar assumptions regarding potential fatalities from chemically-induced cancers are not possible because of the diverse nature of chemically-induced cancer. More details about the methodologies and assumptions used to assess human health impacts can be found in Section 5.4.1 in Volume I, Appendix D in Volume III, and Appendices E and F in Volume IV of the WM PEIS.

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Comment (3906)
DOE needs to explain expected rates of cancer to the public so they can understand.

Response
Section 5.4.1 in Volume I describes the methods used to evaluate health risk impacts in the WM PEIS. This section contains a discussion on how risk results should be interpreted. Section 5.4.1.4 in Volume I specifically explains cancer fatalities and incidences, and how they are analyzed in the PEIS. Chapters 6 through 10 in Volume I present the waste-type specific results of the health risk analyses.

The PEIS health risk analyses evaluated the potential impacts of exposure to radionuclides and hazardous chemicals released from waste treatment, storage, and disposal facilities. Risks were estimated for populations of workers and the general public living within a 50-mile radius either from existing waste management facility or the geographic center of the site. The PEIS analysis estimated the potential numbers of *cancer fatalities* for populations of workers and the general public receiving exposure to radionuclides or direct radiation (workers). The analysis also estimated the numbers of *cancer incidences* in these populations resulting from exposure to hazardous chemicals. In addition to these estimates of collective risks to populations of receptors, the analysis also evaluated the risks to the individual receptors in the populations estimated to receive the highest exposures. The risks to these maximally exposed individuals are estimated as the probability of cancer incidence or cancer fatality over the lifetime of the individual.

Comment (3942)
Assumptions of impacted regions surrounding DOE sites should be calculated from the site boundaries, not from the center of sites. Calculations of impacted regions should be done by air miles, not road miles.

Response
The WM PEIS considered sites where waste management facilities might be built, but not the precise locations on those facilities. Where to locate a facility on a site is more appropriately addressed in sitewide or project-level environmental analyses. For analysis purposes, the WM PEIS assumed that future waste treatment and storage facilities will be located at the center of the site, except at the larger sites, where the new facilities are assumed to be located in the vicinity of existing waste management facilities. Additional information on the assumed locations at each site used in the health risk analysis is presented in the technical report referenced in Section D.2.1 in Volume III. Note that the new waste management facilities were not assumed to be located at the boundaries of any of the sites evaluated.

The region of interest for health risks was an area with a radius of 50 miles as discussed in Volume I, Section 4.2.2. As discussed in Section 5.4.1.2 in Volume I and in Section D.2.2 in Volume III, the offsite population or general public receptor group was assumed to be the population living within this circle. Since the radius is a straight line, distance is measured in "air miles."

Comment (3991)
Did DOE consider adverse impacts to members of the public who rely on the Ohio River for their drinking water?

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estimate chemical carcinogen-associated risks are derived from animal studies and are believed to be more conservative due to the uncertainty involved in extrapolating results for humans.

Comment (4419)
The Draft WM PEIS addresses only the impacts on human health of air pollution from waste treatment, making the unjustified and unlikely assumption that water pollution impacts will be negligible because associated discharges will go through wastewater treatment systems.

Response
DOE assumed that some impacts on water resources would be minimal at all sites, regardless of the waste type and alternative. The WM PEIS discusses these potential minimal effects (e.g., impacts to floodplains, impacts from runoff and sedimentation, impacts from wastewater discharges, impacts from disposal) in Section 5.4.3.3 in Volume I; they are not addressed in the waste-type impacts analyses presented in Chapters 6 through 10 in Volume I. DOE would conduct further evaluations of these potential effects as part of sitewide or project-level NEPA studies. Releases of hazardous constituents to surface waters from the operation of routine waste management facilities were assumed to be limited because of treatment and recycling of wastewaters. Releases to surface waters could result from accidents at waste management facilities or from transportation accidents. The WM PEIS assumes that the impacts from a spill or leak of wastes will be limited by:

- Dilution in the receiving water body;
- Remedial actions taken to contain or remove the contaminants;
- The relatively smaller number of individuals potentially exposed than those exposed through the air pathway.

Finally, the potential frequency of occurrence of the accident or initiating event could limit the impacts; that is, an accident could have the potential to produce adverse impacts on a relatively large area of surface water if it occurred, but the actual probability of occurrence could be small.

Comment (4426)
DOE should quantitatively evaluate the differences in the conservatism of modeling and associated assumptions for evaluating transportation impacts versus stationary source impacts and their implications concerning trade-offs between site impacts and transportation impacts. The WM PEIS should also include information on the combined risks of transportation and stationary source impacts. An imbalance in the systematic uncertainties between transportation and stationary source models and associated assumptions could systematically bias the relative differences in risk estimates among risk management alternatives to favor alternatives with minimum transportation.

The Draft WM PEIS does not contain information on the combined impacts for enough combinations of alternatives for the cumulative impacts section to provide adequate input for deciding where to treat, store, and dispose of waste.

Response
The WM PEIS used different types of models to estimate potential risks from stationary sources, such as waste management facilities, versus those from wastes transported under the Regionalized and Centralized Alternatives. The risk analyses for waste management workers considered the effects of shielding on limiting exposures to direct radiation from stationary sources. However, the transportation

assessment could not use shielding as a factor in reducing exposures because of uncertainties about potential locations of the receptors (e.g., the offsite population) in relation to the shipments. As a result, the transportation radiological risk estimates are conservative, i.e., higher than would be likely to occur on the implementation of the alternatives. This difference in conservatism does not complicate the risk management decisionmaking process because transportation radiological risk estimates are routinely lower than transportation physical trauma risks. Therefore, the risk manager must balance potential risks associated with exposure to radionuclides and radiation released from waste management facilities under the various alternatives against potential transportation risks associated with physical trauma from accidents.

The combined impacts analysis looks at the impacts of waste management operations at a particular site as defined in the WM PEIS analysis of alternatives.

Transportation and stationary source risks are not combined because the receptors differ between the two sources. The maximally exposed individuals for transportation occur along the transportation route, whereas, the maximally exposed individuals for stationary sources occur in the offsite populations of individual DOE facilities.

Comment (4432)
When delineating exposures from DOE sites, DOE should quantitatively characterize, in the affected environment and cumulative impact sections of the WM PEIS, impacts at the locations of existing receptors and potential maximum impacts at the location where the general public currently has access (or would in the future under WM PEIS assumptions), unless mitigating measures are taken. The Hanford Site, ORR, ANL-E, and PGDP have hot spots near the site boundaries that are not currently occupied, but which could be in the future unless appropriate mitigating measures are taken.

Response
The WM PEIS evaluates potential health risk impacts to offsite populations from waste treatment operations that would occur over an assumed 10-year period. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. Impacts to offsite populations during the operations period would result primarily from airborne releases of radionuclides and hazardous chemicals from waste treatment facilities. DOE would maintain institutional control of the sites during this 10-year operations period. As a consequence, the offsite population should not be able to come in contact with hot spots of contamination inside the site boundary. The WM PEIS Affected Environment Technical Report cited in Chapter 4 in Volume I contains quantitative estimates of existing hot spot contamination at the sites. This technical report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS. DOE deals with mitigation measures for hot spots at each site as part of the site environmental restoration and health and safety programs.

The PEIS evaluates the health risk impacts from waste treatment to offsite populations living within a 50-mile radius either from an existing waste management facility or the geographic center of the site, to site workers not directly involved in waste management activities (noninvolved workers), and to waste management workers. The health risk analyses include quantitative estimates of risk for maximally exposed individuals (MEIs) in the offsite population and the noninvolved worker populations. The modeling analyses estimate the locations of the MEIs in the regions of influence and on the site. The

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location of the offsite MEI was considered only in the environmental justice analysis and was determined by reviewing the WM PEIS risk modeling results to locate the census tract in the sector block containing the offsite MEI for each selected site. It is inappropriate to compare the locations of MEIs estimated by the PEIS analyses to those identified in other DOE reports, such as site annual monitoring reports, or to estimate waste treatment exposures and risks at other locations (e.g., at fencelines) because different models and assumptions were used for these calculations. Within the WM PEIS, the MEIs for chemical risk assessment and radiological risk assessment could be in different physical locations.

Comment (4443)
With respect to the time periods over which health risks were evaluated, the statement in the Draft PEIS Summary, Section 3.2.1, that 70-years was used to evaluate risks from exposure is misleading because the number of fatalities from radiation from existing DOE sites in the Cumulative Impacts section of the Draft PEIS is based on only one year of exposure.

In addition, radiation and radionuclide exposure can cause mutagenic impacts that can be passed from generation to generation. These should be evaluated in terms of the risk to the children and to those exposed, and in terms of the total expected number of persons adversely impacted for all future generations combined.

According to other studies, the number of persons suffering severe mutation from radiation and among their offspring for all future generations combined from a single exposure could be an order of magnitude higher than the number predicted by the theory used in the WM PEIS, due to such persons having children and genetic equilibrium limiting the extent of their reproduction in future generations. In addition, the proportion of a population suffering from severe handicaps due to continuous exposure could be an order of magnitude higher than the modeling predicts.

The impacts of soil contamination often manifest as a maximum risk to the public decades or even hundreds of years after the soil was contaminated, when the contaminants leach out of the soil and into groundwater. Persons are exposed to much larger volumes of contaminated groundwater than contaminated soil. The routes of exposure include direct ingestion, skin contact, and airborne contact (when showering, washing, cooking, as well as when using groundwater irrigation).

Soil contamination and associated groundwater contamination could occur from dustfall and other deposition phenomena from air pollution. DOE should evaluate this route of exposure, at least to the degree necessary to determine if it could be significant compared to the other routes of exposure evaluated.

Response
DOE revised Chapter 11 in Volume I of the WM PEIS to incorporate estimates of the collective radiation dose and cancer risk for the offsite population. These estimates represent doses and risks that would occur over the 10-year time frame of operations. The PEIS presents offsite maximally exposed individual impacts as annual exposures and risks.

The PEIS does not address the tracking of mutagenic effects across generations. The limited methodologies developed to address inheritable mutagenic effects from radiation have not been sufficiently adopted by the risk assessment community to justify their use in all cases.

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Section D.2.3.1 in Volume III of the WM PEIS reports that human health risk from the consumption of surface water contaminated by airborne deposition would be at least three orders of magnitude smaller than the dose resulting from inhalation. Therefore, DOE eliminated this pathway from detailed analysis. Airborne deposition onto soils and subsequent leaching into the groundwater probably would have less health risk than direct deposition onto surface water due to the time lag involved and the adsorption of contaminants onto the solid particles.

DOE assumed groundwater pathways of exposure were most significant for disposal scenarios in which waste is buried. For routine operations associated with treatment and storage, exposures resulting from atmospheric emissions from stacks and vents were assumed to be of primary concern. Although contaminants released to the atmosphere could settle on the ground and migrate through soil into the groundwater, the contaminants would be highly diluted at this point and subsequent risks would not be expected to be significant. The analysis of health risks resulting from the disposal of low-level waste and low-level mixed waste evaluated only ingestion of contaminated groundwater as drinking water and use of contaminated groundwater to irrigate crops. The PEIS evaluated potential health risks of the irrigation scenario in the hypothetical farm family analysis. In this analysis, a farm family receptor draws water from a well 300 meters (984 feet) downgradient from the center of the disposal facility. The receptor drinks water, irrigates crops, and waters livestock from a contaminated well. The farm family scenario addresses potential risk to a series of individual receptors. This analysis has been supplemented in Section 6.4.1.8 and 7.4.1.7 in Volume I in the Final WM PEIS by an analysis of the relative vulnerability of the proposed disposal sites for risks to the offsite public from groundwater contamination.

Although any number of exposure pathways could be applicable to a particular scenario at a particular site, DOE selected the pathways assumed to be applicable and most significant with regard to risk for assessment in the PEIS. Although other routes of exposure (e.g., shower inhalation) could be applicable, DOE assumed that exposures from disposal would be driven by the ingestion of contaminated drinking water and of agricultural products contaminated by irrigation.

Comment (4454)
In the Draft WM PEIS Summary, analysis of human health risks in Section 4.3 focuses on population risks exclusively, failing to cover risks to the maximally exposed individual (MEI). Many State and Federal regulations (such as the Clean Air Act of 1990 and the National Contingency Plan and associated Superfund regulations), as well as RCRA guidance to permit writers, focus on risks of cancer (not cancer fatality) to the MEI in the general public. DOE should include meaningful summaries of this for members of the general public workers.

The information on population risks in the Draft PEIS is inadequate to resolve differences among alternatives concerning cancer risks to the general public. Many categories of population risks are not adequately quantified. DOE should quantify the order of magnitude of such risks.

Information on the order of magnitude of the uncertainties in the population risk numbers and MEI risk numbers should be provided in the WM PEIS Summary. They should be quantified as they impact the relative impacts of alternatives compared to each other, and in terms of uncertainties in absolute risks.

In addition, the tables in the PEIS should specifically delineate the risks for workers and for members of the general public if trains rather than trucks are used for transportation.

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Response
The summary sections in the WM PEIS present a general overview of the analysis of particular waste types. Specific numbers associated with the waste types (i.e., costs, risks [including MEI], volumes, etc.) are reported in other sections of the WM PEIS along with interpretations and discussions of the results. For example, MEI cancer incidence and cancer fatality risks are reported in Chapters 6 through 10 in Volume I and Appendix D in Volume III.

Table 4.3-1 in the Summary document lists estimated numbers of fatalities in receptor populations from low-level mixed waste treatment, disposal, and transportation. The information in this table is a subset of the more detailed information presented in Section 6.4 in Volume I. In addition, Table 4.3-1 in the Summary lists only transportation risks for trucks because truck risks are higher than those for rail. Tables 6.4-17, 7.4-14, 8.4-9, and 9.4-7 in Volume I list information on rail transportation risks.

Comment (4468)
Section 8.3.1 of the Draft WM PEIS Summary document states that incidences of cancer to the offsite populations for routine operations and accidents would be less than one for all hazardous waste management alternatives. DOE should evaluate an incidence of cancer of even 0.00001. Merely saying that the incidence of cancer is less than one is inadequate. Cancer risks to the maximally exposed individual should be summarized. Section 8.3.1 also refers to noncancer risks to the maximally exposed individual as low. What is meant by "low"?

Response
The Section referenced in the comment is intended to summarize the risk of cancer for the offsite populations. Therefore, Section 8.3.1 of the Summary document indicates that less than one incidence of cancer is likely to result in the offsite populations at the hazardous waste treatment sites. More specific information on the WM PEIS health risk analysis for hazardous waste is presented in Section 10.4 in Volume I. As described in Section 10.4, risks were estimated for both the entire offsite population receptor group at each site and for the maximally exposed individual in the offsite population. Collective population risks are presented as numbers of incidences of cancer or other adverse effects in the population. Maximally exposed individual risks are presented as probabilities of incidence in the lifetime of the maximally exposed individual.

DOE estimated cancer incidences for the offsite population and waste management worker populations for every alternative; the estimates include those reported only as "less than one" in Section 10.4. The estimates are presented in Appendix D in Volume III and in the Volume II Site Data Tables for each of the proposed hazardous waste management sites identified in Section 10.1.2 in Volume I.

The statement in Section 8.3.1 about maximally exposed individual noncancer risks being "low" means that adverse noncancer health effects are not likely to result from exposure to hazardous chemicals released from waste treatment facilities.

Comment (4474)
The WM PEIS analysis of cumulative impacts should include the following considerations: While an individual worker might not work simultaneously at more than one type of facility, some workers have more than one job and some workers might change jobs during their careers. Measures designed to prevent excessive exposure to people with multiple jobs should also be factored into the analysis.

Response
Chapter 11 in Volume I of the Final WM PEIS was revised to incorporate waste management worker risk information into the cumulative impacts analysis. Collective radiation dose and cancer risk for the worker population at each site over a 10-year period of operations was included. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS.

The detailed analysis for individual workers as described by the commentor is not appropriate for the cumulative impact analysis of a programmatic EIS and has not been incorporated into Chapter 11. However, DOE takes precautions to minimize worker exposures including multiple exposures. DOE would comply with all applicable laws and regulations pertaining to worker exposure, such as 10 CFR Part 835 and DOE Order 5480.11. DOE uses further guidance provided in the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, Standard Operating Safety Guides, Field Standard Operating Procedures, and the DOE Radiological Control Manual.

Comment (4483)
The Draft WM PEIS does not adequately characterize the differences in risk assessment for radiation versus chemical exposure.

Response
Section D.2.6.3 in Volume III of the Final WM PEIS has been revised to provide the following clarification: In comparing the risks associated with radionuclide exposures to those from chemical carcinogen exposures, it is important to note that radionuclide and chemical carcinogen risks are determined by different methods. The dose conversion factors used to estimate radionuclide associated risks are based on observed potency in humans (typically studies of atomic bomb victims). The slope factors used to estimate chemical carcinogen associated risks are derived from animal studies and believed to be more conservative due to the uncertainty in extrapolating results for humans. These differences in risk estimation should be considered when comparing radionuclide and chemical carcinogen risks.

Comment (4488)
No justification for limiting human health impacts to 50 miles from sites is provided in the Draft WM PEIS. DOE should analyze how much the number of predicted fatalities would increase if inputs were evaluated worldwide to determine if the relative and absolute impacts of the alternatives beyond 50 miles could be significant. Even if this is not done for a new Draft PEIS, it must be done for cumulative impacts to meet NEPA requirements. This requires coordination of the human health impact assessment methodologies and assumptions and sharing of information among the various PEISs being written by DOE. It also requires a detailed evaluation of the methods and parameters used to evaluate human health impacts in past PEISs, and mapping the results into the framework used to evaluate risks, with appropriate caveats for uncertainties.

Response
Estimating exposures to the population residing within a 50-mile radius of a site is very typical in the field of risk assessment and in NEPA assessments in general, and is reasonable for the purposes of the WM PEIS. Most atmospheric fate and transport models are designed to calculate exposures within a 50-mile radius. For the WM PEIS, the public receptor group was assumed to be the population living within an 80-kilometer (50-mile) radius of either an existing waste management location for the largest

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DOE sites (the Hanford Site, INEL, LANL, NTS, ORR, and SRS) or the geographic center for the 11 smaller DOE sites.

Comment (4520)
Taken alone, the hazard quotients referred to in Section 5.4.1 of the Draft WM PEIS are inadequate for evaluating the threshold toxic impacts of chemical pollutants to the general public. Standard EPA Superfund risk assessment procedures use hazard indices for these purposes, based on the sum of hazard quotients. The hazard index concept is very similar to the Exposure Quotients used to evaluate worker exposure.

Most Occupational Safety and Health Administration standards for carcinogenic risks are based on Threshold Limit Values (TLVs). Exposure at TLVs, when based on threshold toxicity, is unlikely to cause adverse impacts on normal healthy workers. However, about 10% of the workers are considered to be hypersusceptible and may be adversely affected at TLVs. Screening procedures, medical monitoring, and other measures taken to reduce the number of hypersusceptible workers who may be exposed should be evaluated as part of the WM PEIS.

Response
The WM PEIS evaluation of noncancer toxic effects resulting from exposures to hazardous chemicals follows the recommendations for such analyses in EPA risk assessment guidelines. As described in Section D.2.9 in Appendix D (Volume III), Hazard Quotient values are calculated for each hazardous chemical to which receptors might be exposed. These values are calculated by estimating the receptor's predicted exposure and dividing by maximum acceptable exposure levels based on chemical-specific EPA Reference Dose and Reference Concentration values. The Hazard Quotient values for each hazardous chemical are summed to yield a Hazard Index estimate. According to the EPA risk assessment guidelines, if the Hazard Index value is less than or equal to 1, the potential exposure is unlikely to produce adverse toxic effects.

As a screening-level analysis, the WM PEIS worker health risk assessment does not address particularly susceptible members of the workforce. Risks to sensitive subpopulations of receptors and any needed mitigation measures can only be meaningfully addressed in site worker protection and medical monitoring programs.

Comment (4521)
DOE should provide in the WM PEIS a credible analysis of the adequacy of the risk assessment within a 50-mile radius of sites as well as within 0.5 mile of transportation routes for estimating the total numbers of fatalities associated with alternatives (regardless of the distance from the source).

Response
The primary route of exposure of offsite populations to contaminants released from waste management actions would be airborne exposure to radionuclides or hazardous chemicals released from waste treatment facilities. Air dispersion of contaminants within a 50-mile radius of the discharge point is commonly used in these types of analyses. This distance is believed to adequately address potential exposure and risk from this pathway.

Exposure to members of the public from waste transportation is primarily from direct radiation of the cargo. Exposure decreases as distance from the surface of the truck or railcar increases. A 0.5-mile

distance from transportation corridors adequately addresses potential exposure and risk from this pathway.

Comment (4526)
DOE should evaluate in the WM PEIS exposure to the offsite population from surface water contamination and associated contamination of fish. The impacts from this exposure pathway exceed those from air pollution and groundwater at several sites, and from high-level waste treatment at West Valley, according to site safety report information. DOE does not provide convincing evidence in the Draft WM PEIS that discharges to surface water would not be significant for the alternatives being evaluated, and that the resulting exposure pathways would not cause the highest potential human health and environmental impacts for waste treatment, storage, disposal (especially for intruder scenarios), along with transportation accidents.

Groundwater pathways from waste treatment, storage, and transportation accidents should be evaluated in the WM PEIS to establish if their significance compared to other pathways is negligible, or to quantify the impact if it is not.

Contamination of wildlife and subsequent ingestion of such wildlife in accident scenarios (including transportation accidents) should be evaluated in the WM PEIS, along with mitigating measures. DOE should commit to appropriate containment and operation of waste storage, treatment, and disposal facilities to ensure that contamination by direct contact with contaminated portions of waste treatment, storage, and disposal facilities (such as open-top wastewater treatment tanks, landfills while material is being placed in them, waste storage piles, etc.) or by eating biota that had direct or indirect contact.

Response
The WM PEIS health risk analysis does not address bioconcentration of contaminants in aquatic systems, which would require an array of assumptions about site-specific variables, including exact locations of new waste treatment facilities on DOE sites. Siting treatment facilities is not part of PEIS decisionmaking. Any such analysis would be subject to extreme variability based on the analysis assumptions and location selection. However, Section 5.4.3 in Volume I and C.4.3.4.10 in Volume III have been revised in the Final WM PEIS to provide more detailed discussions of the potential vulnerability of sites to surface water impacts from waste management actions. In addition, the groundwater pathway was evaluated in the hypothetical farm family scenario analysis for disposal of low-level mixed waste and low-level waste.

Consumption of wildlife contaminated as a result of the routine operation of waste management facilities or from facility or transportation accidents is not evaluated in the WM PEIS because this exposure pathway is not relevant for most members of the offsite public. Additional site-specific information, which would be better addressed in sitewide or project-level NEPA, would be required in order to develop credible estimates for this pathway.

As noted in Section 1.7.3 in Volume I, reduction of human health risk and minimization of adverse environmental impacts were criteria for selecting the WM PEIS preferred alternatives. Moreover, DOE must comply with all applicable environmental and safety laws and regulations, which ensures that DOE's waste management facilities will be appropriately contained and operated.

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Comment (4528)
With regard to Section 5.4.1 of the Draft PEIS, which discusses surface water contamination: While the concentrations in surface water may be less than those in groundwater, surface water contamination may nevertheless have higher impacts than groundwater contamination because the contaminants are bioconcentrated in fish, which are eaten.

Response
The WM PEIS health risk analyses does not address bioconcentration of contaminants in aquatic systems. This type of analysis would require that an array of assumptions be made about site-specific variables, including the exact locations of new waste treatment facilities on DOE sites. The latter is not part of programmatic decisionmaking. Any such analysis would be subject to extreme variability based on the analysis assumptions and location selection. However, Section 5.4.3 in Volume I and Section C.4.3.4.10 in Volume III have been revised in the Final WM PEIS to provide a more detailed discussion of the potential vulnerability of sites to surface water impacts from waste management actions.

Comment (4530)
With regard to the observation in Section 5.4.1 of the Draft WM PEIS that genetic toxicity is more difficult to assess because of its diverse nature: It is not the diverse nature of chemicals that makes genetic toxicity more difficult than radioactivity toxicity to assess; it is the lack of information and methods to assess the genetic potency of the chemicals and the mixtures of chemicals.

Response
Genetic toxicity includes a number of different kinds of effects or endpoints, including gene mutations, which alter the makeup of genes, and gross chromosomal aberrations, which alter the structure or number of chromosomes. The type of genetic toxicity resulting from exposure to hazardous chemicals depends on the mechanism of action by which the compound interacts with the genome. Because different compounds can produce different types of effects, such an analysis must consider chemical-derived genetic toxicity on a compound-specific basis. This kind of analysis is more difficult and requires more assumptions than appropriate for a programmatic study.

By contrast, it is easier to analyze potential genetic effects resulting from radiation exposure because the mechanism of radiation effects on genetic material is similar for all radionuclides. Potential exposures were estimated using the environmental fate models identified in Section D.5 in Volume III of the WM PEIS. These models summed potential exposures from different types of radionuclides as person-rem (population) or rem (individual) estimates. The estimated doses were converted to risks by the application of International Commission on Radiological Protection risk factors. For example, the International Commission on Radiological Protection risk factor for genetic effects (which is treated as a single endpoint) for public receptors was 0.0001 genetic effects per rem-lifetime. This value was multiplied by the estimated population exposure (person-rem per lifetime) to obtain an estimate of the number of genetic effects that could occur in the population. This analysis did not require tracking exposure to individual radionuclides.

Comment (4531)
DOE should explain in more detail in Section 5.4.1 of the Draft WM PEIS how the probability of cancer fatalities is calculated. The probability of cancer and cancer fatality for individuals is generally calculated for the most exposed individual, or for various individuals with various levels of exposure.

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Calculating total cancer fatalities for populations involves multiplying the populations with various amounts of risk of cancer fatality by the associated risks and adding the resulting amounts of calculated fatalities to get a total for the population, or computing some sort of risk and population weighted average risk and multiplying by the population (a mathematically equivalent procedure). DOE indicates that the total number of people in the population in each generation is assumed to stay the same. Elsewhere in the Draft WM PEIS, the problem of estimating impacts to future offsite populations of unknown sizes is used as an excuse for not calculating offsite population impacts and focusing on a farm family. This seems quite contradictory.

Response
In accordance with common risk assessment practice, the WM PEIS health risk methodology includes the estimation of collective risks to populations of receptors and risks to maximally exposed individuals living in those populations. The health risk methodology discussion in Section 5.4.1 in Volume I is a summary of the detailed information presented in Sections D.2.6, D.2.7, and D.2.8 in Volume III.

The hypothetical farm family scenario used to assess potential health risks from the disposal of low-level mixed waste and low-level waste assumed a family of four individuals. The size of the family was assumed to remain constant over each of the 143 generations analyzed. In the discussion of populations and individuals at risk in Section 5.4.1.2.3 in Volume I, the rationale for not evaluating risks to current offsite populations from disposal is based on the use of generic siting assumptions in the WM PEIS, not on problems related to estimating future population sizes. The rationale goes on to state that analysis of future offsite population risks from disposal requires similar information on the exact location of disposal facilities on a site, and involves additional uncertainty about the sizes of future offsite populations (i.e., non-farm family receptors living in the region of influence). Therefore, the discussions are not contradictory.

Comment (4532)
The statement in Section 5.4.1 of the Draft WM PEIS that the occurrence of other health impacts evaluated (except noncancer toxicity) generally follows the same pattern as radionuclide impacts is misleading, because the occurrence of genetic impacts does not follow the same pattern as radionuclide-induced cancer fatalities; the impacts of genetic damage continue for future generations and spread throughout populations.

Response
In the discussion of potential cancer fatalities in Section 5.4.1.4 in Volume I, the other health impacts evaluated, except noncancer toxicity, were reported to follow the same general pattern as potential radionuclide-induced cancer fatalities. Genetic effects are noncancer toxic effects. The WM PEIS considers genetic effects only for currently exposed generations, and does not attempt to assess such impacts across future generations. This issue is seldom addressed in risk assessments. Although limited methodologies for addressing inheritable genetic effects from radiation might have been developed, these methodologies have not been sufficiently adopted by the risk assessment community to justify their use in all cases.

Comment (4533)
DOE should provide evidence to support the statement in Section 5.4.1 that total cancer incidence and cancer fatalities are overestimated by a factor of two. The high incidence of skin cancer is one of the

reasons why the proportion of calculated cancer fatalities from radiation is as low as it is, and total cancer incidence would include all cancers (including skin cancer).

Response
Section 5.4.1.1 in Volume I states that the risk assessment conducted for the WM PEIS overestimates total cancer incidence and nonfatal cancer incidence, not potential cancer fatalities, by a factor of about two because the International Commission on Radiological Protection dose conversion factor produces estimates that contain a relatively large component of skin cancers. Skin cancers are not likely to be induced by the internal exposure pathways evaluated in the WM PEIS.

Comment (4534)
Hazard quotients are used by EPA to indicate (not measure, as stated in Section 5.4.1 of the Draft WM PEIS) noncancer chemical effects of single chemicals. The sum of hazard quotients for all chemicals in a mixture that cause the same effect through the same mechanism, and the sum regardless of the route and effect are used by EPA for detailed and screening level estimation of noncancer chemical exposure impacts on human health. The WM PEIS should use hazard indices to evaluate risks from mixtures of chemicals, and not merely use hazard quotients for the individual chemicals.

Response
The WM PEIS evaluation of noncancer toxic effects resulting from exposure to hazardous chemicals follows the recommendations for such analyses in EPA's risk assessment guidelines. As described in Section D.2.9 in Appendix D in Volume III of the WM PEIS, for each of the hazardous chemicals to which receptors may be exposed, Hazard Quotient values are calculated. These values are calculated by estimating the receptor's predicted exposure and dividing by maximum acceptable exposure levels based on chemical-specific EPA Reference Dose and Reference Concentration values. The Hazard Quotient values for each of hazardous chemicals are summed to yield a Hazard Index. According to EPA's risk assessment guidelines, if the Hazard Index value is less than or equal to 1, the potential exposure is unlikely to produce adverse toxic effects.

Comment (4535)
Bureau of Labor Statistics do not cover all significant physical injuries because such injuries are not always reported to the Bureau of Labor Statistics. Significant discrepancies have been reported in some private companies when insurance medical records on injuries on the job were compared to Bureau of Labor Statistics. No evidence for the adequacy of Bureau of Labor Statistics for appropriately counting all injuries in the sanitary services occupational group is provided in the WM PEIS, nor is the applicability of these statistics to DOE waste management workers documented.

Response
DOE believes that the Bureau of Labor Statistics data are the best overall source of statistical information for worker injuries. The Bureau of Labor Statistics, National Safety Council, and DOE maintain records of worker-related personnel illnesses, injuries, and fatalities. The U.S. Department of Energy Worker Health Risks Associated with Environmental Restoration and Waste Management Technical Report (ORNL 1994) provides a table comparing construction illness and injury rates from these three sources. The risks per person-hour are less for DOE-related activities than for commercial activities. Therefore, Bureau of Labor Statistics data were used for illness/injury rates in the WM PEIS because they are more conservative.

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Comment (4536)
Why were exposure indices used for workers and similar hazard indices not used for characterizing non-threshold impacts on the general public?

Response
The WM PEIS evaluation of noncancer toxic effects resulting from exposure to hazardous chemicals follow the recommendations for such analyses in EPA's risk assessment guidelines. As described in Volume III, Section D.2.9 in Appendix D of the WM PEIS, for each of the hazardous chemicals to which receptors may be exposed, Hazard Quotient values are calculated.

Section 5.4.1.4 in Volume I of the Final WM PEIS has been revised to clarify that Hazard Index values were used to evaluate potential noncancer risks for members of the offsite population as well as for workers.

Comment (4537)
Models and assumptions used in the Draft WM PEIS to estimate the numbers of fatalities from different causes are based on models and assumptions with different amounts of conservatism, and DOE lacked the will, expertise, and/or resources to conduct the research necessary to sort this out.

To attempt to add the fatalities, without appropriate caveats and adjustments, with a scientifically sound analysis of the limitations of the procedures used, would have invited scientific criticism. The result is that disconnected estimates of fatalities of unknown accuracy and conservatism from different methods are presented in the WM PEIS. Such estimates also lack scientific credibility.

The estimated fatalities from transportation and stationary source radiation, radionuclide, accidents, chemical exposures, groundwater impacts, air pollution exposures, chemical exposures, and radiation exposures are presented separately. This flood of disconnected information is presented in a manner that makes it unusable for providing a meaningful overview of the total numbers of fatalities that can be expected for the various alternatives, or for understanding the limitations of the modeling.

Trade-offs between transportation impacts versus stationary source impacts are central to the nature of the relative environmental impacts of the alternatives and should be presented in a common frame of reference to provide adequate, understandable input for identifying the relative impacts of potential configurations of waste management facilities. The WM PEIS fails to do this, and, as a result, fails to provide adequate input for informed decisionmaking.

The problem is solvable by having people who actually understand the models and assumptions used in the WM PEIS, and their differences, do the analysis needed to integrate the results of the modeling of fatalities, risks to maximally exposed individuals, etc., in a meaningful, valid, and useful manner. The purpose of such work is to provide the information needed by administrators to make informed decisions and by the public to understand what those decisions imply, along with the limitations of our current ability to predict impacts. The Draft WM PEIS fails at this concerning human health impacts (except for supporting the conclusion that trains should be used for waste instead of trucks).

When the Draft WM PEIS is revised, and a new Draft PEIS written (the problems in the current Draft WM PEIS are too severe to go directly to a Final WM PEIS), this problem can be and must be solved

5.2 Human Health Risk Assessment

if the human health impact assessment work is to provide useful input for selecting configurations of waste management facilities.

Response
DOE believes that the WM PEIS health risk estimates are scientifically credible. These estimates were developed using the best available data at the time of the analysis and state-of-the-art environmental fate and dose conversion models.

The WM PEIS health risk analysis does not aggregate estimates of potential fatalities either across or within receptor groups. For example, waste management worker fatalities from physical trauma are reported separately from latent cancer fatalities that would result from radiation exposure. In addition, latent cancer incidence from radiation exposure is not aggregated with latent cancer incidence from exposure to chemical carcinogens. The analysis did not combine these different health risk endpoints because they involve different mechanisms of action and are operative over different time frames (e.g., acute physical trauma hazards versus latent cancer fatalities).

The uncertainties associated with the WM PEIS health risk estimates have not been quantitatively evaluated. However, risk estimate uncertainty can be qualitatively differentiated. Certain risks, such as transportation accident physical trauma injuries, are based on a limited number of parameters (e.g., number of miles traveled) for which historical statistical data are available. These risks can be estimated with a relatively high degree of confidence. On the other hand, risks associated with the release of radionuclides or chemicals to ambient environmental media during the routine operation of treatment or storage facilities are estimated using probabilistic models. Therefore, the risk estimates produced by these models have a larger uncertainty than those based on historical data. These mathematical models generally use many parameters and information on these parameters is often limited.

Comment (4538)
The interpretation of CERCLA risk assessment guidelines in the Draft WM PEIS is wrong and grossly misleading. Average risks are not compared to the 1 in 10,000 or the one in one million criteria, according to EPA CERCLA guidance. In CERCLA guidelines and in the National Contingency Plan, risks to the maximally exposed individual in the general public should be compared to these levels. EPA technical directives for CERCLA remedial investigations, feasibility studies, and baseline risk assessments, require this. To compare the "average individual risks" to these levels and to cite CERCLA guidelines to justify it is misleading. Moreover, EPA, in its CERCLA, RCRA, and Clean Air Act regulations, uses calculated individual lifetime risks of cancer, not of fatal cancer.

Based on the National Contingency Plan, lifetime cancer risks above 10^{-4} (E-4) to the maximally exposed individual in the general public are unacceptable, and a lifetime risk of 10^{-6} (E-6) is used as a point of departure when evaluating remedial action objectives. A risk of 10^{-6} (E-6) is also used as a goal in the Clean Air Act of 1990 that, if not achieved, will result in a re-assessment of the need for further pollution control eight years after promulgation of the initial Clean Air Act regulations. Risks exceeding one in ten thousand to the maximally exposed individual in the general public are also unacceptable, according to EPA guidance for RCRA permit writers, which allows permit writers to issue special requirements to sources causing impacts more restrictive than the regulatory limits in the Code of Federal Regulations, and that could be as restrictive as limiting risks to one in ten million.

Response
The WM PEIS does not estimate "average" individual risks. In the Draft PEIS, the Chapter 5 (Volume I) discussion on interpreting health risk results introduced the concept of "average" individual risk as an aid to the reader interested in obtaining site-level information from the analyses. DOE has revised Section 5.4.1.4 in Volume I to delete the comparison of average individual risks to the CERCLA target risk range.

As described in Appendix D, Section D.2.6.3 (Volume III), the WM PEIS health risk analysis estimates both cancer incidence and potential cancer fatalities for radionuclide exposure, but only cancer incidence for exposure to hazardous chemicals.

Comment (4539)
The health risk conversion factors used by ORNL and ANL in WM PEIS calculations (including $1.7x10^{-3}$ (1.7E-3) induced cancer cases per person-rem, for members of the general public) were derived from ICRP-60. The NESHAPS regulations (40 CFR 61) state that "emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr."

These standards do not include radon. Under NESHAPS, for a 70-year exposure, the maximum lifetime risk of cancer would be $1x10^{-3}$ (1E-3) at the EPA limit (based on ICRP-60 as used in the WM PEIS). However, for a 30 year exposure (used in Risk Assessment Guidance for Superfund), the maximum individual risk of cancer would be $5x10^{-4}$ (5E-4). Neither is approximately equal to 1 in 10,000.

Furthermore, a 1E-02 risk would not be acceptable for even one person in the general public, since the standards apply to any member of the public.

Response
The discussion of the NESHAPs limits in the section on interpreting risk results in Section 5.4.1.4 in Volume I has been revised in the Final WM PEIS to address the comment.

Comment (4540)
DOE should explain in detail the relevance of the disposal standard for spent nuclear fuel, high-level waste, and transuranic waste as a benchmark, and the limitations of its relevance to the specific waste treatment, storage and disposal actions analyzed in the WM PEIS. One thousand premature deaths over a 10,000-year period and an average of 0.1 fatality per year (seven over a 70-year lifetime) may meet certain Federal standards for certain situations; but the public in impacted areas and their local elected officials are likely to be justifiably outraged at the lack of adequate protection indicated by such standards.

Their outrage and its impact on their health and the potential impact of actions they may take to try to prevent such impacts could have significant environmental impacts that need to be adequately assessed in the WM PEIS.

Response
Section 5.4.1.4 in Volume I has been revised in the Final WM PEIS. DOE has revised the discussion on interpreting risk results to indicate that the disposal standard benchmark for spent nuclear fuel, high-

5.2 Human Health Risk Assessment

level waste, and transuranic waste presented in 40 CFR 191 is a maximally exposed individual exposure of 15 millirem per year or less.

Comment (4547)
Groundwater plumes may impact receptors hundreds of years after the waste is disposed of and, therefore, institutional control sufficient to ensure compliance with current standards should not be the only results displayed in the main body of the WM PEIS. The unadjusted risk estimates, which could be used to help indicate the difficulty of disposing of the waste at a given site, should appear in the main body of the WM PEIS, along with an analysis of the amount of control needed to reduce the impacts to the levels associated with compliance with current standards, and the environmental impacts of such mitigating measures.

Response
Unadjusted farm family risks resulting from the disposal of low-level mixed waste and low-level waste are discussed in Sections 6.4.1.8 and 7.4.1.7, respectively, in Volume I of the WM PEIS, and are presented in Volume II in the disposal risk tables.

5.2.1 Treatment and/or Storage Risks

Comment (67)
Seepage or other distribution of radioactive and hazardous materials from storage sites at Site 300 would be disastrous for the residents of the City of Tracy.

Response
DOE would store radioactive and hazardous materials in compliance with all regulatory requirements. For example, any radioactive and/or hazardous waste must be solidified or stabilized prior to disposal, so any low-level waste or low-level mixed waste disposed of at Site 300, or at any facility, would be disposed of in a dry form. Because stored wastes will not come in contact with surface water, groundwater, or soil, the WM PEIS does not consider impacts to these media under routine operating conditions. The potential health risk impacts resulting from storage facility accidents are described in Sections 6.4.3.1, 7.4.3.1, 8.4.3.1, and 10.4.3 in Volume I. In the unlikely event of a storage facility accident, DOE would take response actions consistent with all applicable regulations to minimize adverse health risks.

Comment (350)
A serious health and safety study including economic impacts must be done addressing LLNL as the preferred site for treating mixed wastes containing radioactive components.

Response
The WM PEIS provides a serious study of health, safety, and economic impacts at the 17 "major" sites, including LLNL. DOE found that human health and environmental risks would be low for low-level mixed waste treatment; however, some sites, such as LLNL, would probably require different technologies to minimize treatment risks. The most adverse effects from treatment of transuranic waste would result from the alternatives under which transuranic waste would be treated to meet the land disposal restrictions. Such alternatives are not considered for LLNL.

Nationwide, the greatest economic benefits resulting from low-level mixed waste and transuranic waste management would be for the Decentralized Alternative, and would generally decrease as the alternatives become more centralized. The greatest benefit at any site occurs when low-level mixed waste and transuranic waste are managed at that site.

Low-level mixed waste would be treated at LLNL only under the Decentralized Alternative and Regionalized Alternative 1, whereas transuranic waste would be treated at LLNL (only to meet WIPP waste acceptance criteria) under the No Action and Decentralized Alternatives. Section 3.7 in Volume I of the WM PEIS presents DOE's preferred alternatives and the reasons they are preferred for low-level mixed waste and transuranic waste treatment.

Before actual waste management facilities, including low-level mixed waste and transuranic waste treatment facilities, are constructed, site-specific studies would be prepared.

Comment (493)
The WM PEIS would have to be updated to account for the risks associated with the treatment technology used at the vendor sites, as well as transportation risks.

5.2.1 Treatment and/or Storage Risks

Response
The impacts at offsite commercial facilities are generally not analyzed in the WM PEIS. DOE assumes that these facilities meet all applicable regulations and are permitted by the appropriate agencies. Moreover, there are many offsite waste management facilities that are operated by private companies. It would be difficult to determine which facilities DOE would use, how much waste they would receive, and what types of waste they would receive. All of these factors are fundamental to determining the potential impacts from transportation to, and waste management at, commercial facilities.

DOE has changed portions of the PEIS (Sections 1.5, 6.2, 6.16, 7.2, and 7.16) and a new section (1.7.4) to discuss the issue of waste management privatization at DOE sites. As stated in Section 1.7.4, the impacts associated with DOE waste management facilities are expected to be representative of the impacts of private facilities located on DOE sites.

Although DOE identifies preferred alternatives in the WM PEIS (see Volume I, Section 3.7), decisions on privatization are site-specific in nature, and would be addressed in site-specific documents. Under the Decentralized, Regionalized, and Centralized Alternatives, DOE would maintain the flexibility to use private facilities.

Comment (1486)
Clarify the potential effects from receiving low-level and low-level mixed waste at LANL. The Regionalized Alternative indicates that 97% of the low-level mixed waste generated at offsite facilities would come to LANL. Clarify the facilities that would be contributing to this 97%, and when DOE would dispose of this waste at LANL.

Response
Regionalized Alternative 5 would bring the largest amount of offsite low-level waste to LANL for management. Under this alternative, 64% of the waste would come from three DOE sites: Pantex, RFETS, and SNL-NM. The potential health impacts at LANL from the implementation of the low-level waste Regionalized Alternatives are described in Volume I, Section 7.4, of the WM PEIS.

Regionalized Alternative 2 would bring the largest amount of offsite low-level mixed waste to LANL. Under this alternative, 22% of the waste coming to LANL for treatment would be from the DOE sites at Pantex and SNL-NM; in addition, 97% of the low-level mixed waste coming to LANL for disposal would come from the DOE sites at Pantex, SNL-NM, Grand Junction, Kansas City, and RFETS. The potential health impacts from the implementation of the low-level mixed waste Regionalized Alternatives at LANL are described in Section 6.4.

For purposes of analysis, the PEIS assumes that DOE would locate new facilities near existing facilities or at the center of the site. Before building a new waste treatment facility at LANL or any site, DOE would conduct detailed site-specific studies to design and locate the facility.

Comment (1583)
There is no safe way and place to store high-level waste, and if the true costs of waste disposal were included, nuclear power would be too expensive.

5.2.1 Treatment and/or Storage Risks

Response
High-level waste is (1) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and (2) other highly radioactive material that NRC, consistent with existing law, determines by rule requires permanent isolation. Only four sites (Hanford, INEL, SRS, and WVDP) store and manage high-level waste. DOE is proceeding with plans to treat high-level waste by vitrification, which will process it into a solid form that would not be readily dispersible into air or leachable into groundwater or surface water, as explained in Volume I, Section 9.1.1 of the WM PEIS. This PEIS analyzes the impacts of the *stored vitrified* high-level waste. The potential disposal of high-level waste is not within the scope of the WM PEIS. Possible environmental impacts from construction, operation, and eventual closure of a potential repository for spent nuclear fuel and high-level waste would be addressed in a separate, ongoing EIS.

Comment (1702)
Volume I, Table 4-4, does not include treatment facilities within ORR that process DOE-generated wastes. This data should be included in the region of influence, maximally exposed individual dose, and population dose studies because they would influence the impacts of wastes when the processing operations are assumed by waste management sites determined by this PEIS.

Response
The maximally exposed individual and population dose values presented in Table 4.2-2 in Volume I of the WM PEIS do include releases from existing treatment facilities at ORR. Additional information is presented in Section 4.4.9 of the WM PEIS, and in Volume I, Section 2.8, of the WM PEIS Affected Environment Technical Report.

Comment (1723)
Incineration of transuranic waste at RFETS is not an acceptable treatment because of the high mobility of airborne contaminants and local weather patterns, such as inversions.

Response
Volume I, Section 8.4, of the WM PEIS contains the health risk impacts analysis for the treatment of transuranic waste. Under Regionalized Alternative 2, treatment at RFETS includes thermal treatment of wastes to satisfy RCRA land disposal restrictions.

The health risk impacts to members of the offsite population were evaluated for airborne releases of radionuclide and hazardous chemical contaminants resulting from thermal treatment of transuranic waste. Airborne releases were modeled using site-specific meteorological and population distribution data, as described in Appendix D (Volume III) of the WM PEIS. For RFETS, the air dispersion modeling took prevailing wind conditions and historical weather patterns, including inversion potential, into consideration.

Properly designed and operated incinerators have been shown to be as or more effective than other *proven* treatment technologies and DOE does not preclude their use at any site. However, DOE has an aggressive technical development program to explore alternatives to incineration, and technologies will be tested and deployed depending on their potential to safely and effectively treat wastes.

5.2.1 Treatment and/or Storage Risks

Comment (1985)
The low-level mixed waste Regionalized Alternative might increase worker exposure to radionuclides. Therefore, DOE should institute a radiation protection program for the safe placement and inspection of waste in storage, and for maintaining occupational exposures as low as reasonably achievable. Such a program should include periodic radiation and contamination inspections of storage areas, as well as posting the storage area (see 10 CFR 20.203 and 10 CFR 20.1902).

Response
DOE is committed to worker safety and must comply with all applicable worker safety standards at all times. This includes protecting workers from radiation hazards. When new activities might expose workers to radionuclides or radiation, DOE implements radiation protection programs that include periodic inspections and appropriate postings.

DOE's radiation protection standards and program, including adherence to the principle of maintaining radionuclide exposure as low as reasonably achievable (the ALARA principle), are described in Volume III, Section D.2.7.2, of the WM PEIS.

Comment (2137)
Risks associated with dioxin and incineration need to be addressed in more detail in the WM PEIS.

Response
Emissions of dioxin from hazardous waste treatment facilities were considered in the health risk analysis conducted for that waste type, the results of which are presented in Section 10.4 in Volume I. The estimated population risks from treatment facility routine operation would be generally small for most sites and most waste types, but not zero. In addition, Section 5.4 of the WM PEIS states that "secondary pollutant" discharges resulting from the burning of fuel for waste treatment are analyzed in the air quality sections of the waste-type chapters. The air quality impacts analysis considered emissions of criteria pollutants from waste incineration and from combustion processes used to provide heat for buildings. Emissions of these pollutants were compared to applicable standards to determine compliance. The standards are set, in part, through consideration of adverse health effects. Therefore, the health impacts of "secondary pollutants" were indirectly considered in the air quality impact analysis. Secondary pollutants discharged from waste treatment facilities were not directly considered in the health risk assessments conducted for waste types other than hazardous waste because the potential impacts from exposure to these contaminants are expected to be minor in comparison to impacts from releases of radionuclides.

Trial burn data were used to estimate emissions for air quality modeling. None of the trial burn data indicated that dioxins had been measured. Current regulations require the burn temperature to be high enough that dioxin emissions are extremely small and have very low impacts. These impacts would be expected to be addressed in sitewide or project-level NEPA studies.

Comment (2307)
What happens to storage sites in deserts as a result of global warming and the resulting climate change? These changes should be considered in both storage and transport.

5.2.1 Treatment and/or Storage Risks

Response
For purposes of this programmatic analysis, DOE defines storage as the collection and containment of waste (in such a manner as not to constitute disposal) to await treatment or disposal. Thus, storage, by definition, is not permanent.

The 10- to 20-year time frames considered for operation of waste management facilities and transportation of waste in the WM PEIS would not be subject to long-term climatic change. The impacts of long-term climatic changes for proposed disposal sites are more appropriately addressed in site-specific performance assessment evaluations. In general, future changes in climate are too speculative to yield a highly accurate assessment.

Comment (2542)
Volume I, Section 9.4.1.2 states that, on a site-level basis, estimated cancer incidences exceeded one. Where is this shown? The incidence values in Table 9.4-6 are all *below* one for Hanford and SRS. Is a table missing?

Response
Section 9.4.1.2 in Volume I of the WM PEIS discusses the estimated number of cancer incidences and genetic effects resulting from storage of high-level waste canisters at Hanford, INEL, SRS, and WVDP under the alternatives evaluated. The discussion is a summary of data presented in the Site Data Tables for Hanford, INEL, SRS, and WVDP contained in Volume II. The values presented in Table 9.4-6 are incremental annual risks from storage beyond 2015, which is a different scenario.

Comment (2617)
The text in Volume I, Section 10.4.1.2, does not agree with Table 10.4-3 (i.e., one cancer death under Regionalized Alternative 1 and two cancer deaths under Regionalized Alternative 2).

Response
Section 10.4.1.2 in Volume I of the WM PEIS describes the estimated number of cancer *incidences* program-wide resulting from hazardous waste treatment. The text explains that the program-wide waste management worker cancer incidences of one and two were estimated under Regionalized Alternatives 1 and 2, respectively. These values are presented correctly in Table 10.4-3.

Comment (2646)
Volume III, Section D.3.3.2. Since the health risks for commercial treatment are not addressed in this analysis, is the percentage of waste treated commercially across the DOE complex presented somewhere in the text? This weakness should also be addressed in the risk characterization.

Response
More than 90% of hazardous waste in a given year is generated by 11 or fewer DOE sites. Section 10.1.2 in Volume I of the WM PEIS presents the estimated volumes of hazardous waste at such sites. In terms of volume percentages, more than 99% of this hazardous waste is hazardous wastewater and some hazardous waste treated or stored onsite. The remaining 1% is shipped offsite for commercial treatment. The WM PEIS alternatives focus on that 1% being shipped offsite.

5.2.1 Treatment and/or Storage Risks

Comment (3151)
The WM PEIS does not fully discuss the impacts of transuranic waste storage, as evidenced by the lack of analysis of accidents and source terms for current storage. Thus, it does not provide a basis for selecting storage options to meet RCRA requirements, the analytical basis for selecting among sites to minimize impacts for consolidated storage options, or the basis for determining which sites should be given priority for upgraded or new storage facilities.

Response
The WM PEIS does not separately analyze accidents and source terms for current storage because the results would not help to discriminate among the alternatives. The PEIS analysis assumed that all sites would accumulate (or, at least, not reduce) their inventories for approximately 10 years, at which time complex-wide treatment would begin. Therefore, all DOE sites would achieve their maximum inventories (leading to maximum potential releases during a storage facility accident) regardless of the alternative. Recent DOE safety analysis reports and NEPA evaluations provide guidance on the potential risk impacts applicable to transuranic and low-level mixed waste storage facility accidents.

Current safety analysis reports and site-specific NEPA analyses are valid indicators for predicting the consequences of a range of selected waste storage accidents of varying frequency. This information is qualitatively discussed in Volume I, Section 8.4.3.1. Section 8.4.3.2 presents quantitative estimates of the potential risks resulting from transuranic waste treatment facility accidents. Appendix F (Volume V) summarizes some key accidents and assumptions the sites used to prepare the analyses and the related release or health effects-related results. Examples of existing safety documentation results applicable to transuranic waste storage facility accidents include a range of accidents from severe breaches of single drums to severe fires in centralized facilities from both man-made and natural sources. Appendix F contains a more detailed explanation of these accidents scenarios. Although there is considerable variation in the assumptions the DOE sites used to develop accident scenarios and predicted impacts, the studies suggest that public risk for transuranic waste storage would be low.

The WIPP SEIS-II addresses the potential impacts of operating WIPP as a repository for transuranic waste. As part of the WIPP SEIS-II, the No Action Alternatives evaluate the continued management of transuranic waste at treatment/generator facilities and the decommissioning or other disposition of the WIPP facility if transuranic waste is not disposed of at WIPP.

In addition, the WM PEIS does identify potential mitigation measures, including the options of combining facilities for the management of waste types and waste streams. DOE will consider project- or site-specific issues after it select locations for waste management facilities on sites.

Comment (3383)
Volume III, Table D.3.2-6, lists 7.0E-1 cancer fatality in the offsite population from tritium due to low-level waste treatment under Centralized Alternative 5. Table D.3.2-2 lists 9.8E-2 cancer fatalities in the offsite population at *all* sites from *all* isotopes due to low-level waste treatment under Centralized Alternative 5. Similar discrepancies appear for other alternatives (Regionalized 4 and 5; Centralized 3 and 5) and in associated text discussions.

Response
DOE has corrected Tables D.3.2-6, D.3.4-18, D.3.4-34, and D.3.5-6.

5.2.1 Treatment and/or Storage Risks

Comment (3992)
Volume I, Section 6.10. DOE has failed to consider risk to public health from a treatment alternative it apparently plans to construct and operate at the Portsmouth Plant.

Response
Section 6.10 in Volume I is a description of the results of the environmental justice analysis for low-level mixed waste. The risk to human health from proposed treatment facilities at the Portsmouth Plant are considered for the low-level mixed waste alternatives in Section 6.4.

Data for the Portsmouth Plant were inadvertently omitted from Table 6.4-8 in the Draft WM PEIS. However, the Portsmouth Plant health risk data for low-level mixed waste were provided in the Volume II Site Data Tables (Table II-13.1-4). DOE has revised the PEIS to include data for the Portsmouth Plant in Table 6.4-8.

Comment (4469)
DOE should rewrite the second paragraph in Section 8.3.1 of the Draft WM PEIS Summary document because it appears to contain contradictions. Risks to workers at DOE sites or at commercial sites should be evaluated.

Response
DOE has revised the WM PEIS Summary document to clarify the distinctions made between a DOE waste management worker and a waste management worker at a commercial facility. Worker risk is assumed to be similar at either facility, although the WM PEIS did not analyze risk from commercial treatment facilities. DOE would treat more of its hazardous waste under the Regionalized Alternative, and would use commercial hazardous waste treatment facilities under the No Action and Decentralized Alternatives.

5.2.2 Disposal Risks

Comment (478)
The exposure risks to the hypothetical farm family over a 10,000-year time frame are extreme.

Response
The hypothetical farm family represents an exposure that occurs at a time when institutional controls (fences, warning lights, land records, etc.) no longer exist. The purpose of this analysis is to determine upper-bound exposures only. The farm family is assumed to draw water from a well 300 meters (984 feet) downgradient from the center of the disposal facility. The distance ensures that the farm family's groundwater well would be beyond the boundary of the disposal site.

Risks to the hypothetical onsite farm family were evaluated for 143 consecutive 70-year lifetimes (i.e., 10,000 years) to determine the upper bound of long-term risks from exposure to groundwater contaminated by the failure of an underground waste disposal facility. The maximum exposure could be significant over a series of lifetimes. The 10,000-year period was selected for the analysis in the Draft PEIS to maintain consistency with the *Guidelines for Radiological Performance Assessment of DOE Low-Level Radioactive Waste Disposal Sites* (Case & Otis, 1988) that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessment has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A.

To provide some perspective on the timing of health risks predicted to result from disposal, the risk analysis identifies the 70-year lifetime during which the highest exposures (and hence, risks) are estimated to occur for the hypothetical farm family. This lifetime is referred to in the results as the "most-exposed lifetime" of the farm family.

Comment (498)
The loss-of-institutional-control assumption in the risk assessment is extreme and not very realistic. If a loss of institutional control were to occur at ORR, a social or domestic disaster would have to precede it. The magnitude of such a disaster would surely overshadow any risks of impacts from the loss of institutional control. Exposure scenarios in the WM PEIS need to be more reasonable.

Response
NEPA requires DOE to consider a range of potential exposure scenarios to evaluate the risks of possible program occurrences. Although it is extreme, DOE believes that loss of institutional control is an assumption necessary to address potential risks to generations far in the future. DOE used conservative scenarios to ensure that estimates of potential risks would represent the upper limit.

Comment (544)
In the scenarios described in the WM PEIS, the distance of the hypothetical farm family well from the disposal unit should be site-specific information. Depending on the size of the disposal facility, it could be shorter or longer than the 300 meters assumed in the analysis.

Response
The evaluation of health risks to the hypothetical farm family is a screening-level analysis that enables a comparison of the relative sensitivity of various sites to disposal actions. Therefore, it uses a generic set of scenario assumptions (see Volume I, Section 5.4.1), including the location of a well 300 meters

(984 feet) from the center of the disposal unit at all sites. Sitewide or project-level NEPA reviews would incorporate the environmental conditions unique to a particular site.

Comment (546)
The risks resulting from the "intruder drilling scenario" should be assessed. The long-term collective risks associated with failure of the disposal facility could be significant if the facility is located near populated areas or water supplies.

Response
The WM PEIS analysis of disposal health risks includes consideration of a hypothetical intruder scenario for low-level mixed waste and low-level waste. The intruder scenario used in the WM PEIS assumes that a single adult drills a well directly through the disposal facility to the water table. The methods and assumptions used in the hypothetical intruder scenario are presented in Section 5.4.1 in Volume I and Appendix D in Volume III. The results of the analyses are presented in Sections 6.4.1.10 and 7.4.1.9 in Volume I and in Appendix D.

The WM PEIS does not address quantitatively collective risk to offsite populations from disposal of low-level waste and low-level mixed waste. DOE believes that it is not possible to develop plausible estimates of risk to offsite populations resulting from exposure to contaminated groundwater in this programmatic document because the exact locations of disposal units are not being determined in the PEIS. DOE determined that some relative indicator of the potential for offsite risk would be an appropriate approach. It has, therefore, added a population risk vulnerability analysis in Section 5.4.1.2.3 in Volume I and in Section C.4.1.2 in Volume III, which provides a basis for comparison of low-level mixed waste and low-level waste disposal alternatives using measures that characterize their relative potential to cause risks to offsite populations from groundwater contamination.

Comment (548)
The 10,000-year period used for estimating risks from the disposal of low-level mixed waste and low-level waste might not be sufficient to provide upper-bound risk estimates for some radionuclides (e.g., long-lived radionuclides that move slowly through the soil).

Response
DOE selected an evaluation period of 10,000 years to conform with the analysis period used for the performance assessments required by DOE Order 5820.2A for the design and siting of low-level waste disposal units. This clarification has been added to the Summary document and to Chapters 5, 6, and 7 in Volume I of the WM PEIS.

Certain long-lived, relatively immobile radionuclides may take longer than 10,000 years to leach from disposal units into drinking water wells. Estimation of future risks resulting from exposure to these contaminants is constrained by the limitations of the models to accurately predict conditions so far into the future. These limitations, however, do not prohibit comparison of the relative risks estimated for the potential disposal sites for the 10,000-year period of evaluation.

5.2.2 Disposal Risks

Comment (549)
The WM PEIS should provide information about the assumed design life of the low-level mixed waste and low-level waste disposal facilities and how long DOE assumes it will retain institutional control over these sites.

Response
The assumed design life of disposal facilities for low-level and low-level mixed wastes would vary with the different types of units. The WM PEIS assumes that shallow land burial units would breach immediately after disposal, and that aboveground vaults and belowground vaults would breach 300 years and 750 years after disposal, respectively.

DOE intends to maintain indefinite institutional control of these facilities. However, for purposes of analysis, DOE assumes that the hypothetical farm family scenario would occur in the future under conditions without institutional control, enabling the family to establish a residence adjacent to the disposal unit.

Comment (550)
Since it is possible for the disposal facilities to fail following the institutional control period, the PEIS should include the leach rates assumed for the radionuclides in the waste.

Response
The WM PEIS analysis used leach rates from the *Mixed Low-Level Waste Systems Analysis Methodology Report* (prepared for DOE by IT Corporation, 1992); the rate for concrete is 0.001 grams per square centimeter per day, and that for borosilicate glass is 0.000001 grams per square centimeter per day.

Comment (551)
Since it is possible for the disposal facilities to fail following the institutional control period, the PEIS should include the radionuclide partition coefficients or distribution coefficients that were assumed for the unsaturated zone and the saturated zone. Are they site specific or generic?

Response
DOE selected the partition coefficients used in the WM PEIS from a contaminant-specific matrix of nine possible predetermined values, depending on the geology of the site. Geologic parameters influencing the selection of a value included the percent clay composition, percent organic matter, and pH. As such, the partition coefficients used in the PEIS are both contaminant- and site-specific. DOE also selected specific coefficients for each unsaturated and saturated zone. Documentation for the fate and transport model used for evaluating migration in the vadose and saturated zones (MEPAS Application Guidance: PNL-7216) also describes the distribution coefficients and their applicability.

Comment (553)
How do the uncertainties of the assumed leach rates, radionuclide partition coefficients, and distribution coefficients affect the long-term results of the health risk assessment?

Response
Leach rates have a direct impact on source terms. A higher leach rate would result in a higher concentration of contaminants reaching a receptor at an earlier point in time. A lower leach rate would

allow more time for radioactive decay, thus decreasing the source term and associated health risks. This effect is not as significant for long-lived radionuclides. Partitioning coefficients and distribution coefficients (i.e., K_d values) would have a similar impact on health risks. These parameters influence the rate at which contaminants move through vadose and saturated zones. This in turn influences the time period in the future at which the contaminants reach the receptor. Longer periods of time would result in more dispersion and decay, which would result in lower health risks.

Section D.2.15 in Volume III of the WM PEIS presents an overview of uncertainty in the WM PEIS health risk analyses. Section D.4 provides a more detailed discussion, as well as estimates of the magnitude of uncertainty in the estimates of health risks resulting from waste treatment, storage, and disposal actions.

Comment (556)
The WM PEIS should evaluate the potential risk to current and future local populations from the disposal of low-level waste and low-level mixed waste.

Response
To supplement the quantitative estimates of maximally exposed individual disposal risks presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I, DOE performed semi-quantitative analyses of the potential for offsite population risk in Section 5.4.1.2.3 of the Final PEIS. These analyses produced estimates of relative population vulnerability of the sites, rather than quantitative estimates of person-rem doses and cancer fatalities. For these semi-quantitative analyses, DOE used simple statistical methods and information about site characteristics known or expected to be associated with the potential for offsite population disposal risk to develop "risk vulnerability" groupings of the sites. The sites within each of the three vulnerability groups developed in this analysis have similar potential for offsite population health risk from disposal.

Comment (557)
How do the models used in the waste disposal risk assessments treat the decay of long-lived radionuclides, the ingrowth of daughter products, and their transport to groundwater?

Response
DOE assumes that the disposal facilities evaluated for the WM PEIS would break down after a certain period of the time, depending on the type of facility (300 years for tumulus, 750 years for belowground vaults, and immediately for shallow land burial). To calculate the source term, the analysis would "predecay" the inventory in the facility for the lifetime of the facility. The DUST code simulates the release of the decayed inventory (including daughter products) and estimates an annual flux of the contaminants from the facility. The flux rates go into the MEPAS groundwater model, which simulates the fate and transport of the contaminants to the receptor. MEPAS does not track ingrowth of daughter products, but accounts for decay by tracking radionuclide parents to the receptor boundary and estimating the amount of associated daughter product at the receptor based on the concentration of the parent. Additional details are presented in Volume III, Section D.5.

Comment (558)
How do the models used in the waste disposal risk assessments treat the inhalation and exhalation of radon-222 and radon-220?

5.2.2 Disposal Risks

Response
As described in Section 5.4.1 in Volume I and Appendix D in Volume III, the WM PEIS health risk analysis for disposal of low-level mixed waste and low-level waste evaluates human exposure only through the groundwater pathway. The hypothetical farm family is assumed to be exposed via the consumption of contaminated groundwater as drinking water and its use in irrigation of crops and livestock, which are subsequently consumed. Inhalation of radon, tritium, or other volatile radionuclides or hazardous chemicals was not considered in the disposal risk analysis.

Comment (1675)
ORR with its complex geology, hydrogeology, and shallow groundwater, as shown by the National Governors Association/DOE Disposal Workgroup, is suitable for disposal of only a very restricted list of radionuclides since protection of human health and the environment is of primary importance. To truly evaluate the suitability of ORR for low level mixed or low level waste disposal, technical siting criteria such as that used by NRC in 10 CFR 61.50 will have to be applied.

Response
The WM PEIS low-level mixed waste disposal analysis is a screening-level assessment. The objective of the assessment is to provide a relative comparison of the potential suitability of sites for disposal of low-level mixed waste as waste management alternatives are varied. The analysis assumes the use of conceptual, generic disposal facilities; generic waste forms (e.g., polymers or grout); and that the entire inventory of waste will be disposed of (i.e., no waste exclusion). Although generic ORR hydrogeological and meteorological data were used in the environmental fate modeling, no attempt was made to site disposal units at specific locations on ORR. The results of the PEIS screening-level analysis include the potential risk to hypothetical maximally exposed individual farm family members from new disposal facilities, since no credit is taken for the use of engineering controls and careful site selection that could minimize potential groundwater contamination.

In the actual design of a disposal facility at ORR or any other DOE site, more detailed, site-specific analyses would be conducted in accordance with the requirements of DOE Order 5820.2A. The objective of the analyses required by this Order is to design and site a facility that will satisfy the performance objectives specified for the protection of human health and environmental quality. Implementation of the requirements of the Order could involve: (1) modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase contaminant adsorption, or a concrete cap to reduce infiltration); (2) modifying the form of the waste to be disposed of (e.g., changing from grout or polymer to a vitrified waste form); and (3) imposing waste acceptance criteria (i.e., restricting the amounts of radionuclides or hazardous chemicals allowed in a given disposal facility).

DOE Order 5820.2A is intended to satisfy the substantive requirements of NRC regulations (10 CFR Part 61) for DOE facilities, which are not subject to NRC requirements, or those imposed by States through agreements with NRC.

The results of the low-level mixed waste disposal risk analysis, presented in Volume I, Section 6.4.1.8, of the WM PEIS, suggest that disposal of low-level mixed waste at ORR should not present significant risks to the individual farm family receptor. However, the results of collective risk vulnerability analyses presented in Section 5.4.1.2.3 suggest that ORR is among the DOE sites with the highest potential vulnerability for offsite population health risks from disposal. Results of this PEIS evaluation

support the findings of other studies (e.g., National Governor's Association/DOE Disposal Workgroup).

Comment (1678)
The intruder theory, with calculations based on 10,000-year period (173 lifetimes), is totally misleading. In the event of a serious accidental exposure or contaminant ingestion, the imminent danger to the population during one lifetime, or at the most two, is significant. Beyond that point, since migration patterns are much more complex, risk calculations have no validity.

Response
The exposure scenarios are discussed in Section 5.4.1 in Volume I of the WM PEIS. Risks to the hypothetical onsite farm family were evaluated for 143 consecutive 70-year lifetimes (i.e., 10,000 years) to determine the upper bound of long-term risks from exposure to groundwater contaminated by the failure of an underground waste disposal facility. The maximum exposure could be significant over a series of lifetimes. The 10,000-year period was selected for the analysis to maintain consistency with the *Guidelines for Radiological Performance Assessment of DOE Low-Level Radioactive Waste Disposal Sites* (Case & Otis, 1988) that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessment has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A.

The hypothetical "intruder" is an imaginary adult who drills a well directly through a low-level mixed waste or low-level waste disposal unit to the groundwater. As a result of the drilling, contaminated soil from within the unit is brought to the surface, where it mixes with the top layers of the surface soil. The exposure pathways for the intruder were inhalation of resuspended contaminated soil, and direct radiation from contaminated soil. Two hypothetical intrusions were assumed to occur; 100 years and 300 years after closure of the disposal facility. The intruder scenario is assumed to occur at a time in the future after the loss of institutional control.

Evaluating the potential risks to the hypothetical intruder is consistent with the analysis required for disposal facilities under DOE Order 5820.2A.

Comment (1680)
ORR groundwater quality reports for the years 1992 through 1994 reveal contaminants at levels of concern, gradually decreasing with progressive time periods. Additional incremental increases in pollutants released (by incremental increases in treatment and disposal of low level mixed waste) can cause elevated levels of radionuclide contamination that exceed drinking water standards.

Response
The potential interaction of groundwater contamination from low-level mixed waste disposal facilities and existing groundwater contamination would depend on the locations of the facilities. The WM PEIS does not attempt to identify potential locations for disposal facilities at ORR or other DOE sites. The siting of disposal facilities would require additional analyses and the performance assessments required for conformance with DOE Order 5820.2A. This Order is intended to satisfy substantive requirements of NRC regulations (10 CFR Part 61) for DOE facilities, which are not subject to NRC requirements, or those imposed by States through agreements with NRC.

5.2.2 Disposal Risks

In April 1996, DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help ensure that continued disposal of low-level waste will not compromise the future radiological protection of the public. The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned low-level waste disposal facility and other sources of radioactive material in the ground that might interact with the low-level waste disposal facility.

Comment (1681)
For the intruder hypothesis to gain validity, DOE would have to lose institutional control. Under that circumstance, the pressing issues would be population migration.

Response
The hypothetical intruder scenario evaluated in the WM PEIS for the disposal of low-level mixed waste and low-level waste is a very conservative accident analysis. The scenario is assumed to take place in the future at a time when the disposal facilities are no longer under institutional control. The loss of institutional control is a hypothetical assumption that would have to be true to allow the intruder to be located directly above the disposal unit. Note, however, that DOE does not intend or expect to loose institutional control, nor is this assumption consistent with current land use plans, as described in the April 1996 publication, *Charting the Course - The Future Use Report* (DOE/EM-0283). The scenario further assumes that the adult intruder drills a well directly through the disposal unit to the water table. Contaminated soil from within the unit is brought to the surface as a result of the drilling, where it mixes with the top layers of the surface soil. The individual raises crops on the contaminated plot of land and consumes the resulting produce. The intruder is assumed to be exposed to disposal unit contaminants via inhalation of resuspended contaminated soil, inadvertent ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and direct radiation from contaminated soil.

Comment (1706)
Referring to Volume I, Section 4.3, a commentor stated that in its evaluation of land-based waste disposal, the WM PEIS consideration of hydrology and geology are inadequate. Specifically, the commentor stated:

Performance assessment strategies have been primarily restricted to deterministic modeling of radionuclide fate and transport, followed by risk assessment. The potential of a land-based disposal site to impact human health and the environment should be considered by alternative means to provide a check on fate and transport models, which might be inappropriate or misapplied to greater or lessor extents at the various sites.

DOE should use the NEPA process as an opportunity to evaluate relative suitability of disposal sites based on generic technical requirements similar to those used by NRC. Demographic and land-use considerations are discussed in some detail in this PEIS, but hydrology and geology have received little attention. Evidently, only seismic activity, flooding, and some general characteristics of soils and topography have been considered.

If the hydrogeology and geochemistry of a site are complex and/or the correct chemical and physical processes of contaminant transport are not incorporated into the model, these qualitative technical requirements might offer guidance that will prove to be superior to risk assessment when evaluating relative performance between sites.

Faulting, folding, and karstification at ORR have produced an extremely complex hydrogeology that has not yet been adequately monitored or modeled. It is doubtful that generic transport models of the kind used in this PEIS can yield much but misinformation when applied in such circumstances.

Response
The hydrology, geology, and meteorology of ORR are considered in Section 4.4.9 in Volume I of the WM PEIS and in Volume I of the WM PEIS Affected Environment Technical Report. Sections 5.4.1 and 6.4.1.8 of the PEIS provide additional information about the analyses of disposal risks. Please note that site-specific environmental setting data are used in the environmental fate models.

The WM PEIS risk analyses do not attempt to predict risks to current or future offsite populations from the disposal of low-level waste and low-level mixed waste. Estimating these risks requires knowing the exact location of disposal facilities on a site with respect to existing aquifers and the populations that might use them. Since the PEIS does not attempt to make decisions about locations of facilities on sites, quantitative estimates of collective dose and risk are not attempted. However, Section 5.4.1.2.3 in Volume I describes an analysis of the relative vulnerability of offsite populations to risk from disposal based on site environmental data. The results of the analysis indicate that ORR is among the group of sites with the highest potential vulnerability.

Comment (1713)
Waste should not be buried at RFETS or anywhere else.

Response
Analyses performed for the WM PEIS presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I indicate that disposal of low-level mixed waste and low-level waste at RFETS would result in a low risk of groundwater contamination and a low risk to human health for a member of a hypothetical farm family. However, on the basis of site environmental data, the results of a collective population risk vulnerability analysis presented in Section 5.4.1.2.3 suggest that RFETS is intermediate among the 16 proposed DOE disposal sites in its potential for offsite population risk from disposal. DOE would take further actions to minimize the potential for contamination at RFETS or other sites by selecting locations for disposal facilities only after conducting additional environmental analyses. Furthermore, DOE will design and operate new facilities in compliance with all applicable regulations, and will adapt the facilities to site-specific conditions as necessary.

DOE prefers waste disposal to long-term storage for two primary reasons. First, disposal involves the placement of treated waste in facilities that will effectively remove the material from contact with human or environmental receptors for very long periods of time. For example, disposal of treated transuranic waste and high-level waste in geologic repositories will isolate these materials for the long periods of time they are likely to remain hazardous. If DOE kept these materials in long-term storage facilities they could be subject to potential releases as a result of facility accidents or natural disasters.

Second, fewer resources are required to dispose of treated materials than to store them for indefinite periods. The operational costs associated with maintaining, securing, and monitoring aboveground storage facilities exceed those for underground disposal facilities.

5.2.2 Disposal Risks

Comment (1733)
The selection criteria for the PEIS for acreage available for site development is unclear. Assuming that the area is available, has any work been done to ascertain that it is acceptable for treatment, storage, or disposal facilities? This is vital, because ORR is underlain by known solution-prone limestones and varying carbonaceous geological formations.

Response
The land area used in the analysis was either the acreage designated by the site for use for waste management facilities or estimated as available for construction of facilities by subtracting unsuitable areas from the site total acreage. DOE made no attempt in the WM PEIS to identify or select the actual locations of new waste management facilities on any site, including ORR, or to determine the suitability of the available land, in terms of soils or hydrologic conditions, for constructing waste management facilities. Rather, the PEIS determines whether sufficient land will be available to enable DOE to avoid environmentally or culturally sensitive areas. Site-specific or project-level NEPA reviews for ORR to support the development of particular facilities at this site would determine if specific locations on a site are suitable for treatment, storage, or disposal facilities.

The results of the low-level mixed waste disposal risk analysis, presented in Volume I, Section 6.4.1.8, of the WM PEIS, suggest that disposal of low-level mixed waste at ORR should not present significant risks to an individual farm family receptor. However, the results of collective risk vulnerability analyses presented in Section 5.4.1.2.3 indicates that ORR is among the DOE sites with the highest potential for offsite population health risks from disposal. Results of this PEIS evaluation support the findings of other studies (e.g., National Governor's Association/DOE Disposal Workgroup).

In the actual design of a disposal facility at ORR or any other DOE site, more detailed, site-specific analyses would be conducted in accordance with the requirements of DOE Order 5820.2A. The objective of the analyses required by this Order is to design and site a facility that will satisfy the performance objectives specified for the protection of human health and environmental quality. Implementation of the requirements of the Order could involve: (1) modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase contaminant adsorption, or a concrete cap to reduce infiltration); (2) modifying the form of the waste to be disposed of (e.g., changing from grout or polymer to a vitrified waste form); and (3) imposing waste acceptance criteria (i.e., restricting the amounts of radionuclides or hazardous chemicals allowed in a given disposal facility).

DOE Order 5820.2A is intended to satisfy the substantive requirements of NRC regulations (10 CFR Part 61) for DOE facilities, which are not subject to NRC requirements, or those imposed by States through agreements with NRC.

Comment (1736)
Generic groundwater contaminant transport models will not be capable of simulating the transport of contaminants through the fractures and karst conduits that are the contaminant pathways in bedrock at ORR, and such models will not necessarily yield conservative results when misapplied in fracture flow situations.

Response
Section 6.4.1.8 in Volume I of the WM PEIS discusses the objectives and outputs of the hypothetical farm family disposal risk analysis in comparison to those of the DOE Order 5820.2A performance

assessment process. The objective of the PEIS disposal risk analysis is to provide a relative comparison of potential risk among low-level mixed waste and low-level waste management alternatives. The analysis assumed generic disposal facilities and generic waste forms. The outputs of the analysis are risk estimates for the hypothetical farm family and hypothetical intruder. The Final WM PEIS has been revised to incorporate an analysis of the potential for offsite population risk from waste disposal. Section 5.4.1.2.3 describes the methodology used in the analysis, which involves consideration of a number of site-specific parameters, including groundwater travel time. The results of this risk vulnerability screening analysis for low-level mixed waste and low-level waste disposal are presented in Sections 6.4.1.9 and 7.4.1.8, respectively.

DOE would conduct detailed groundwater modeling that can better characterize the fracture flow conditions at ORR as part of the performance assessment analyses required before the implementation of any disposal alternatives. The objective of the performance assessment analyses is to design a disposal facility that will satisfy the performance objectives specified in DOE Order 5820.2A. The facility design could involve modifying the engineering design of the disposal facility, modifying the waste form, selecting the location of the disposal facility, and imposing waste acceptance criteria. To a large extent, these factors will influence potential risk from implementation of disposal facilities. The WM PEIS analysis does not address these factors at each of the 17 major sites, but rather serves as a screening analysis to identify potential problem sites and contaminants.

Comment (1738)
It appears that the only exposure considered to the hypothetical farm family is exposure from future disposal facilities. The PEIS failed to provide risk analyses that include continuing releases from past operations, as well as releases from potentially sited waste disposal facilities.

Response
Section 5.4.1 in Volume I of the WM PEIS explains that the hypothetical farm family disposal risk estimates are only for new disposal facilities. The risk estimates assume that each disposal unit is a discrete structure. For sites that would require the construction of multiple disposal units under certain alternatives, the analysis assumes that there will be no mixing of groundwater plumes from these units at the 300-meter (984-foot) well. DOE assumes that each of these close-in receptors will be affected primarily by the contaminant plume from the facility closest to him/her. Commingling of contaminant plumes from multiple disposal units could occur as distance from the units increases. However, at greater distances from the disposal units, the concentrations in any given plume should be lower than those estimated at the 300-meter well as a result of dispersion and dilution.

In addition, the PEIS analysis does not account for existing disposal inventory or existing groundwater contamination at a site, since the PEIS does not attempt to locate disposal units on the sites. More detailed analyses, such as the performance assessments required under DOE Order 5820.2A, will address the issues of existing groundwater contamination and multiple disposal units. For example, in April 1996 DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help ensure that continuing disposal of low-level waste will not compromise the future radiological protection of the public. The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned low-level waste disposal facility and other sources of radioactive material in the ground that might interact with the low-level waste disposal facility.

5.2.2 Disposal Risks

Although the WM PEIS cumulative impacts analysis for human health risk does not account for existing disposal inventory or existing groundwater contamination, the cumulative impacts analysis for groundwater quality does consider existing groundwater contamination (which in some instances may be due to disposal activities) to the extent that the information is available.

Comment (1753)
Because transuranic waste is dangerous waste and has long-lived radionuclides, environmental pathways should be protected for hundreds to thousands of years into the future. The overriding factor in transuranic waste management should be long-term health impacts.

Response
The WM PEIS evaluates alternatives to support programmatic decisions on national transuranic waste treatment and storage siting configurations. The WM PEIS alternatives analyze minimal processing of waste to meet current WIPP waste acceptance criteria, intermediate treatment to reduce the potential for gas generation, and more extensive treatment to satisfy RCRA land disposal restrictions.

DOE is analyzing long-term impacts of disposal and continued storage of transuranic waste in the WIPP SEIS-II and will make both disposal and transuranic waste treatment decisions based on that analysis. The WM PEIS will provide a basis for decisions on where any transuranic waste treatment and storage facilities would be sited.

Comment (2106)
One commentor stated that the hypothetical farm family scenario is not so imaginary. There is a woman who lives downgradient of a site who performs farming activities and uses the water. DOE needs to explain how this can be considered a worst-case scenario when the situation already exists.

Response
The WM PEIS health risk analysis uses the hypothetical farm family scenario to address the potential risks from groundwater contamination following disposal of low-level mixed waste and low-level waste. The scenario takes place in the future when a farm family moves onto the site and drills a well 300 meters (984 feet) from the center of a disposal unit. This scenario is assumed to represent potential future maximum exposure conditions, since the well is located only 300 meters from the center of the disposal unit. At this distance, radionuclide and hazardous chemical contaminant concentrations should be higher than concentrations at locations further from the unit. Therefore, the hypothetical farm family receptors should receive higher doses from contaminated groundwater than persons using wells located farther from the disposal units, where dispersion and dilution are more likely to reduce concentrations of contaminants to which the offsite public might be exposed.

Some elements of this scenario, such as the use of groundwater by individuals living downgradient from the site for farming purposes, might be similar to existing conditions at some sites. However, the total scenario is considered to be hypothetical because it should produce impact estimates that would be greater than those expected under reasonable future conditions. For example, although individuals currently living offsite might utilize potentially contaminated groundwater, and site boundaries might change in the future, it is unlikely that a member of the general public will, at some time in the future, develop a drinking water well within 300 meters of a low-level mixed waste or low-level waste disposal unit.

5.2.2 Disposal Risks

Comment (2393)
We do not find persuasive the WM PEIS use of the "hypothetical intruder" and "hypothetical farm family" to model the risk of individual exposure. The use of these categories in the WM PEIS may contribute to a misunderstanding of what levels of exposure might actually be encountered because of the extreme assumptions used in the models.

Response
The WM PEIS uses farm family and intruder scenarios to evaluate the potential public health risks from long-term exposure and accidental exposure, respectively. The farm family and intruder scenarios are typical of scenarios used in performance assessments. Given the scope of the PEIS, the farm family and intruder scenarios seem appropriate. Specific disposal sites will invariably have conditions or features that are not addressed within the limits of the PEIS methodology. These issues would be more appropriately addressed in site-specific assessments performed by site experts using fate and transport models designed and calibrated specifically for that site.

The Final WM PEIS has been revised to incorporate an analysis of the potential for collective risk from waste disposal. Section 5.4.1.2.3 describes the methodology used in the analysis, which involves consideration of a number of site-specific parameters. The results of this risk vulnerability screening analysis for low-level mixed waste and low-level waste disposal are presented in Sections 6.4.1.9 and 7.4.1.8, respectively.

Comment (2447)
The WM PEIS estimates the impacts of waste disposal using generic disposal facilities and practices. Actual disposal at a particular site will certainly differ, and this uncertainty needs to be incorporated into the risk interpretation for waste management workers and the hypothetical intruders and farm families.

Response
Section 5.4.1.1 in Volume I of the WM PEIS contains a summary of uncertainty in risk estimates used in the health risk analyses. More detailed information on the hypothetical farm family and hypothetical intruder scenarios is in Section D.4 in Volume III. The risk models were applied consistently to all sites in order to have comparable results. As indicated in Section 5.4.1.1, the uncertainty associated with the disposal risk estimates for waste management workers is relatively smaller than the uncertainty associated with the farm family and intruder risk estimates.

Sections 6.4 and 7.4 in Volume I of the WM PEIS further describe the screening-level risk analyses conducted for low-level waste and low-level mixed waste disposal, respectively. These sections also describe the performance assessment process and compare the performance assessments to the screening-level analyses conducted for the WM PEIS.

Actual design, siting, construction, and operation of disposal facilities will require additional analyses, such as performance assessments, and will be in compliance with all applicable site-specific requirements.

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Comment (2502)
The intruder scenario assumes that crops can be grown on the waste-contaminated soil. This might not be true for some sites due to poor soil, adverse climatic conditions, etc.

Response
Section 5.4.1 in Volume I of the WM PEIS explains that the hypothetical intruder scenarios used in the analyses are not intended to suggest that farming is a reasonable or preferred future land use at DOE sites upon loss of institutional control. DOE used farming in the scenarios to ensure that it did not underestimate potential risks associated with exposure to and risk from contaminated groundwater (through its use as drinking water and crop irrigation at arid sites) and soils (through uptake of contaminants by crops).

Comment (2532)
In Volume I, Section 6.4, the assumptions made in the intruder scenario represent a maximally exposed intruder and this should be indicated. The uncertainty in the scenario needs to be better characterized.

Response
The term "maximally exposed individual," or MEI, refers to the single receptor within a population estimated to receive the highest dose. Since the intruder scenario involves one individual, the MEI designation would be redundant and is not necessary.

Sections 5.4.1, 6.4.1.7, and 7.4.1.8 in Volume I of the WM PEIS contain descriptions of the hypothetical intruder scenario, including qualitative discussions of the relative uncertainty associated with the intruder analyses. These sections provide fuller descriptions than the section cited in the comment.

Comment (2533)
The box on page 6-32 in Volume I in the Draft WM PEIS states that a downgradient distance of 300 meters was used for the hypothetical farm family and that this distance is consistent with DOE Order 5820.2A requirements for analysis of disposal facilities. In the INEL performance assessment for active low-level waste disposal units, the site boundary was used for the first 100 years after facility closure and then, assuming the loss of institutional control, a distance of 100 meters. How did DOE choose 300 meters for the WM PEIS analysis?

Response
The hypothetical farm family scenario uses a distance of 300 meters (984 feet) from the center of the disposal unit as the location for the downgradient drinking water well. Given the assumed dimensions of the disposal facility, this distance is roughly equivalent to the 100-meter (328-foot) distance from the edge of the disposal unit used in the performance assessment analyses. In other words, 100 meters from the *edge* of the unit is approximately 300 meters from the *center* of the unit. Thus, the analyses are comparable.

Comment (2535)
Volume I, Section 6.4.1. Is the contaminated soil considered to be contaminated with both radionuclides and chemicals?

Response
Yes. DOE revised Volume I, Section 6.4.1, to clearly state this assumption.

Comment (2572)
How was 300 meters downgradient selected for the hypothetical drinking water well, and why is it worst-case?

Response
DOE used the distance of 300 meters (984 feet) from the center of the disposal unit as the location for the downgradient drinking water well for the hypothetical farm family scenario, which describes one potentially exposed population. Given the assumed dimensions of the disposal unit, this distance is essentially equivalent to the 100-meter (328-foot) distance from the edge of the disposal unit (including buffer zones) used in assessing the performance of a disposal unit. The 300-meter distance is, of course, a simplifying (yet conservative) assumption. The scenario also assumes that the hypothetical farm family would not live closer to the *center* of a waste disposal facility.

Comment (2800)
DOE used computer models to compute the risk of human health impacts from waste disposal operations, generically and for each particular option. Because the assumptions used and modeling results are "in dispute," DOE should not use any value developed from these models for BNL. DOE should consider it extremely relevant to any consideration of human health impacts that BNL has the greatest population potentially exposed to adverse effects from disposal operations.

Response
Since the WM PEIS analysis attempts to estimate future risk, a number of environmental fate, exposure assessment, and risk assessment models must be used to prospectively predict exposure and risk. The WM PEIS human health impacts methodology is provided in Section 5.4.1 in Volume I and in Appendix D in Volume III of the WM PEIS.

The toxicity data used as benchmarks or dose conversion factors in the models are not in dispute. The values used were developed by recognized organizations and they have been subjected to scientific peer review. They are the standard values used in radiological and chemical risk assessments. The dose conversion factors used to estimate chronic health effects resulting from exposure to direct radiation or radionuclides were developed by the International Commission on Radiation Protection. The cancer (i.e., slope factor) and noncancer (i.e., reference dose and reference concentration) toxicity values used were developed by EPA.

To identify reasonable proposed sites for waste management facilities in the WM PEIS, DOE determined where the largest volumes of waste are and where transportation requirements would be minimized. Although storage and disposal in less populated regions might lessen some impacts, the risks from transporting waste to these remote areas would increase. These trade-offs are described in the WM PEIS and are important factors that will be considered in the actual decision process. Waste management decision criteria and factors are described in Section 1.7.3 in Volume I of the WM PEIS.

The Final WM PEIS has been revised to incorporate an analysis of the potential for collective risk from waste disposal. Section 5.4.1.2.3 describes the methodology used in the analysis, which involves consideration of a number of site-specific parameters, including population size. The results of this risk

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vulnerability screening analysis for low-level mixed waste and low-level waste disposal are presented in Sections 6.4.1.9 and 7.4.1.8, respectively.

Comment (2830)
DOE's failure to incorporate and discuss many BNL-specific factors prevents the WM PEIS from achieving a serious, substantive review of the impacts caused by conducting any disposal activities at BNL.

Response
The WM PEIS analysis of impacts from proposed waste disposal actions focused on impacts to groundwater quality and on health risk. Impacts on land use and ecological resources were also addressed. The environmental fate models used to estimate the movement of radionuclide and hazardous chemical contaminants from disposal units to groundwater used site-specific information on hydrogeology and meteorology. In addition, DOE added an offsite population risk vulnerability analysis for the proposed disposal sites to the Final WM PEIS. This analysis, which is presented in Sections 5.4.1.2.3, 6.4.1.9, and 7.4.1.8, considered a number of BNL site factors, including the size of the offsite population, site acreage, annual rainfall, aquifer depth, annual aquifer recharge, and an estimate of groundwater travel time (see Table 5.4-1 in Volume I). The analysis indicated that BNL is intermediate among the 16 proposed disposal sites in its potential vulnerability from offsite population risk from disposal. Therefore, BNL-specific factors were included in the analyses of water quality and health risk impacts from the proposed disposal of low-level mixed waste and low-level waste at BNL.

Comment (2835)
40 CFR 191 does not set disposal criteria in terms of average population cancer fatality rates. The requirements are set in terms of annual committed effective dose (15 millirem per year) to the maximum exposed individual.

Response
DOE deleted the description of disposal criteria in terms of average population cancer fatality rates from Volume I, Section 5.4.1, and replaced it with the requirements provided in the comment.

Comment (2936)
Assumptions regarding the health risks from radiation and exposures to other environmental contaminants presented in Chapters 5, 6, and 7 are still in serious dispute. A computer model necessarily needs to use particular values of risk(s). If the underlying assumptions of a model are later shown to be incorrect, the conclusions of the model are extremely likely to be flawed. We would prefer not to use any value developed from these models, even as a measure of relative risk. However, we do believe there is one fact that is extremely relevant to any consideration of human health impacts: BNL has the greatest population potentially exposed to adverse effects from disposal operations.

Response
Since the WM PEIS analysis attempts to estimate future risk, a number of environmental fate, exposure assessment, and dose conversion models must be used to prospectively predict exposure and risk. The toxicity data used as benchmarks or dose conversion factors in the models are not in dispute; they are the standard values used in radiological and chemical risk assessments. The values used were developed by recognized organizations and they have been subjected to scientific peer review. The dose conversion factors used to estimate chronic health effects resulting from exposure to direct

radiation or radionuclides were developed by the International Commission on Radiation Protection. The chemical cancer (i.e., slope factor) and noncancer (i.e., reference dose and reference concentration) toxicity values used were developed by EPA.

The health risk estimates presented in the WM PEIS do have associated uncertainties, as discussed in Section 5.4.1 in Volume I and in Sections D.2.15 and D.4 in Volume III. As described in these sections, many of the uncertainties associated with the WM PEIS risk estimates are applied consistently or systematically throughout the analysis. Therefore, the relative differences in risk estimates among waste management alternatives should not be affected by errors associated with these systematic uncertainties.

DOE added an offsite population risk vulnerability analysis for the proposed disposal sites to the Final WM PEIS. This analysis, which is presented in Sections 5.4.1.2.3, 6.4.1.9, and 7.4.1.8 considered a number of BNL site-specific factors, including the size of the offsite population.

Comment (2941)
The WM PEIS Summary document states that doses to the hypothetical farm family were estimated for a 10,000-year period because the maximum exposure would occur in the future. This is not at all clear; the half-lives of everything except the transuranic waste isotopes are much shorter.

Response
In Volume I, Section 5.4.1, and Volume III, Appendix D, the WM PEIS provides details on the hypothetical farm family scenario. In the scenario evaluated in the PEIS, the farm family could be affected by groundwater contaminated by leachate from the disposal unit, which takes thousands of years to reach the farm family well, located 300 meters (984 feet) from the center of the disposal unit. Most short half-life radionuclides would decay to levels that are not harmful before they reach the farm family well. Therefore, most of the radionuclides that would cause adverse health effects for the farm family are long half-life radionuclides, which are not confined to the transuranic radionuclides. For example, thorium-232 and uranium-238 have half-lives of 14,000,000,000 years and 4,500,000,000 years, respectively. Both are considered in the PEIS analysis.

As described in Section 5.4.1, the 10,000-year modeling period consists of 143 farm family lifetimes, each assumed to be 70 years. The lifetime having the highest dose is reported as the maximally exposed farm family lifetime in the PEIS. DOE revised the Summary document (Section 3.2.1), and Sections 5.4.1, 6.4.1, and 7.4.1 in Volume I of the Final WM PEIS to indicate that the 10,000-year analysis period was selected to be consistent with the guidelines for the conduct of performance assessments that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A.

Comment (2947)
If the hypothetical well is drilled at some locations on ORR, there could be a major exposure. How is this treated in the PEIS?

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Response
As discussed in Volume I, Section 5.4.1, the location of the hypothetical farm family well was assumed to be 300 meters (984 feet) downgradient from the center of an underground disposal unit. The WM PEIS does not attempt to identify specific individual disposal locations on DOE sites or pre-existing contaminants in groundwater. The locations of the disposal units on a DOE site would determine the effect on the hypothetical farm family and the well. Site-specific decisions about the locations of individual disposal units will be based on site-specific studies as explained in Section 1.7.3 in Volume I of the WM PEIS.

Comment (3018)
Volume I, Table 6.4-11, states in the footnote that hypothetical cancer fatality probabilities have been "adjusted" so that groundwater contamination represents 100% of the current standards. DOE must explain these adjustments.

Response
Section 6.4.1.8 of the WM PEIS provides the rationale for adjusting maximally exposed individual cancer fatality risk estimates based on groundwater contamination data. As explained in this section, the performance assessment process required under DOE Order 5820.2A would ensure the design and siting of a disposal unit that complies with the performance objective requirements of the Order, including groundwater protection. Several mitigation measures are available to achieve this objective. Therefore, the hypothetical farm family risk estimates have been adjusted to reflect groundwater contamination that does not exceed existing standards.

Unadjusted risk estimates are provided in the Volume II Site Data Tables and in Appendix D (Volume III).

Comment (3068)
In Table 5.4.1, the disposal phase should include "accidental" releases due to such things as earthquakes, floods, etc.

Response
As discussed in Volume IV, Appendix F, disposal accidents were not evaluated because of the lack of details of ultimate disposal. However, except for dedicated centralized repositories such as Yucca Mountain or WIPP, disposal sites would generally lack a concentrated volume of material at risk being stored in a configuration susceptible to phenomena such as fires and explosions capable of causing significant releases. These repositories have accident analyses performed as part of their site-specific EISs. Although seismic events could breach in-ground containers leading to airborne releases, the potential impacts from such events would be included by accidents breaching the concentrated volumes of waste being held in a treatment or storage facility because the disposed of waste would be in a stabilized form (e.g., grout).

Comment (3080)
Volume I, Section 7.4.1.5. Although DOE will conduct performance assessments for disposal facilities according to the requirements of DOE Order 5820.2A, the WM PEIS discounts the Order and assumes a generic disposal-unit size. This could markedly underestimate disposal-unit requirements and land required for disposal.

Response
The discussion in Volume I, Section 7.4.1.5 (7.4.1.7 in the Final WM PEIS), is not meant to discount the requirements of DOE Order 5820.2A. Rather, reference to this Order was meant to indicate that implementation of the performance assessment analyses findings could increase or decrease the estimated number of disposal units presented in Table 7.4-10. A brief comparison of the performance assessment process and the WM PEIS low-level waste disposal analysis is contained in Section 7.4.1.7. A brief description of DOE Order 5820.2A is presented in Section 1.4.3.

Comment (3147)
The WM PEIS does not support decisions that DOE intends to make for using WIPP for disposal regarding transportation and facility capacity because (1) DOE intends to use truck and not rail, although the fatalities for the former are higher and (2) DOE fails to analyze non-fatal transportation accidents and their effects on various communities, and the costs and benefits of providing emergency training and equipment required by the WIPP Land Withdrawal Act.

Response
The specific potential impacts from operating WIPP as a transuranic waste repository, including transportation by truck and/or rail over current specific routes are addressed in the WIPP SEIS-II. The WIPP SEIS-II also discusses provisions for emergency training.

In keeping with the programmatic nature of the PEIS, DOE utilized a broad-based, or more generic analysis of transportation routes, and transportation modes. The PEIS analyzes transportation-related impacts in terms of health risks, and ecological resources. These health and ecological risks for transuranic waste are found in Sections 8.4 and 8.7 in Volume I, respectively, and detailed in Appendices C (Volume III) and E (Volume IV) of the PEIS.

Comment (3182)
DOE examined the capabilities of the various sites to handle waste. The results of this analysis are available to DOE in a draft report prepared by the Federal Facility Compliance Act Disposal Workgroup. It is clear from this report that Hanford is among the least suitable sites for a low-level or low-level mixed waste repository. Based on geology, hydrology and related issues, 10 other sites have fewer restrictions on the materials they could accept. Despite this, Hanford is the only site DOE considered for a centralized national low-level and mixed waste repository.

Response
The draft report mentioned in the comment was a scoping-level analysis used to compare the strengths and weaknesses of 15 DOE sites for disposal of low-level mixed waste. Except for uranium, Hanford was typical of an arid disposal site in that the water pathway (which was analyzed along with atmospheric pathways and inadvertent intrusion) was of minor importance. However, due to factors not accounted for in the draft report, uranium exposure from the water pathway will likely be lower than estimated. The final report clarifies this point. The final report and site-specific performance assessments will be factored into DOE's waste management decisionmaking process.

As described in Section 6.3.5 in Volume I of the PEIS, candidate low-level mixed waste disposal sites were selected as the reasonable upper bound based on screening performed in coordination with the States under the Federal Facility Compliance Act. To narrow the number of possible low-level mixed waste disposal sites, three exclusionary criteria were applied to the 37 sites with low-level mixed waste,

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reducing the number of reasonable sites to 22 locations. The exclusionary criteria related to proximity to floodplains and seismic faults, and to buffer area between the disposal structure and the site boundary. Three additional sites were then removed with the concurrence of the States for technical and practical considerations, leaving 19 sites for disposal consideration. DOE eliminated three other sites for reasons related to land ownership, availability, and ground conditions. This left 16 sites currently evaluated for low-level mixed waste disposal in the PEIS. For consistency, the same sites were also evaluated for low-level waste disposal.

Hanford was evaluated for centralized disposal based on anticipated large onsite volumes of low-level mixed waste and low-level waste. This included considerations of secondary streams of low-level mixed waste and low-level waste from the high-level waste treatment process that is evaluated in other documents, and recognized to exist at Hanford. Another site, NTS, is also evaluated for centralized disposal of low-level mixed waste and low-level waste.

Comment (3235)
A draft DOE report entitled *Performance Evaluation of The Capabilities of DOE Sites For Disposal of Mixed Low-Level Waste* (Predecisional Draft, 10/10/95) indicates that many sites, including Hanford, have severe restrictions on the concentrations of waste they can accept without violating applicable standards. Section 6.2.3 of the Draft WM PEIS asserts that no acceptance criteria are imposed. Appropriate acceptance criteria must be imposed to limit the risks to the appropriate standards when considered along with the risks from all other wastes and activities on the site.

Response
For purposes of analysis, DOE assumed that each low-level mixed waste disposal site would be able to accept all wastes designated for the site, according to the proposed waste management alternative (see Volume I, Section 6.2.3). If subsequent analyses, including the performance assessment process, show that additional measures must be taken to meet waste acceptance limitations, DOE will take such measures. In addition, DOE will comply with all applicable regulatory requirements for disposal of its low-level mixed waste.

The performance assessment process, described in Section 6.4.1.8, provides for a more detailed analysis of site-specific factors than the PEIS screening-level analysis. The performance assessment process will identify whether disposal facilities will require engineering controls, waste form controls, facility location controls, or waste acceptance criteria to meet the performance objectives of DOE Order 5820.2A. A combination of these and other measures will ensure protection of human health and the environment from waste disposal activities.

Comment (3246)
Appendix D, Table D.4-5, identifies the uncertainties of risk predictions via the groundwater pathway. The table shows uncertainties for Hanford of 12 orders of magnitude. Page D-343, first paragraph states "Excluding the lower 80th to 95th percentile of the uncertainty for Hanford from consideration (because this behavior appears to be unique to Hanford and is extremely uncharacteristic of the other sites), the most reasonable estimate of the uncertainty with respect to disposal risks in the PEIS would be between 1 and 2 orders of magnitude." It is unacceptable to disregard the Hanford risk uncertainty in this manner. Some groundwater pathways at Hanford move quickly. Some members of the public and Tribes are more likely to be exposed.

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Response
The paragraph to which the commentor refers explains that most of the uncertainty in the Hanford estimates are in the lower risk range as values approach zero. Orders of magnitude change in this direction reflect a much lower absolute change in risk estimates than orders of magnitude change in the upper range. Thus, it is more conservative, in terms of risk interpretation, to exclude the skewed uncertainty in the lower range of values at Hanford, which is what the paragraph describing Table D.4-5 in Volume IV suggests.

Comment (3255)
The WM PEIS does not address the risks of vapor phase transport of radionuclides disposed of in shallow land burial sites. At Beatty, Nevada, a commercial radioactive waste site is leaking tritium and carbon-14 into the vadose zone. The vadose zone contamination due to radionuclide migration at Beatty should cause DOE to take another look at its fate and transport models. Appendix D does not have enough information on the DUST and MEPAS models to determine if all likely transport scenarios were included. DOE should examine the risks of its continued shallow land burial of radioactive waste and its future plans for the burial of radioactive waste.

Response
The WM PEIS is a screening-level analysis. It assumes that engineered containment of radionuclides is lost after a certain period of time and that risks are driven by the leaching and subsequent transport of contaminants in the groundwater. For the purposes of the PEIS analysis, other exposure pathways (e.g., vapor phase transport) were assumed to be less important than the groundwater pathway and were not evaluated. Therefore, the discussion of the DUST and MEPAS models in Appendix D (Volume III) focuses on the groundwater pathway because the WM PEIS evaluated only this exposure pathway in developing risk estimates for the hypothetical farm family. Multimedia pathways will be better addressed in site-specific NEPA reviews or performance assessments required under DOE Order 5820.2A. This Order requires that site-specific performance assessments be conducted to demonstrate that a given disposal practice can be reasonably expected to comply with specified performance objectives for protection of public health and groundwater resources.

In April 1996, DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help ensure that continuing disposal of low-level waste will not compromise the future radiological protection of the public. The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned low-level waste disposal facility and other sources of radioactive material in the ground that might interact with the low-level waste disposal facility.

Comment (3367)
Is it common for owners of wells to spread the core soil over a 2,500 square-meter area? (See Volume III, Section D.2.2.)

Response
A number of assumptions were required for the hypothetical intruder scenario analysis. The 2,500-square-meter soil coverage area assumption is based on information contained in Kennedy and Peloquin (1988).

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Comment (3393)
Volume I, Sections 5.4.1, 6.4, and 7.4, state that the WM PEIS analysis does not attempt to predict the potential risks to current offsite populations from the disposal of low-level waste and low-level mixed waste and does not predict adverse human health impacts from disposal for future offsite populations. Such analysis could be relevant in selecting or eliminating a site for waste disposal. How can the site(s) for disposal of low-level waste and/or low-level mixed waste possibly be selected in the absence of such analysis? Analysis of farm family and intruder scenarios is not sufficient for site selection without analysis of potential offsite impact.

Response
Risk assessments generally evaluate potential health risks for populations of receptors and for maximally exposed individuals. However, the WM PEIS disposal risk analysis provides quantitative estimates of risk only for the farm family maximally exposed individual. Although this screening-level assessment used site-specific hydrogeologic and meteorologic data, the analysis did not attempt to identify exact locations of the "conceptual" disposal units on a site. Rather, new waste management units were assumed to be placed either near existing disposal units (where such units exist) or at a location on the site expected to be most sensitive to groundwater contamination. Since the analysis does not attempt to actually locate the disposal units on sites, DOE believes it cannot develop plausible estimates of the risks to offsite populations resulting from exposure to contaminated groundwater. Both the concentrations of contaminants in the groundwater and the number of people potentially exposed will be strongly influenced by the locations of the disposal units and receptor wells. Therefore, a hypothetical siting decision for purposes of this analysis is not recommended. The results of the analysis would be a direct reflection of the choice of location. Such a subjective location choice would produce a quantitative analysis that might mislead rather than inform.

To supplement the quantitative estimates of individual disposal risks presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I, DOE performed semi-quantitative analyses of the potential for offsite population risk. These analyses produced estimates of the relative vulnerability of sites, rather than quantitative estimates of person-rem doses and cancer fatalities. For these semi-quantitative analyses, DOE used simple statistical techniques and information about site characteristics known or expected to be associated with the potential for offsite population disposal risk to develop "risk vulnerability" groupings of the sites. Sites in each of the groups have similar potential for offsite population health risk.

Comment (3644)
Where is the hypothetical farm family maximally exposed individual in the transuranic waste analysis?

Response
The hypothetical farm family analysis was used to address potential health risks from disposal of low-level waste and low-level mixed waste. Disposal of transuranic waste is not within the scope of the WM PEIS and, thus, there is no hypothetical farm family analysis for transuranic waste. The environmental impacts, including potential human health risks, of disposal of transuranic waste are addressed in the WIPP SEIS-II.

Comment (3783)
What is the buffer zone for having a disposal facility? DOE needs to explain what regulations may restrict a site within so many miles of a populated area.

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Response
DOE Order 58202.A, *Radioactive Waste Management*, specifies performance objectives for disposal of low-level waste at DOE sites. The performance objectives are intended to provide for protection of (1) members of the public who might be exposed to radionuclides released to the general environment, (2) inadvertent intruders onto disposal sites following loss of active institutional control, and (3) groundwater resources that might be contaminated by releases of hazardous materials from disposal facilities. The Order also defines a low-level waste disposal site as consisting of disposal units (i.e., discrete portions of the disposal site into which waste is place for disposal) and a surrounding buffer zone, which is defined as the smallest region beyond disposal units that is required as controlled space for monitoring and for taking any needed mitigative measures.

DOE guidance developed in 1994 (DOE/LLW-157) states that the buffer zone should be defined in site-specific performance assessments, but it should not extend more than 100 meters (3,281 feet) from any disposal unit.

Due to its programmatic nature, the WM PEIS assumes the use of generic disposal facilities located near existing disposal facilities or in hydrogeologically sensitive areas. Two types of disposal facilities were analyzed: engineered disposal and shallow land burial. Candidate disposal sites were identified using three exclusionary criteria: (1) sites could not be located within a designated 100-year floodplain; (2) sites could not be located within 200 feet of a seismic fault; and (3) sites were required to have sufficient area for a 100-meter buffer zone between the disposal unit and the site boundary.

Comment (3945)
The farm family scenario lacks merit and does not address impacts of exposure and actual risk to populations that grow both crops and livestock as food. It completely "glosses over" the fact that rural and indigenous peoples gather plants and hunt wild game as major sources of food.

Response
As described in Section 5.4.1.2.2 in Volume I, the farm family scenario evaluates long-term impacts of exposure due to the ingestion of contaminated drinking water, crops, and livestock following waste disposal. The estimates of human health risk were determined assuming the receptors were located close to the disposal units. As a result, the analysis is a conservative estimate of potential risk and potential long-term impacts. Specific subsistence issues were not the focus of this analysis.

Section D.2.2.1 in Volume III explains that DOE did not evaluate health risks to subpopulations living near DOE sites that might derive a major portion of their food supply from native plants and animals. The results of such complex analyses would likely vary widely both within and among sites, depending on the assumptions used for parameters, such as locations of facilities on the sites, routes of exposure, and dietary habits of subpopulations. Therefore, analysis of potential health effects from subsistence consumption of fish, wildlife, and native plant species is not included in the WM PEIS, but could be considered in sitewide or project-level NEPA reviews. Section 5.4.7.2.3 in Volume I provides additional information about subsistence consumption for specific subpopulations.

Comment (3982)
The hypothetical farm family and hypothetical intruder scenarios presented in Chapter 5 do not consider former disposal units currently onsite, do not include existing groundwater contamination

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onsite, and assume no mixing of groundwater plumes has occurred or will occur. These assumptions and omissions make the risk assessments meaningless.

Response
The WM PEIS uses the simplifying assumptions cited in the comment because (1) the locations of the future disposal facilities on the sites are not known; (2) releases from the tumulus and below-ground vault facilities would not occur for hundreds of years; (3) many contaminants do not reach peak concentrations for thousands of years; (4) the population distributions around the sites are predictable for tens of years but not for thousand of years; (5) new facilities are generally located in uncontaminated areas to simplify groundwater monitoring; and (6) environmental restoration activities are containing and/or cleaning up much of the existing contamination.

In addition, risks from existing groundwater contamination are outside the scope of the WM PEIS; therefore, they only added to the waste management risks in the cumulative impacts analysis (see Chapter 11).

Comment (4445)
With respect to health risks from disposal, the WM PEIS should include a summary of the available information on risks from disposal for transuranic waste (TRUW) and high-level waste (HLW) (forever, not just for 10,000 years), as well as the potential significance of alternative sites to Yucca Mountain and WIPP on the relative impacts of the alternatives evaluated in the WM PEIS.

DOE should also address basic policies on how much risk would be acceptable, and whether to use relatively unretrievable storage versus retrievable long-term storage at the DOE sites that currently have the waste or at other locations.

Population impacts were not adequately evaluated in the Draft PEIS. While individual members of a hypothetical farm family might have the highest individual risks, what assumptions were made to evaluate risks to entire populations?

Where did the assumption of the distance of the farm family to the sites comes from? How conservative and how realistic is it, and how does this compare to current distances of people from the sites? How would the alternative distances impact the relative risks posed by alternatives?

Response
The impacts of the disposal of TRUW and HLW are outside the scope of the WM PEIS; DOE is evaluating them in separate EISs. However, to the extent available, information on such impacts has been considered in the WM PEIS cumulative impacts analysis presented in Chapter 11 in Volume I.

Issues related to disposal technologies, and associated risks are discussed in the WIPP SEIS II and the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste in a Geologic Repository at Yucca Mountain EIS.

Sections 5.4.1, 6.4.1.8, and 7.4.1.7 in Volume I describe the hypothetical farm family scenario as a screening-level assessment. Impacts to the farm family would include impacts to families living farther from the disposal facility boundary. Extrapolation of farm family risks to the entire population would be speculative. DOE has supplemented the farm family scenario analysis in the Final WM PEIS with

an analysis of the relative vulnerability of the candidate disposal sites for potential risks to offsite populations from disposal. The results of this analysis are presented in Sections 5.4.1.2.3, 6.4.1.9, and 7.4.1.8 in Volume I.

The 300-meter (984-foot) distance from the farm family to the center of the disposal facility is analogous to the 100-meter (328-foot) distance to the edge of the disposal facility suggested by DOE guidance on performance assessments required for low-level waste disposal by DOE Order 5820.2A.

Comment (4473)
With regard to groundwater risks and contamination, what is the basis for the assumption referred to in Section 9.2 of the Draft WM PEIS Summary document that contaminants from different disposal sites do not merge or commingle? Given that plumes move up to 50 miles in the environment, this seems to be a highly unlikely assumption. Also, people move around and might be exposed to contaminants at several locations. The weather also moves the air so that people are exposed to plumes from more than one source during a lifetime.

Response
DOE has revised the PEIS Summary document and Section 5.4.1.2 and Chapter 11 in Volume I to clarify this assumption. Concentrations of groundwater contaminants are assumed to be higher at 300 meters (984 feet) from the center of the disposal unit than at greater distances due to the dispersion of contaminants. DOE assumes that contaminant plumes from multiple units will not commingle at the 300-meter wells, but that the likelihood of commingling increases with distance from the unit. However, at distances greater than 300 meters, the concentrations of groundwater contaminants in any given plume should be lower as a result of dispersion and dilution than those estimated at 300 meters.

Comment (4524)
The risk assessment in Section 5.4.1 of the Draft WM PEIS is inadequate because it does not predict potential risks to current or future offsite populations from disposal of low-level waste, and low-level mixed waste, the range of risks at such sites, availability of locations at different sites, or availability of locations at different DOE sites that would render such risks negligible, minimal, or monitorable.

Response
Risk assessments generally evaluate potential health risks for populations of receptors and for maximally exposed individuals. However, the WM PEIS disposal risk analysis provides quantitative estimates of risk only for the farm family maximally exposed individual. Although this screening-level assessment used site-specific hydrogeologic and meteorologic data, the analysis did not attempt to identify exact locations of the "conceptual" disposal units on a site. Rather, new waste management units were assumed to be placed either near existing disposal units (where such units exist) or at a location on the site likely to be the most sensitive to groundwater contamination. Because the analysis does not attempt to identify the actual location of disposal facilities on sites, DOE believes it is not possible to develop plausible quantitative estimates of the risks to offsite populations resulting from exposures to contaminated groundwater. Both the concentrations of contaminants in the groundwater and the number of people potentially exposed will be strongly influenced by the locations of the disposal units and receptor wells. Therefore, a hypothetical siting decision for this analysis is not appropriate. The results of the analysis would be a direct reflection of the choice of location. Such a subjective location choice would produce a quantitative analysis that might mislead rather than inform.

5.2.2 Disposal Risks

To supplement the quantitative estimates of individual disposal risks presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I, DOE performed statistical analyses of site environmental characteristics. These analyses produced groupings of sites by relative vulnerability, rather than quantitative estimates of person-rem doses and cancer fatalities. Section 5.4.1.2.3, 6.4.1.9, and 7.4.1.8 in Volume I and Appendix C in Volume III contain additional details about the methods and results of these analyses.

Actual design, siting, construction and operation of disposal facilities will require additional analyses, such as performance assessments, and will be in compliance with all applicable site-specific requirements.

Comment (4525)
The problem of estimating impacts from waste disposal on future offsite populations of unknown sizes could be avoided by assuming that the population distribution remains as it was in 1992 (as was apparently done for air emissions) and caveating the results appropriately. DOE should evaluate extent and severity of potential contamination, along with the amount of uncertainty in such estimates, to understand the potential hazards posed by subsurface disposal. Alternatives to subsurface disposal should also be evaluated.

Response
Even if DOE assumed a certain population distribution, since the analysis does not attempt to actually locate the disposal units on sites, DOE believes it cannot develop plausible estimates of the risks to offsite populations resulting from exposure to contaminated groundwater. Both the concentrations of contaminants in the groundwater and the number of people potentially exposed will be strongly influenced by the locations of the disposal units and receptor wells. Therefore, a hypothetical siting decision for purposes of this analysis is not recommended. The results of the analysis would be a direct reflection of the choice of location. Such a subjective location choice would produce a quantitative analysis that might mislead rather than inform.

To supplement the quantitative estimates of individual disposal risks presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I, DOE performed statistical analyses of the site environmental characteristics. These analyses produced groupings of sites by relative vulnerability, rather than quantitative estimates of person-rem doses and cancer fatalities. Sections 5.4.1.2.3, 6.4.1.9, and 7.4.1.8 in Volume I and Appendix C in Volume III contain additional details about the methods and results of these analyses.

The evaluation of disposal in the WM PEIS is not limited to subsurface disposal (shallow land burial). For sites with relatively high water tables east of the Mississippi River, DOE's current and planned disposal facilities are aboveground engineered facilities such as the tumulus concept. The WM PEIS reflects DOE's practice and plans by assuming the use of engineered facilities east of the Mississippi River. In any event, the WM PEIS will not lead to a decision on disposal technologies. Disposal technologies will be selected only after sitewide or project-level NEPA studies are completed.

Comment (4544)
If cancer risks exceeding one in 1,000,000 could occur to the maximally exposed individual in the hypothetical farm family described in the Draft WM PEIS due to groundwater contamination, the extent and duration of such potential exposure should be determined over at least the 10,000-year period specified, assuming receptors could draw water from anywhere in the groundwater plume. Furthermore, the 10,000-year period might not be adequate. Risks should be evaluated at least until

the cumulative risk from direct exposure becomes less than one in 1,000,000 anywhere due to radioactive decay and chemical changes in the waste.

Response
The hypothetical farm family risks were calculated for a period of 10,000 years to conform with the analysis period generally used for the performance assessments required in DOE Order 5820.2A. The results of the farm family risk analyses for the disposal of low-level mixed waste (Section 6.4.1.8) and low-level waste (Section 7.4.1.7) indicate that the estimated maximum future radionuclide exposure at most sites would occur within the 10,000-year analysis period.

Comment (4545)
DOE should evaluate the long-term potential maximum impact from loss of containment of waste if institutional control for waste disposal sites is not maintained. The intruder scenario described in the Draft WM PEIS should include what would happen if the intruder (such as a construction company building a new barn, a shopping center with a basement, or a garden apartment) dug up the waste and exposed it at the surface, and users of the site then established farms in the waste. Risks to those on the intruding farms (or gardens), to nearby persons, to those eating food from the farm, and to the environment from the unconfined waste should be evaluated. Risks if high-density residential development occurred in the waste should also be evaluated.

Routes of exposure for unconfined waste include direct ingestion of contaminated soil (or the exposed waste), exposure from the inhalation of contaminated gases and dust, groundwater and surface water contamination, runoff, soil gas, dustfall, exposure to radiation, exposure from the ingestion of animals and plants exposed to the waste and contaminated soil and water, etc.

Response
The WM PEIS uses farm family and intruder scenarios to evaluate the potential public health risks from long-term exposure and accidental exposure, respectively.

The hypothetical "intruder" is an imaginary adult who drills a well directly through a low-level mixed waste or low-level waste disposal unit to the groundwater. As a result of the drilling, contaminated soil from within the unit is brought to the surface, where it mixes with the top layers of the surface soil. The exposure pathways for the intruder were inhalation of resuspended contaminated soil, and direct radiation from contaminated soil. Two hypothetical intrusions were assumed to occur: 100 years and 300 years after closure of the disposal facility. The intruder scenario is assumed to occur at a time in the future after the loss of institutional control.

Evaluating the potential risks to the hypothetical intruder is consistent with the analysis required for disposal facilities under DOE Order 5820.2A. However, it is important to note that the WM PEIS intruder scenario analysis assumes the use of generic disposal facilities and generic waste forms (e.g., grout or polymers), and that the entire inventory of waste will be disposed of (i.e., no exclusion of particular radionuclides or chemicals). The objective of the WM PEIS risk analyses is to provide a relative comparison among the waste management alternatives. In the actual design of a disposal facility at a particular location or a site, more detailed, site-specific data would be required. The objective of the analyses required by DOE Order 5820.2A, including the intruder scenario, is to design a facility that will satisfy the performance objectives (including the multimedia radiation exposure limits) specified in the Order. In practice, implementation of the requirement could involve modifying

5.2.2 Disposal Risks

the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration); modifying the form of the waste to be disposed of (such as changing to a vitrified waste form); and imposing waste acceptance criteria (i.e., restricting the amounts of radionuclides or chemicals allowed in a given waste disposal facility).

Therefore, although it might be possible to construct an alternative intruder scenario that would result in potentially higher exposures (by displacement of more waste from within the unit to the surface), the relative risks among the sites and alternatives evaluated in the WM PEIS are not expected to change, and the risks that are likely to result upon implementation of the disposal alternatives should still be included by the performance objectives specified in DOE Order 5820.2A. As stated in DOE's draft *Interim Policy on Basic Assumptions for Compliance with All-Pathways Performance Objective* in DOE 5820.2A, countless numbers of intruder scenarios can be proposed because all such scenarios are speculations about future human actions. Since it is not possible to authoritatively predict future human actions, social structures, or technologies, there is no way to authoritatively predict the effects an intruder might have on infiltration barriers and environmental pathways.

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Comment (563)
The NRC is currently revising its regulations for the transportation of radioactive material to make them compatible with International Atomic Energy Agency regulations. How would these revisions affect the results of the WM PEIS analysis?

Response
The NRC did revise its regulations (10 CFR 71) governing transportation of radioactive material to conform with International Atomic Energy Agency regulations. The final rule was published in the *Federal Register* on September 28, 1995, and became effective April 1, 1996. DOE has reviewed the revised rule and has determined that none of the changes affect the WM PEIS radiological transportation risk analysis.

Comment (564)
How were transportation accidents evaluated using RADTRAN?

Response
In the WM PEIS, the RADTRAN accident risk assessment accounts for accident rates, the spectrum of potential accident severities, and potential release rates from different types of shipping packages. Human exposure pathways include inhalation, external exposure from the passing radioactive cloud, external exposure from contaminated soil, and potential ingestion of contaminated foodstuffs. Volume IV, Section E.5.1.2.1, contains a more detailed explanation of the RADTRAN accident risk assessment. Section E.6 contains more on the relevant input parameters.

Comment (565)
Why didn't the WM PEIS transportation accident analyses include the potential risks from direct external radiation exposure from ground contamination and ingestion exposure pathways through food and soil contamination? These ingestion and direct radiation pathways could be more important than the inhalation pathway for transportation accidents occurring in agricultural areas.

Response
The WM PEIS radiological transportation accident risk analyses considered potential risks from external exposure to ground contamination and from ingesting contaminated foodstuffs. Volume IV, Sections E.5.1.2.1 and E.5.1.2.2, discuss relevant exposure pathways considered for the transportation accident risk and consequence assessments, respectively.

Comment (566)
What were the values of the food transfer factors (ACCDNT (6,k)) and soil transfer factors (ACCDNT (6,k)) and cleanup level following an accident (CULVL) used in the RADTRAN calculations? Please provide references in the Final PEIS. The cleanup criterion, which depends on the total radiation dose from all contributing nuclides in the shipment, should not be a fixed value. For example, using a high cleanup level would underestimate risks.

Response
As discussed in Volume IV, Section E.5.1.2.1, DOE derived the RADTRAN food transfer factors (ACCDNT(6k)) and soil transfer factors (ACCDNT(7k)) in accordance with the methods described in NRC Regulatory Guide 1.109. These State-specific transfer factors were derived using the transfer coefficients from NRC Regulatory Guide 1.109 and the State agricultural productivity data in *Data*

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Base of Accident and Agricultural Statistics for Transportation Risk Assessment (Argonne National Laboratory Report ANL/EAIS/TM-2). These references are listed in Appendix E in Volume IV of the Final WM PEIS.

To ensure the analysis did not underestimate risks, no credit was given for cleanup after potential accidents. The RADTRAN cleanup level input parameter (CULVL) was set *higher* than any ground concentration estimated from potential releases of the most severe accidents postulated in the WM PEIS. As a result, the RADTRAN program did not make any adjustments to lower the risk based on a cleanup level. If the cleanup level had been set lower than the estimated contaminant ground concentration, RADTRAN would calculate a lower risk using the cleanup level rather than the estimated contaminant ground concentration as input.

Comment (570)
DOE used only one weather condition in the WM PEIS transportation accident risk assessments, which underestimates, by several orders of magnitude, the potential risks (particularly noncancer and acute radiation effects) because the risks are very complicated functions of weather conditions. DOE should use all weather conditions based on STAR data weather categories to calculate transportation risks. The PEIS did not consider microclimates or waste shipments during changing or adverse weather conditions.

Response
Section E.6.7 in Volume IV of the WM PEIS describes the atmospheric conditions used in the accident analyses. Radioactive material released to the atmosphere is transported by the wind. The amount of dispersion, or dilution, of the radioactive material in the air depends on the meteorological conditions at the time of the accident. Because predicting the specific location of an offsite transportation-related accident is impossible, generic atmospheric conditions were selected for the accident risk and consequence assessments.

For the accident risk assessment, neutral weather conditions were assumed. Because neutral meteorological conditions constitute the most frequently occurring atmospheric stability condition in the United States, these conditions are most likely to be present if an accident occurs involving a waste shipment. On a yearly average, neutral conditions occur about half (50%) the time, while stable conditions occur about one-third (33%) of the time, and unstable conditions (Pasquill Classes A and B) occur about one-sixth (17%) of the time.

For the accident consequence assessment, doses were assessed under neutral atmospheric conditions and stable conditions. The results calculated for neutral conditions represent the most likely consequences, and the results for stable conditions represent a weather situation in which the least amount of dilution is evident with the highest air concentrations of radioactive material, producing maximum potential consequences.

In addition, stable weather conditions were used to estimate the most severe credible accidents. These conditions represent the worst weather conditions (potential for highest risk) considered in the accident consequence assessment.

Comment (1182)
Moving wastes by rail is too risky; there are many derailments and accidents every day.

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Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Truck and/or rail could be used for waste shipments between sites and the sites could choose the mode in their transportation plans. The WM PEIS explores ranges of transportation-related impacts for truck and rail transportation. The PEIS includes a detailed assessment of the risks of a complete range of credible accidents for both rail and truck transportation (see Volume IV, Appendix E), including low-probability/high-consequence and high-probability/low-consequence accidents.

Comment (1807)
The conservative risk analysis presented in the WM PEIS suggests that a combination of physical hazards and radiation exposures could cause as many as 65 fatalities from the transport and disposal of these waste types in Nevada. In addition to these wastes, as much as 85,000 tons of civilian spent nuclear reactor fuel could also be transported to Yucca Mountain. Yet the PEIS failed to provide any analysis of the resulting cumulative socioeconomic, environmental, or radiological risks associated with the transport of spent fuel to Yucca Mountain.

The analysis of significant socioeconomic risks associated with the transportation and disposal of large amounts of radioactive waste at NTS was simply not addressed in the document. While an accident involving radioactive waste might be a low probability event, the result of just one accident, regardless of its severity, could have profound negative economic and social consequences on this unique tourism-based economy.

Response
As indicated in Volume I, Section 9.1.1, the impacts of disposing of high-level waste in a repository are not within the scope of the WM PEIS, but will be analyzed in a subsequent DOE NEPA document relating to a geologic repository. The NEPA document for a geologic repository will address the cumulative socioeconomic, environmental, and radiological risks associated with the transport and disposal of DOE spent nuclear fuel, commercial spent nuclear fuel, and high-level waste.

DOE is committed to the continued safe transportation of its radioactive waste.

Only transport of high-level waste to Yucca Mountain was analyzed in the WM PEIS. Transportation accidents involving high-level waste are not likely to release cargo. This is because the transportation casks will be very robust before they are licensed by NRC. DOE agrees that a transportation accident that released spent nuclear fuel or high-level waste cargo to the environment would be a high-consequence event. However, such an event is no more likely to happen in Nevada than it is at any other location along the transportation route.

Chapter 11 in Volume I of the WM PEIS analyzes the cumulative impacts of all past, present, and reasonably foreseeable future actions at each site. DOE revised Section 11.20 to include combined trips for shipments of each waste type, as well as the maximally exposed individual doses at each site. Section 11.20 also summarizes the combined impacts that could occur nationally and regionally from

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the transport of waste management waste, including shipments of high-level waste if Yucca Mountain is found suitable for the emplacement of defense high-level waste. Table 11.20-4 includes shipments of commercial spent nuclear fuel to the candidate geologic repository at Yucca Mountain as reasonably foreseeable activities. Potential impacts from the emplacement of high-level waste in a proposed geologic repository for spent nuclear fuel and high-level waste are not included in the cumulative impacts analysis because that information is not yet available.

NEPA requires the analysis of potential impacts which are reasonably foreseeable. Potential impacts that are speculative are not considered reasonably foreseeable under NEPA. Although a NEPA document can--and the WM PEIS does--address human health and other environmental risks, how people might perceive those risks and how they might act in accordance with their perceptions is speculative. While DOE analyzed health and environmental impacts of an accident at NTS, DOE believes that the impacts of an accident on tourism in the NTS region are speculative and, therefore, did not analyze them in the PEIS.

Comment (2177)
The WM PEIS estimates that there will be 315 fatal cancers from DOE's movement of radioactive material. Twenty-two fatal cancers could occur because of the decisions in this PEIS. You should consider the cumulative impacts, where they occur, and the other 300.

Response
The WM PEIS addresses the cumulative impacts of transportation at the national level in Section 11.20 in Volume I. Table 11.20-4 summarizes potential cumulative transportation-related radiological collective doses and latent cancer fatalities. The commentor is incorrect in interpreting the cancer fatality data. Most fatalities are not a result of DOE's movement of radioactive materials. Over the 93-year period from 1943 through about 2035, the estimated total number of potential radiation-related cancer fatalities would be 315, or about 3 latent cancer fatalities per year on an average annual basis. However, within this cumulative total non-DOE shipments of radioactive material would account for approximately 252 radiation-related latent cancer fatalities. The total number of potential radiation-related latent cancer fatalities associated with the WM PEIS alternatives could be as high as 7% of the cumulative total, or as the commentor notes, 22 potential latent cancer fatalities out of 315 would be the result of WM PEIS decisions. Thus, the analysis does address the cumulative impacts of the doses from all radioactive materials transportation activities. These doses are spread over a large segment of the population along transportation corridors and at shipping points and among transportation workers. Therefore, there is no way to predict with certainty specific locations where the fatalities will occur.

The estimates for potential fatal cancers were calculated by developing the collective operational dose in person-rem and the collective general population dose in person rem for past and future DOE transportation activities. The dose is then used to calculate the total latent cancer fatalities. This is the dose given to all occupational workers and the general population during cumulative transportation activities. The total latent cancer fatalities developed from the dose are used for comparison of dose only. It is unlikely that 315 fatal cancer fatalities have resulted from cumulative transportation activities. The actual dose has been spread among all workers and to the population on the transportation route.

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Comment (2196)
The WM PEIS transportation analyses used improper accident rate assumptions from one of the reference sources. In addition, the transportation analyses did not deal with the issue of peak storm events, and the potential for difficult cleanups and high environmental damages after such events.

Response
The WM PEIS transportation risk analyses used accident rate statistics based on information from the U.S. Department of Transportation (DOT), as discussed in Volume IV, Section E.6.4. These accident rates are State averages based on historic commercial carrier performance with all types of cargo under all weather conditions. Actual accident rates are likely to be slightly lower because commercial carriers of hazardous and radioactive waste have a higher awareness of transportation risk and prepare their shipments accordingly, especially in relation to weather conditions.

Transportation packaging was designed to account for the shipment of wastes during changing or adverse weather conditions. The transportation packaging required is based on DOT and NRC requirements. The design of the packaging makes it unnecessary to review localized adverse weather conditions in the transportation analysis because the design already accounts for such conditions.

For the assessment of transportation accident risks, the PEIS assumed neutral weather conditions. Neutral conditions are the most frequently occurring atmospheric stability condition in the U.S. and, therefore, are the most likely to be present if an accident occurs. Accidents involving radioactive material would be handled by State and local officials in cooperation and compliance with the Federal Emergency Management Agency, DOE, DOT, NRC, and EPA. No transportation accident with a release has ever led to a measurable human health impact due to the radioactive nature of the cargo.

Comment (2230)
The PEIS does not analyze transportation risks for specific routes, such as Cabbage Hill and the Umatilla Reservation. In some cases, those rail routes are not safer than truck routes. The PEIS did not consider microclimates or waste shipments during changing or adverse weather conditions.

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

The transportation analysis is based on representative transportation routes in order to be consistent with existing routing practices. However, because the routes were determined for the purpose of risk assessment, they do not necessarily represent actual routes that would be used to transport waste in the future. Section E.4.2 details representative transportation routes. In some cases specific transportation issues, including the determination of transportation mode(s), will be addressed when actual waste management facilities are sited based on sitewide or project-level NEPA reviews. Within its analysis of risks to human health and the environment, the implementation of programmatic waste management decisions regarding actual transportation routes, modes, etc., will consider factors such as historical transport modes at waste management sites, existing infrastructures; emergency response training programs, practices, and management skills of local and regional officials, etc.

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Due to the programmatic nature of the PEIS, microclimates, or site-specific climatology, are not specifically addressed. However, the PEIS did consider waste shipments during different weather conditions. Radioactive waste transportation analysis in the PEIS considered waste shipments during both neutral and stable weather conditions to estimate accident consequence assessments. Hazardous waste transportation analysis considered waste shipments during neutral weather conditions. Neutral weather conditions occur about 50% of the time and are considered conservative. Stable weather conditions were used in the radioactive waste transportation analysis to represent the case producing maximum consequences. Therefore, risks resulting from adverse or changing weather conditions would be covered by the stable weather condition analysis. Further information on atmospheric conditions is found in Appendix E, Sections E.6.7 and E.16.4, in Volume IV.

Comment (2313)
The WM PEIS does not address the possible public dose due to traffic and accidents, such as when traffic is stopped, and the potential for public exposure.

Response
The transportation analyses in Appendix E in Volume IV examine the potential dose to the public from both normal operations and accidents. The analyses consider traffic patterns, including conditions where the vehicle is stopped in traffic.

Comment (2411)
There is a concern with regard to the many shipments of radiological materials, both to and from INEL and non-INEL-related shipments, across the State of Idaho. These shipments must be accounted for and given a comprehensive evaluation.

Response
Appendix E in Volume IV of the WM PEIS does provide for each alternative for each waste type the cumulative risks for a maximally exposed individual near a site entrance for the five sites with the maximum impacts, which includes the total number of shipments for the alternative. INEL is identified as a site with maximum impacts under each alternative for high-level waste (Table E-13) and for transuranic waste (Table E-25), and for the Centralized Alternative for low-level mixed waste (Table E-31).

Tables 11.20-1 through 11.20-4 in Volume I of the PEIS list information about the potential Department-wide impacts of transportation. This section addresses both the combined impacts of the transportation of all the waste types evaluated in the WM PEIS, and the cumulative impacts of transportation from other actions (e.g., shipments of spent nuclear fuel and naval reactor components).

Table 11.2-1 of the Final WM PEIS identifies other DOE EISs that analyze impacts of actions that were considered in the cumulative impacts analysis in Chapter 11. Table 11.2-1 identifies for each DOE EIS the sites analyzed in the WM PEIS that would potentially be affected by the impacts of the actions analyzed in the other EISs. The two EISs that analyzed actions with impacts that might affect INEL are the SNF/INEL EIS and the Foreign Research Reactor Spent Nuclear Fuel EIS. The SNF/INEL EIS analyzed impacts of shipping spent nuclear fuel to INEL, and the Foreign Research Reactor Spent Nuclear Fuel EIS analyzed shipment of foreign research reactor spent nuclear fuel to INEL.

Further analysis of shipments by State is not provided in the WM PEIS because, although the routes identified are representative, they might not reflect actual routes.

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Comment (2648)
Volume IV, Sections E.6.3 and E.16.2. Is the population density around the Hanford Site representative of all the sites?

Response
No, the population density around the Hanford Site is not representative of all sites. The commentor apparently has confused the two types of transportation risk assessments (onsite and offsite transportation) discussed in Appendix E.

Transportation risk was estimated for both the *onsite* and the *offsite* shipment of radioactive and hazardous wastes. Onsite transportation involves movement of waste between facilities located within the boundaries of a DOE site. Offsite transportation refers to the movement of waste between different DOE sites.

Section E.2.1 in Volume IV states that the human health risks associated with onsite transportation are generally much smaller than those from offsite transportation, largely because of the limited distances for onsite shipment, limited population densities along the routes, and limited average travel speeds. Accordingly, the impacts of onsite transportation are not likely to contribute significantly to differences among the alternatives being considered. Therefore, for purposes of the PEIS, the onsite risk assessment has been limited to one site -- Hanford. This site was chosen primarily because it is relatively large and conducts activities for managing all of the waste types considered in the WM PEIS. Transportation radiological risks are dominated by exposure during routine transport when compared to potential accident releases; routine transport risks are typically 100 to 1,000 times higher than accident transport risks. The Hanford Site carries out extensive waste management operations involving all waste types and often makes many shipments across a large area within the site. Therefore, it is not expected that any other DOE site has operations that would involve *onsite* transportation risks significantly greater than those at Hanford.

Section E.6.3 in Volume IV describes the population density zones used for the *offsite* transportation radiological risk assessment. Section E.16.2 provides similar information for the hazardous chemical risk assessments. Note that these population densities were used only in the *offsite* transportation risk assessments. They were not considered or used in the *onsite* transportation risk assessment.

Comment (2649)
Volume IV, Section E.7, states that worst-case waste (highest potential radiological risk) is used in the transportation accident consequence assessment. Section E.6.2.1 states that an external dose rate at the existing regulatory limit of 10 mrem per hour (at 2 meters) is assumed for all high-level waste shipments. Sections E.6.2.2, E.6.2.3, and E.6.2.4 state that average external dose rates are used in the routine transportation risk analysis. It is not clear why worst-case waste exposures are assumed for the transportation accident scenario when average dose rates and conservative dose rates at the regulatory limit (for high-level waste) are used in routine transportation exposure analyses.

Response
Volume IV, Section E.2.4, of the WM PEIS states that the impacts of transporting radioactive materials were evaluated for both routine transportation and for transportation accidents. The health risk associated with routine transportation results from the potential exposure of individuals to low levels of external radiation near the surface of shipments. The risk from transportation accidents involves the

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potential release and dispersal of radioactive material into the environment, with individuals exposed through a number of pathways, including inhalation and ingestion of contaminated food. The external dose rates summarized in Table E-5 were used in the calculation of routine transportation risks. Section E.6.2 describes the shipment external dose rates for routine transportation.

The transportation accident analysis is intended to provide an estimate of the maximum potential radiological impacts of a severe transportation accident. Historical information provides a more accurate analysis for the routine transportation risks. The highest radiological risk is obtained by screening the site-specific characteristics for radiological waste (that is, activity concentrations) developed for the PEIS, by taking into account the physical forms of the waste and the relative hazards of individual radionuclides, and selecting for analysis those wastes with the highest radiological risk. Section E.7 describes the results of the transportation risk assessment for radioactive waste.

Comment (2657)
Volume IV, Appendix E, Parts I and II, use different references for vehicle-related accident and fatality rates. The fatality rate used in the first part (for general trucking) is lower by about a factor of 5 than that quoted in the second part (for hazardous material trucking). A review of the fatality rates used might be appropriate, since vehicle fatalities are significant for some alternatives for some waste types.

Response
The fatality rates in Part I of Appendix E are for the use of heavy-haul combination (tractor-trailer) trucks for the shipment of large volumes of radioactive wastes. The hazardous waste shipments discussed in Part II of Appendix E tend to be small shipments using smaller single-unit trucks. The accident rates used reflect the differences in the two truck types.

Comment (2660)
Volume IV, Section E.8.1. Was the uncertainty in any site's waste inventory "large as compared with other site inventories?" A statement to the effect that "this was not so" needs to be incorporated into the text (if, in fact, this is true). Otherwise, the impact of incorporating this uncertainty into the relative risk comparisons needs to be better explained.

Response
As stated in Section E.8.1 in Volume IV, DOE assumes the uncertainty in each site's inventory to be reasonably consistent across sites. This approach is expected to limit the overall uncertainty in the data and the likelihood that the level of uncertainty varies significantly among sites.

Comment (2662)
Volume IV, Section E.12.4. The statement, "the potential for the public's exposure by inhalation of particulates is considered to be much lower than that for inhalation of vapors or gases because... (3) acute toxicity of inhaled particulate is low" is a non sequitur.

Response
DOE has revised this text to state that the acute toxicity of inhaled particulates is lower than that of inhaled vapors or gases for the same quantities released in the DOE shipments.

5.2.3 Transportation Risks

Comment (2663)
Volume IV, Page E-114, Paragraph 1 states that some solids (e.g., sodium cyanide, sodium azide) generate highly toxic (airborne) gases in contact with water and others (e.g., phosphorus) generate toxic fumes in contact with air. Arsenic forms arsine gas in contact with sulfuric acid or when aqueous arsenical solutions come into contact with reactive metals (iron, aluminum, zinc). Lindane decomposes to hydrogen chloride and phosgene when heated (in a fire). Have these types of reactions been considered? Were any solids or nonvolatile liquids discounted that could release hazardous substances in a transportation accident? Is there a list of the substances that were not assessed because of their physical state?

Response
Chemical compounds in DOE waste that could produce significant amounts of toxic gases upon reaction with water ("water reactives") were assessed in the hazardous waste transportation risk assessment. The potential risk from water-based (i.e., spills into waterways adjacent to truck routes) accidents associated with these "water reactives" was found to be extremely small (less than 1% of the risk associated with land-based accidents).

In general, secondary chemical compounds formed by chemical transformation of reactive chemicals in the atmosphere or generated from fires in accidents involving flammable compounds were not specifically assessed in the transportation risk assessment. Because of the relatively dilute concentrations of chemical compounds considered poisonous by inhalation or producing other adverse health effects in DOE hazardous waste, the concentrations of transformation products from these substances are likely to be of lesser significance from a health risk prospective.

Most of the compounds that were not considered in the PEIS transportation risk assessment are low volatility (vapor pressures less than 10mm Hg) liquids or solids. There is no list of substances because any commercial chemicals with these physical properties could potentially be found in DOE hazardous waste or mixed waste.

Comment (2667)
Volume IV, Section E.16.4. Shouldn't the last sentence of this section read, "This position was also adopted for modeling *atmospheric conditions* in this assessment?"

Response
The sentence, as written, conveys what was intended. Atmospheric conditions are input to the consequence assessment modeling that was used in estimating chemical exposures.

Comment (2668)
Volume IV, Section E.16.5.1.1. The toxicity data references contain data that are generally not regarded as having been peer reviewed. How were true LC_{50} and representative non-human LC_{LO} values selected?

Response
The LC_{50} values were obtained from laboratory animal experiments that were extrapolated to humans. The LC_{LO} values were obtained from animal tests or from events involving accidental human exposures. Because of the limitations of both the human LC_{LO} values and the LC_{50} values, a

conservative approach was taken in selecting the chemical-specific toxicity values. The approach adopted is discussed in Section E.16.5.1.1 and in further detail in Hartmann, et al., 1994.

Comment (2669)
Volume IV, Section E.16.5.1.3. Shouldn't a universal scaling assumption have been applied in deriving PLC values?

Response
The issues involved in deriving potentially life-threatening concentration (PLC) values are discussed in detail in the technical report cited in E.16.5.1 and included in the references for Appendix E, and summarized in Section E.16.5.1.

The procedure followed in scaling PLC values from the experimental exposure times to the estimated duration of exposure was to use either a linear or an exponential function, whichever resulted in the lower PLC value. The time dependence of dose response relationships is chemical-specific; with appropriate experimental data, the correct assumption (linear or exponential relationship) for each chemical could be ascertained. However, these data are available for only a few chemicals in the literature. Due to the large number of chemicals assessed for the WM PEIS transportation analysis, it was necessary to make the simplifying (yet conservative) assumption that the time-dependence relationship resulting in the lower PLC value was correct for each chemical. Applying either the linear or exponential assumption universally could have resulted in underestimation of toxic effects for some chemicals; therefore, this was not done.

Comment (2670)
Volume IV, Section E.16.5.2.1. Were *absorbed dose* or *administered dose* reference doses/reference concentrations *or both* used?

Response
In general, the reference concentrations reported in EPA's Integrated Risk Information System (IRIS) database are expressed as the administered dose, but adjusted from animal experiments to equivalent human doses on the basis of comparative physiological considerations (e.g., ventilatory parameters, regional lung surface areas). These adjustments make it appropriate to use the reference concentrations directly as reference values for comparison with air concentrations, because air concentrations are effectively administered doses.

Comment (2672)
Why are traditional 10-factor uncertainty factors used in Section E.16.5.2.2, when factors of 3 (logarithmic mean of 1 and 10) are used in Section E.16.5.1.2?

Response
The uncertainty factor of 10 was used in both cases. Section E.16.5.1.2 explains that values for LC_{50} or mammalian LC_{LO} were reduced by an uncertainty factor of 10.

Comment (2673)
Volume IV, Section E.16.5.3, states that several inorganic and organic substances were not evaluated for cancer risks. Were these substances evaluated for noncancer endpoints or just eliminated?

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Response
The WM PEIS evaluates hazardous waste transportation risks due to air exposure based on three health endpoints, potential lethality, any adverse effects and potential for increased cancers. The substances evaluated as carcinogens would typically not be evaluated for two of the endpoints, unless these substances also met the health criteria for evaluation as a potential lethality (e.g., meets the criteria for designation as a U.S. Department of Transportation poison by inhalation chemical) or any adverse effect chemical (e.g., EPA published inhalation reference dose).

Comment (2675)
Volume IV, Section E.17.1.3.3. Is the distribution of the various classes of carcinogens (e.g., confirmed human carcinogens such as benzene and vinyl chloride) similar across all of the complex's waste shipments for all alternatives under consideration? If not, then equal cancer risks for alternatives might not be representative of human cancer epidemiology.

Response
For analysis purposes, the source term for hazardous chemicals used in the transportation risk assessment, including carcinogens, was assumed to be similar for all of the waste shipments across the complex under all of the proposed waste management alternatives.

Comment (2676)
Volume IV, Section E.18, states that, in principle, one can estimate the uncertainty associated with each model input data parameter, each model empirical parameter, and each model theoretical assumption, and predict the resultant uncertainty in each set of calculations. The text goes on to discuss input parameter uncertainty in detail. But where is the overall uncertainty in the risk assessment presented? This whole section leads the reader to believe that a probabilistic risk analysis, with distribution of uncertainty, was to be undertaken when, in fact, it was not.

Response
Transportation risk estimates presented in Volume IV, Appendix E, are single-value or "point" estimates. Each of these point estimates does not have an associated error band (i.e., plus/minus value) because a general quantitative uncertainty analysis was not included in the evaluation of transportation risks. As described in Section E.18, conducting a full-scale quantitative uncertainty analysis is often impractical because the lack of data does not permit the development of the probability distributions needed to quantify uncertainty in every parameter.

DOE revised Section E.18 of the PEIS to address the overall uncertainty in the transportation risk estimates. Using a model that provided both single point estimates (i.e., deterministic estimates) and range estimates (i.e., probabilistic estimates) of risk, the single point estimate values were found to correspond to the upper end (i.e., 99th percentile) of the probability distribution of risk value outputs. This analysis suggests that the point estimate outputs of the transportation risk models are conservative and are not expected to underestimate potential transportation risks. A reference for the paper that provides additional details about this analysis has been added to Section E.18.

Comment (2677)
Volume IV, Section E.18. How does summing the risk from many routes result in cancellation of errors?

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Response
The total risk calculated for a specific alternative (and health endpoint) is actually the sum of the risk values computed for each of the many 1-mile segments encompassing the many routes and chemicals included in the risk analysis. There is some error in the risk predication for each mile. There would be some degree of cancellation of errors during this risk summation process (risk for some miles being overestimated and for others being underestimated), unless there is a systematic overprediction or underprediction of the risk at each mile. DOE has revised Section E.18 to more fully explain this.

Comment (2679)
Volume IV, Section E.18.1. It is not clear what is implied by the statement, "In this summation process for each mile, the interaction among all the previous uncertainties occurs, and errors cancel out." This vague statement is not supported by an example of how such "summation" reduces uncertainty. An example should be given. How did DOE arrive at the combined error estimate of plus or minus one order of magnitude for the total risk numbers?

Response
The referenced text in Section E.18.1 was deleted, and new text was added for clarification. In summary, there is some error in the risk prediction for each mile; some miles were over-estimates and other miles were underestimates. There would be some cancellation of errors during this risk summation process.

Comment (3110)
Referring to Section C.4.3.4, a commentor stated that long-term impacts to water quality from transportation accidents are not the only possible impacts from transportation accidents; therefore, short-term impacts and air quality impacts should be considered.

Response
Potential short-term transportation accident impacts to water quality and aquatic ecological resources are addressed in Sections 6.7.5, 7.7.5, 8.7.5, 9.7.4, and 10.7.5 in Volume I of the WM PEIS. Section C.4.2.1.2.1.3 identifies the transportation source assumptions for air quality impacts used in the environmental impacts analysis methods. Section E.5.1.2.1 describes the radiological accident risk assessment, which accounts for exposure pathways such as the internal exposure from inhaling airborne contaminants in an accident. There would be no long-term impacts to air quality from transportation accidents; therefore, the WM PEIS does not discuss this issue.

Comment (3121)
A commentor expressed appreciation for the thorough transportation analysis and commended DOE's inclusion of dose estimates for Category VIII accidents.

Response
Thank you for the comment.

Comment (3122)
The much higher population doses associated with low-level waste and transuranic waste severe accidents compared to the high-level waste accident, is surprising. If one assumes that the major factor driving the differences relates to Table E-8, "Aerosolized and Respirable Material Releases," the

assumptions used to categorize waste inventories and to apply the factors in Table E-8 need to be discussed (perhaps by expanding the "sensitivity analysis" in Section E.8.4).

Response
As suggested, the differences between the high-level waste severe accident estimates and the low-level waste and transuranic waste accident estimates are mainly due to the fraction of the released material that becomes aerosolized following a potential accident. Specifically, postulated severe high-level waste accidents result in lower consequences than postulated severe low-level waste and transuranic waste accidents because the high-level waste is in a vitrified form and is not readily dispersed to the environment. As discussed in Volume IV, Section E.6.6, the aerosolized fraction of the released fraction is the amount of the material originally in the shipping package that is dispersed in the air after release to the surrounding environment. DOE revised Table E-7, footnote "a" to state that the values must be multiplied by the aerosolized and respirable fractions in Table E-8 for the various waste forms in order to determine the amount of material dispersed in the environment. DOE revised Table E-8 to reflect the waste types for the values used.

Comment (3125)
Section E.2.4 should explain short-term effects from doses to individuals due to severe accidents. For example, are the acute doses in some cases sufficiently high that there are predictable effects (i.e., doses of 300 to 500 rem).

Response
As stated in Volume IV, Section E.2.4, transportation-related operations for all waste types are not expected to cause acute (short-term) radiation-induced fatalities or to produce immediately observable effects in individuals. No severe accident analyzed for the WM PEIS is expected to cause any one individual to receive a 50-year committed effective dose equivalent of more than 34 rem (remote-handled transuranic waste accident, Table E-27). A 34-rem dose over 50 years is not expected to cause any observable effects. Section E.2.4 has been revised to further clarify this result.

Comment (3126)
Two assumptions made in Appendix E probably do not affect the relative impacts of alternatives within each waste category, but likely would affect the overall levels of risk/safety achieved. By making them, the WM PEIS is less useful for making programmatic decisions between modes of transport. One is the assumption that wastes carried by rail will not use special or dedicated trains. This is a conservative assumption, in that risks to both transportation workers and to the public near stops and railyards can be reduced by dedicated trains (since the use of dedicated trains would reduce the length of time of each shipment). Dedicated train use would increase the lower-risk advantage of rail over highway transport. The assumption of no intermodal transfers is convenient for consistency in comparisons, but probably not realistic. Clearly, intermodal containerized shipment is increasingly common. Its risk implications are not clear, but deserve to be explored.

Response
Dedicated trains are an acceptable transportation mode for DOE waste shipments. Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process described in Section 4.3.10, in Volume I of the WM PEIS. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large

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shipping campaigns to ensure that safe routing alternatives and safe havens are utilized. A site may choose to use dedicated trains based on the transportation analysis conducted in the WM EIS. DOE has used dedicated trains in the past including during shipments of foreign research reactor spent nuclear fuel from Charleston, South Carolina, to the SRS in 1994 and 1996, and when shipping low-level waste from FEMP to the Envirocare Site in Utah. The decision to use dedicated trains would be addressed during the transportation planning process at each site.

Based on the amount of time spent in railyards for general freight and dedicated trains, the normal routine radiation exposure of the railyard workers and train crew is approximately a factor of 10 lower for dedicated rail than for general freight. However, the use of a dedicated train is cost-effective only when there are large amounts of material to ship. Many sites are not expected to generate enough waste on an annual basis to fill even a single railcar. Moreover, the dominant risk for rail transportation of DOE wastes is from physical injuries of the type associated with any rail accident. The accident fatality rates used in the WM PEIS are based on single railcars (as opposed to entire trains); therefore, the use of dedicated trains compared to general freight will not make more than a factor of 2 difference for shipments with the highest allowable external dose rates. For example, the estimated fatalities from external radiation exposure and from physical trauma from accidents are roughly the same; if the external dose rate impacts decreased by a factor of 10, the overall number of estimated fatalities would only decrease by approximately a factor of 2. DOE revised Section E.2.6 to clarify this.

Waste to be shipped by rail might require additional handling and preparation, especially for sites lacking rail access, which will contribute to the overall risk. (A review of the transportation facilities at 35 DOE sites indicated that 25 have direct rail access onsite, an additional 12 have access within 10 miles, and 8 have access between 10 and 100 miles.) Secondly, a number of other factors could make rail shipments less desirable than truck shipments. Rail shipments would likely require a large inventory of waste to be shipped in order to be cost-effective, and rail operations are not very flexible or responsive to individual site needs. Volume IV, Section E.8.5, describes uncertainties in the comparison of truck and rail transportation modes. However if a site without rail access does choose to use rail transportation, additional transportation analyses might be required. The WM PEIS analysis assumed there would be no intermodal transfers during rail shipments for sites that do not have rail access onsite. The risk from intermodal transfer is expected to be small.

Comment (3128)
The statement that the radiological accident risk assessment uses route specific information on population density and accident rates derived from individual States is misleading. The population densities are route-specific by State only insofar as the routes are divided into rural, suburban, and urban. The average density data used for these three categories are not route-specific or State-specific data.

Response
For the transportation risk assessment in the WM PEIS, route-specific information on population density was used to determine the fraction of travel in each of the rural, suburban, and urban population zones in each State for each shipment route. However, as stated in the comment, average densities are used for these three zones. The wording in Appendix E, Section E.5.1.2.1, has been revised for clarity.

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Comment (3130)
DOE should explain whether there are any data to corroborate or alter NUREG 0710, which is almost 20 years old, in terms of the fractional occurrences by accident severity category.

Response
DOE is not aware of any comprehensive study that has been conducted since NUREG-0170 to dispute or alter the numbers presented. However, what has come to be known as the Modal Study (NUREG/CR-4829) was performed less than 10 years ago and defined 20 "categories" of accident severity related to spent fuel casks. These were categorized by slightly different variables than those used in NUREG-0170 and are not directly comparable for the different types of shipping packages used for the wastes analyzed in the WM PEIS.

Comment (3131)
Do rail calculations consider the additional risks of those alternatives that result in significant shipments in corridors where commuter rail service exists, or is passenger rail density averaged for urban and/or suburban links?

Response
The additional risks in corridors where commuter rail service exists are not considered in the WM PEIS transportation risk analysis for rail transport. The length of travel in these areas is short compared to the overall shipping distances of waste and not expected to contribute significantly to the overall risk. The on-link commuters for rail shipments would not be expected to be the dominant exposure group even if commuter trains passed a shipment frequently. In addition, most commuter rail service is only significant during peak rush hour periods, further limiting the opportunity for exposure.

Comment (3140)
The description of INTERLINE in Section E.4.2.1.2 is inadequate because it does not indicate the factors that actually determine routing.

Response
The description of INTERLINE in Volume IV, Section E.4.2.1.2, is not intended to provide all the information required to determine a rail route. The basic algorithm used by the program is one that determines the shortest route, as discussed in the text. More detailed information can be obtained from the INTERLINE manual, which is referenced in Section E.4.2.1.

Comment (3206)
Section 4.3.10. The transport models do not adequately consider the route-specific hazards for access to the Hanford Site through Oregon. Interstate 84 crossing northeastern Oregon is one of the major routes. This section of Interstate 84 has two particularly dangerous stretches, through Ladd Canyon and over Cabbage Hill, which necessitate specific modeling, and route restrictions during inclement weather.

Response
As discussed in Section E.4.2.1 in Volume IV of the WM PEIS, transportation risk analyses used representative routes. These routes are deemed representative because they are consistent with current routing practices, but might not be the routes actually used if shipping activities were to occur in the future. In addition, the risk over the entire transportation route is generally not dominated by one

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specific local hazardous area. Therefore, analysis of specific local hazards on hundreds of routes is neither practical nor necessary for the purposes of the WM PEIS. The accident rates used in the transportation analyses are averages over several years in all weather conditions; thus, all types of weather conditions were considered. Also, hazardous and radioactive waste carriers are more conscious of the risks involved in transport and prepare their shipments accordingly, including the avoidance of transport under severe weather conditions. DOE will work with State, local, and Tribal officials prior to waste shipments to deal with site-specific transportation routing issues. Transportation planning is described in Section 4.3.10 in Volume I and Appendix E.9 in Volume IV.

Comment (3208)
The rail lines across northeastern Oregon run through a canyon across the lands of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and are difficult to access. Accidents there would be difficult to respond to and would impact the CTUIR. The WM PEIS does not consider the potential for impacts to the CTUIR.

Response
As discussed in Section E.4.2.1 in Volume IV of the WM PEIS, transportation risk analyses used representative routes. These routes are deemed representative because they are consistent with current routing practices, but might not be the routes actually used if shipping activities were to occur in the future. In addition, the risk over the entire transportation route is generally not dominated by one specific local hazardous area. Therefore, analysis of specific local hazards on hundreds of routes is neither practical nor necessary for the purposes of the WM PEIS. The accident rates used in the transportation analyses are averages over several years in all weather conditions; thus, all types of weather conditions were considered. Also, hazardous and radioactive waste carriers are more conscious of the risks involved in transport and prepare their shipments accordingly. DOE will work with State, local, and Tribal officials prior to waste shipments to deal with site-specific transportation routing issues. Transportation planning is described in Section 4.3.10 in Volume I and Appendix E.9 in Volume IV.

Comment (3210)
Volume IV, Section E.2.4, states that for some severe accident scenarios analyzed, it is possible that doses to individuals would have short-term effects but that these effects have not been assessed. This needs elaboration. If some accident scenarios could result in exposures high enough to result effects such as temporary sterility and changes in blood chemistry, there needs to be a better explanation of why this is not considered in this PEIS.

Response
As stated in Volume IV, Section E.2.4, transportation-related operations for all waste types are not expected to cause acute (short-term) radiation-induced fatalities or to produce immediately observable effects in individuals. No severe accident analyzed for the WM PEIS is expected to cause any one individual to receive a 50-year committed effective dose equivalent of more than 34 rem (remote-handled transuranic waste accident, Table E-27). A 34-rem dose over 50 years is not expected to cause any observable effects. Section E.2.4 has been raised to further clarify this result.

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Comment (3215)
Volume IV, Section E.6.5. The Draft PEIS states that no Category VIII accidents are expected to occur. However, if the chance of a Category VIII accident is greater than zero, the assumption should be one accident rather than none.

Response
Section E.6.5 discusses the conditional probabilities used in the transportation accident risk assessment. These are the probabilities of occurrence of a particular accident severity given an accident has taken place. The accident *risk* estimated in the WM PEIS takes into account all accident severity categories. The risk is determined by multiplying the *consequence* (the impact estimate assuming an accident of a given category has taken place) by its conditional probability, summing these products for all accident severity categories and then multiplying the sum by the accident rate. Also, the WM PEIS presents *consequences* for the most severe accidents for each waste type to give the reader an estimate of what could happen in the worst type of accident. As stated in the same paragraph as the statement in question, for the accident consequence assessment, the doses were assessed for populations and individuals by assuming an accident of severity Category VIII. However, as discussed in the accompanying text, the probability of such an accident is on the order of 10^{-12} per mile of travel and the largest estimated shipment mileage in the WM PEIS is on the order of 10^{8} miles. These numbers suggest that the mileage traveled is four orders of magnitude less than what might be expected before an accident of severity Category VIII would occur.

Comment (3304)
The estimates of truck transport accident risks use "statewide averages." For example, they do not reflect estimates of current traffic volumes on segments of Interstate 15 and U.S. Route 95 in Nevada. In addition, they do not reflect the levels of service on specific routes, such as those in Nevada, which are projected to decline from Bs and Cs to Ds, Es, and Fs over the next 20 years (see *NTS Transportation Study*). Also, would the analysis be significantly affected by factoring in recently increased speed limits in Nevada and other States?

Response
The WM PEIS analyzes representative routes for truck and rail. Appendix E in Volume IV describes the radioactive waste transportation risk assessment. Methods and assumptions used in the transportation-related radiological risk assessment were selected to ensure meaningful comparisons of among programmatic alternatives. Estimates of current traffic volumes on specific segments of highways were not used because a detailed consideration of every possible waste shipment would be impractical for a programmatic EIS. Transportation computer models are updated periodically to account for changes in routes, speed limits, and other factors.

Comment (3394)
Volume I, Section 10.4.2. The 50% figure is not justified. Why do worst case scenarios have to involve chemicals that contribute over 50% of the adverse health risk? Consequently, the 2/100th of 1% quantity might be an underestimate. Please explain.

Response
All waste shipments in the hazardous waste inventory were considered in the transportation risk assessment. Approximately 17% of the hazardous waste shipments (285) under the No Action Alternative would contain chemicals that have an "any adverse effect" health endpoint. Thirty-six of

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these shipments (13%) would contribute over 50% of the risk associated with waste shipments containing "any adverse effect" chemicals.

Comment (3566)
Wastes will be transported across Native reserve lands and boundaries where the regulations of the Native Nations must be obeyed. If there is a release of any kind, the potential of migration across reserve boundaries is very high. Would DOE comply with Tribal regulations?

DOE has a history of ignoring the sovereignty of Native Nations when it comes to transporting wastes through Native Nations. One major accident on a reservation could mean disaster for a Native Nation. Native Nations cannot simply go somewhere else. Will DOE arrange for dealing with such issues (e.g., guarantee additional reserve lands)?

Warning and accurate characterization of Native Nation's unique rights and needs must be heard and integrated in DOE's analysis on impacts on Native Nations. The crucial question is, what if one major accident occurs? What is the Nation to do? Will there be new trust lands, assuming of course the Nation is willing to relocate?

Response
DOE must comply with the standards of all applicable Federal and State environmental and transportation laws and regulations, and must fulfill its trust and treaty obligations, including Tribal lands, as part of the government-to-government relationship between the U.S. Government and Tribal Governments. Consultation with Federally recognized Tribes is an integral part of compliance with several environmental and cultural resource statutes. Section 1.4.5 in Volume I was added to discuss DOE's consultation activities with Tribal Governments and groups.

DOE has a comprehensive emergency management system in place, as described in DOE Order 151.1. In the event of an operational emergency, offsite authorities, including Tribal Governments, will be notified. If there is an actual or imminent catastrophic reduction of facility safety with potential for the release of large quantities of radioactive material such that Protective Action Guides could be exceeded beyond the site boundary, then a General Emergency will be declared. Protective Action Guides, which are limits that, if exceeded, trigger the recommendation to take protective actions, are found in the *Manual of Protective Action Guides and Protective Actions for Nuclear Accidents*, EPA 400-R-92-001 (May 1992). Protective actions are classified as early, intermediate, and late, and depend upon the pathway, either inhalation or ingestion. Early protective actions include sheltering, evacuation, control of access, and ingestion of potassium iodine to block uptake of radioiodine by the thyroid. Intermediate and late protective actions include relocation, food and water controls, and decontamination of land and property.

DOE is concerned with health and safety and the need for emergency preparedness. DOE participates with other Federal, State, Tribal Nations, and local authorities to sponsor and occasionally fund various radiological emergency response training courses throughout the United States. These courses are usually provided for the benefit of local, State, and Tribal authorities responsible for public safety and emergency response to natural disasters or man-made accidents. Funds for these training sessions come from Federal grants or direct allocation of tax dollars.

5.2.3 Transportation Risks

The PEIS includes a detailed assessment of the risks of a complete range of credible transportation accidents for both rail and truck transportation, including low probability/high consequence and high probability/low consequence accidents. Transportation related impacts are discussed in Sections 6.4.2, 7.4.2, 8.4.2, 9.4.2, and 10.4.2 in Volume I, and in Appendix E in Volume IV. The transportation routes analyzed are representative routes chosen for analytical purposes.

Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

The issue of guaranteeing additional trust lands in case of an accident is out of scope in this PEIS. Compensation may be sought under the applicable law.

Comment (3578)
The limitation of 50 miles within the site and only .5 miles of transportation routes is insufficient as an accurate analysis of risks and potential impacts on minority and low-income populations. To begin the .5 mile limitation ignores basic weather influences such as rain and wind on an accidental release. Are we to assume transportation will take place only during good weather? Also, the .5 mile limit ignores the prominent occurrence of major transportation routes (both rail and roadways) to cut through lower income and minority populations, putting such populations at higher risk than non-minority and higher income persons. More importantly, the WM PEIS supplies no maps or figures of the potential routes and populations along the routes.

Response
The WM PEIS risk assessment results indicate that risks from routine shipments would be low to persons exposed near the routes and to populations along the routes within .5 mile of the road or rail line. Risks to individuals or populations at greater distances would be negligible. The .5 mile limit conservatively includes the transportation collective population risk and is described in Volume IV, Section E.5.1.1.1. The risk from exposure due to accidents is also analyzed in Sections E.5.1.2 and E.15.1.2. The accident risk assessment uses route-specific information and accident rates derived for individual States.

The WM PEIS does not include maps of transportation routes because the document does not analyze specific routes. The routes considered in the analysis are representative for risk assessment purposes, but are not necessarily the actual routes that would be used to transport waste in the future. Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Comment (3579)
We would like to point out the potential risks to Native Nations is disproportionately high in regard to transportation issues. This is based on simple historic influences. During the process of creating rail lines and encouraging growth of this industry in the West, the Federal Government was exceptionally

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intrusive on Native reserves, withdrawing unceded treaty lands for land grants to the railways. Thus, railways tend to cut through a great majority of Native reservations in the West. We have analyzed the potential impacts on Native Nations from transportation accidents, and have found that transportation routes (both rail and road) cut through 60 Native Nations. What is particularly important to keep in mind, is that each Nation is unique as a Nation and as a culture. It would only take *one* major accident to irreparably impact a Nation.

Response
DOE recognizes the unique status of Tribes and the government-to-government relationship between the Federal Government and Tribal Governments, as discussed in Section 1.4.5 in Volume I of the WM PEIS. DOE is also concerned with health and safety and the need for emergency preparedness. DOE analyzed the accident risks along representative routes using route-specific data. A description of the analysis is contained in Volume IV in Sections E.5.1.2 and E.15.1.2, and the results are presented in Sections E.7 and E.17. Based on mileage alone, risks of accidents on Native American lands would be lower than risks on non-Native American lands because the overwhelming majority of the transportation route mileage is through non-Native American lands.

DOE participates with other Federal, State, and local authorities to sponsor and occasionally fund various emergency response training courses throughout the United States. These courses are usually provided for the benefit of local, State, and Tribal authorities responsible for public safety and radiological emergency response to natural disasters or man-made accidents. Funds for these training courses come from Federal grants or direct allocation of tax dollars. In addition, DOE sites have emergency plans and equipment to respond to accidents and other emergencies. DOE provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to respond to an accident involving a shipment of radioactive materials and assist local emergency response personnel, if requested. State and local authorities are required to develop response plans to deal with any emergency situation. The PEIS includes a detailed assessment of the risks of a complete range of credible transportation accidents for both rail and truck transportation, including low-probability/high-consequence and high-probability/low-consequence accidents.

Comment (3595)
DOE's evaluation of the management of transuranic waste must be completely re-done because of the assumption that WIPP will open, and for the following reasons: unresolved, incomplete and unfinished EPA disposal standards; unresolved gas and oil leases under the WIPP site; unanswered questions about the gas generation from the drums once inside the repository; concerns about the canceled test phase at WIPP; unanswered questions about the hydrology of the WIPP site, such as water intrusion, well-injection and water moving faster than calculated in early WIPP scientific reports; transportation concerns, including safety of TRUPACT containers, emergency response capabilities of communities along the routes, RADTRAN and HIGHWAY incomplete, and omissions of relevant and important transportation factors; concerns about a catastrophic transuranic waste hoist accident.

Response
The WM PEIS examines reasonable alternatives for treatment and storage of transuranic waste. For purposes of analysis, DOE assumes that WIPP will become operational. The No Action Alternative evaluates for the period of analysis (i.e., 20 years) the impacts if there is a delay in the receipt of transuranic waste at WIPP and waste continued to be stored at the generating sites. The impacts of storage beyond 20 years are analyzed as part of the No Action Alternatives in the WIPP SEIS-II. The

decision whether to operate WIPP as a transuranic disposal facility, and the environmental impacts associated with its operation (including hydrology, transportation, and accidents) are evaluated in the WIPP SEIS-II.

The WM PEIS also conducted an analysis of potential risks from routine shipments of wastes, as well as accident scenarios, using representative routes and route-specific data. The actual routes would not be determined until a specific action has been selected. The WM PEIS analysis of risks from routine shipments indicated that risks to persons exposed near the routes and to populations along the routes within 1/2 mile of the road or rail line would be low. This analysis is described in Volume IV, Section E.7.3.2.

The PEIS also includes a detailed assessment of the risks of a complete range of credible transportation accidents for both rail and truck transportation, including low probability/high consequence and high probability/low consequence accidents.

DOE is concerned with health and safety and the need for emergency preparedness. DOE participates with other Federal, State, and local authorities to sponsor and occasionally fund various radiological emergency response training courses throughout the United States. These courses are usually provided for the benefit of local, State, and Tribal authorities responsible for public safety and emergency response to natural disasters or man-made accidents. Funds for these training sessions come from Federal grants or direct allocation of tax dollars.

Comment (3612)
How exactly, was offsite transportation minimized? Were computerized routing models used? Applicable U.S. Department of Transportation (DOT) regulations? There is basically only one way to go from Washington or Idaho or Colorado to WIPP while following applicable DOT regulations--that is staying on the interstates. Is this the "minimization" factor?

Response
Section E.4.2.1 describes the HIGHWAY computer program used for selecting highway routes for transporting radioactive materials within the United States by truck, as well as the INTERLINE computer program used for selecting railroad routes. Offsite transportation was minimized because routes are calculated within the model by minimizing the total impedance between the origin and the destination. The impedance is basically defined as a function of distance and driving time along a particular highway segment. One of the special features of the HIGHWAY model is its ability to identify routes that maximize the use of interstate highways, thereby conforming to DOE routing regulations and results in minimization of transportation, as discussed in Volume IV in Section E.4.1 of the WM PEIS.

Comment (3634)
The risks to the truck drivers who will transport the waste are not adequately addressed; neither are they addressed for those who come within the health risk range of the trucks along the transportation routes or in stopping places. The health risk to those who live along the transportation routes should be accounted for as well. The analysis of the health risks to the noninvolved workers and workers, as well as those outside the 50-mile radius is cursory at best.

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Response
DOE did address potential risks from transportation to all of the individuals mentioned, including truck drivers, persons at truck stops, persons living along transportation routes, and noninvolved workers. Summary information on radiological and nonradiological health risks from transportation is presented in Sections 6.4.2, 7.4.2, 8.4.2, 9.4.2, and 10.4.2 in Volume I. The details of the analyses are presented in Appendix E in Volume IV.

Truck drivers are trained to establish an exclusion zone around trucks when parked at stopping places. The zone is set up by placing orange cones and signs around a 50-foot perimeter of the truck to warn members of the public to keep back.

The analysis of health risks within a 50-mile radius is only relevant to risks associated with waste treatment facilities or transportation accidents and not routine transportation. The 50-mile radius was used to be consistent with the standard practice for assessing health risk for releases at nuclear facilities.

Comment (3666)
Analysis of DOE records shows 173 accidents occurred between the Fall 1975 and December 1987, or approximately 14 per year. Most were minor incidents in parking lots (*Deadly Defense*, page 36). By changing the definitions of onsite, offsite, and normal facility operations, DOE reduces/manipulates the number of accidents the nuclear and hazardous waste trucks are involved in. This is not acceptable.

Response
The WM PEIS does not reduce the potential number of transportation accidents in its analysis. Commercial truck accident rates are used for estimating risks for transportation between sites, as discussed in Volume IV, Section E.6.4. These rates are generally higher than those experienced by carriers of radioactive materials due to their higher awareness of the risks involved and associated driver training programs and vehicle maintenance.

The WM PEIS onsite transportation assessment used the accident rates for Hanford since Hanford manages all five waste types and the number of shipments within the boundaries of the site are the highest compared with other major sites. The accident rates for Hanford include *all* truck or rail accidents within the boundaries of that site. Transfers of waste within a specific facility constitute very short distances compared to the onsite shipment distances analyzed and any risks incurred are negligible compared to the onsite transportation impacts presented.

Comment (3668)
Why are population densities modeled as being uniformly distributed when that is not an accurate reflection of the population distribution?

Response
The approach for offsite transportation risk assessment is summarized in Figure E-3 and described in detail in Section E.5.1 in Volume IV of the WM PEIS. Both the HIGHWAY 3.1 (Section E.4.2.1.1) and INTERLINE 5.0 (Section E.4.2.1.2) computer programs were used to predict routes for waste shipments between sites. The computer model characterizes population information in rural, suburban, and urban densities. The fraction of travel is then computed for each zone. Once the routes are determined, the population densities are input for risk assessment using the RADTRAN 4 computer

model described in Sections E.5.1.1.1 and E.5.1.2.1. The population densities for each population zone are identified in Section E.6.3. Thus, the population densities are not assumed to be uniformly distributed along the entire shipment route. These population densities might differ from the actual population at a specific location on a route; however, on average the densities are included in the transportation analysis.

Comment (3669)
DOE chose the Hanford Site as the onsite risk assessment model for transportation. Hanford is not a "typical" representation of accidents at DOE sites. In fact, Washington State, the site of Hanford, is not even listed for transportation accidents between Fall 1975 and December 1987 in Figure 7, Department of Energy, Transportation Accidents. Using Hanford as the model is misleading and is not acceptable.

Response
Section E.2.1 in Volume IV of the WM PEIS states that the human health risks associated with onsite transportation are generally much smaller than those from offsite transportation, largely because of the limited distances for onsite shipment, limited population densities along the routes, and limited average travel speeds. Accordingly, the impacts of onsite transportation are not likely to contribute significantly to differences among the alternatives being considered. Therefore, for purposes of the PEIS, the onsite risk assessment has been limited to one representative site - Hanford. The Hanford Site was chosen primarily because it is relatively large and conducts activities for managing all of the waste types considered in the WM PEIS. It should be noted that the transportation radiological risks are dominated by exposure during routine transport when compared to potential accident releases, typically 2 to 3 orders of magnitude higher for the routine risks. The Hanford Site carries out extensive waste management operations involving all waste types evaluated in the WM PEIS and often makes many shipments across a large area within the site. Such activity greatly increases the transportation risk. Therefore, it is not expected that any other DOE site has operations that would have onsite transportation risks significantly greater than those at the Hanford Site.

Comment (3670)
Why it was necessary to separate the vehicle-related risks from the cargo-related risks.

Response
Vehicle-related risks are separated from cargo-related risks because of the differences in the health endpoint (fatalities) considered and the models used to estimate these risks. For example, estimating traffic fatalities from the physical trauma related to an accident has much less uncertainty than estimating potential cancer fatalities due to radiation exposure from a passing shipment. Even estimated fatalities associated with diesel exhaust (vehicle-related) are highly uncertain and are presented separately from vehicle-related accident fatalities in the tables found in Volume IV, Appendix E. Section E.8.4 discusses the uncertainties associated with the calculation of radiation doses, and DOE added a paragraph on some of these uncertainties to Volume I, Section 5.4.1. Thus, vehicle-related risks are concerned with the truck or rail car being driven and cargo-related risks are based on the waste type in the truck or rail car.

Comment (3671)
How are the "road-related" risks included in your calculations? We describe "road-related" risks to include driver fatigue, the weather (temperature, wet, dry, snow, snow tires on the trucks in winter,

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ice, visibility), deer or elk on the roadway at night, the condition of the highway surface (asphalt, road construction), as well as situations around the country such as and similar to Raton Pass on the Colorado/New Mexico border or the incident on the interstate 25 (prior to 1988) where the southbound lane gave way (as a result a portion of the interstate was closed).

Response
Road-related risks are accounted for by the accident rates used. The WM PEIS transportation risk analyses used accident rate statistics based on information from the Department of Transportation as discussed in Section E.6.4 in Appendix E, Volume IV. These accident rates are multiple-year State averages based on historical commercial carrier performance with all types of cargo under all driving conditions. Actual accident rates are expected to be slightly lower since commercial carriers of hazardous and radioactive waste have a higher awareness of transportation risk and prepare their shipments accordingly, especially with regard to such factors as driver preparedness and weather conditions.

Comment (3673)
We are concerned that no attempt has been made (even in cases where both radioactive and hazardous components are present in the same materials) to add or compare the estimated risks for the two classes of contaminants. We are extremely concerned because of (1) the synergistic effects of the radioactivity and the hazardous components on each other, and (2) for the purposes of the WM PEIS analysis, DOE analyzes all TRUW *as if it were mixed waste*. If DOE sets the stage for analysis, then DOE should go forward with the entire act, in essence, and not put the public and the environment at risk for not completing the analysis.

Response
Section D.2.5.1, Appendix D in Volume III, states that the risks from enhanced or diminished toxicity from interactions among components of a contaminant mixture (termed "synergy" and "antagonism," respectively), or the effects of multiple chemical forms of the same atom ("speciation") or combination of atoms ("complexing") were not evaluated because not enough information exists on these effects.

Section D.2.6.3 in Volume III, states that the risk of cancer fatality was calculated for radionuclides but not for chemical carcinogens. This is because research and epidemiological studies have provided enough information to develop risk factors for both cancer incidence and fatality caused by radionuclides; however, there is not yet enough information to develop risk factors for cancer deaths resulting from chemical exposures. These differences between the amounts of information available about cancers associated with chemical and radionuclide exposures have another implication: The risk of cancer incidence from exposure to hazardous chemicals is not, strictly speaking, directly comparable to the risk of cancer incidence from exposure to radionuclides (this becomes an issue only in the risk analyses for transuranic waste and low-level mixed waste, which contain both radionuclides and hazardous constituents). Readers should bear this in mind when assessing the risk analysis results.

Comment (3675)
Volume IV, Appendix E, Foreword, footnote b, Endpoints Used for Human Health Effects: WM PEIS Transportation Risk Assessment, assumes that "no public exposure to the hazardous waste occurs during routine transportation." What if there is an accident?

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Response
"Routine" transportation means transportation during which no accidents occur. The Foreword of Appendix E states that in contrast to radioactive materials, hazardous chemicals do not pose cargo-related risks to humans during routine transportation-related operations. Waste transportation operations are generally well regulated with respect to packaging, such that small spills or seepages during routine transport are kept to a minimum and do not result in exposures (for example, containers of liquids are surrounded by absorbent overpacking). Potential cargo-related health risks to humans can occur only if the integrity of a container is compromised during an accident (that is, a container is breached). Under such conditions, some toxic chemicals (such as chlorine gas) may cause an immediate health threat to exposed individuals. The table referred to in the comment shows that, although no public exposure to hazardous waste occurs during routine transportation, exposure was analyzed for accidents. Section E.17 in Appendix E, Volume IV, presents the risk assessment results for transportation, including accidents.

Comment (3693)
The WM PEIS should not conclude that rail transport is "significantly less risky" than truck transport (PEIS Summary) and thereby appear to preselect a particular transportation mode, because (1) on an absolute basis, risks for both truck and rail transport are negligible; (2) even assuming that the risk factors for trucking wastes are four times greater than those for the rail mode (as found by the WM PEIS), on a probabilistic basis, this factor of four, vis-à-vis absolute risks that are negligible, is irrelevant; (3) since transportation of radioactive and hazardous wastes is regulated by DOT, EPA, and NRC (and not by DOE), individual competitive circumstances (as determined by DOE in consultation with the private sector) should drive the selection of transportation mode; and (4) the DOE Organization Act charges DOE with ensuring competition and maximum use of the private sector.

Trucks are easier to stop, start, reroute, inspect, weigh, and book than trains, which facilitates implementation of shipment tasks and lowers shipping costs.

Response
Actual transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process described in Volume I, Section 4.3.10. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

As shown in Volume I, Section 11.20 of the WM PEIS, shipping waste by truck would result in a combined total of between 12 and 69 potential fatalities from shipping low-level mixed waste, low-level waste, transuranic waste, and hazardous waste over the next 20 years, and for shipping high-level waste over the next 40 years, as shown in Volume IV, Appendix E, and Section 11.20. Shipping low-level mixed waste, low-level waste, transuranic waste, and high-level waste by rail, and hazardous waste by truck would result in a combined total of between 2 and 6 potential fatalities over the same periods. It is important to recognize that, although rail shipments appear to result in a lower number of expected fatalities compared with truck shipments, in general, the risk of transportation operations are relatively small for both modes, given the total number of shipments and miles driven. Volume IV, Section E.8.5, describes uncertainties in the comparison of truck and rail transportation modes.

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As stated in Section E.2.4 in Appendix E (Volume IV) of the WM PEIS, transportation operations for all waste types are not expected to cause acute (short term) effects in exposed individuals. Vehicle related risks from emissions and accidents are also assessed and are presented as estimated fatalities for each alternative. Vehicle and cargo related risks are approximately the same for both truck and rail. Radiological impacts would be less for rail because there would be fewer shipments by rail.

Comment (3695)
The WM PEIS fails to consider in its transportation analysis the long experience and exceptional performance history of companies specializing in the transport of radioactive and hazardous materials. Thus DOE's projections of incident frequency conflict with documented actual historical frequencies. For example, while general trucking has a DOE reportable accident rating of 1.4 accidents per million miles, some commercial trucking companies have never had any incident involving release of radioactive materials.

Response
The reportable accident rating of 1.4 accidents per million miles for general trucking represents a national average. Thus, there may be companies with better ratings and incident records and some with worse ratings. The WM PEIS, however, does emphasize the exceptional transportation record of DOE programs in terms of their safety, for example, in Section 4.3.10 in Volume I of the WM PEIS.

Comment (3698)
The WM PEIS quantitative comparisons of rail versus truck transport accident risks (see Sections E.7.1.4, E.7.2.4, E.7.3.4, and E.7.4.4) are not supportable because they fail to account for the following benefits of truck over rail transport: (1) trucks are much easier to reach in the case of an accident, which lowers the response time in the event of a release; (2) train wrecks tend to be catastrophic accidents; (3) shipment by train increases the number of handling transactions (e.g., trains often load from and unload to trucks), thus potential occupational radiation exposure and incident probabilities; (4) truck shipments take less time per shipment-mile, thus lowering radiological and accident risks; and (5) truck shipments tend to occur on interstate highways, while train shipments run directly through cities, thus exposing a larger population in the event of an accident and raising political opposition and environmental justice issues.

Response
Both truck and rail modes of transport have their benefits and drawbacks. The WM PEIS transportation risk analysis strives to provide conservative estimates of (all truck transport vs. all rail transport) risk as discussed in Section E.2.6 in Volume IV of the WM PEIS. The methodology used is based on historical practice. Total transportation risks are dominated by physical trauma from accidents (not from radioactive releases). As to the specific points in the comment: (1) The reason that trucks are much easier to reach in the case of an accident is because they are much closer to the public in general than are trains. Response time may be lowered, but more people are nearer to the truck shipments and also are more likely to be injured in the case of an accident. However, the major radiological risk is not from potential accidents, but from routine transport, where there is much higher risk of exposure to the public who are much closer to truck shipments than to rail shipments along the transport route. (2) Most train accidents are derailments with little damage to railcars and cargo. It is true that a severe train accident could result in larger impacts than a truck accident due to a larger payload. On the other hand, for the same reason, there are fewer rail shipments required for the same amount of material and, therefore, there is less chance of an accident. (3) Shipment by train only

increases the number of handling transactions when the shipping or receiving site does not have direct rail access. Most of the large DOE sites that would have bulk shipments suitable for rail transport do have direct rail access. (4) The input parameters used in the WM PEIS transportation risk analysis reflect the fact that truck shipments take less time per shipment mile. (5) Train shipments going directly through cities do not necessarily expose a larger population in the event of an accident. On the interstate highway system, trucks must often travel in heavily populated areas on beltways around a city's central location. The trucks are generally in much closer proximity to the public (i.e., fellow motorists) than freight trains operating on a private right-of-way. Environmental justice issues are not relegated to the inner city. Volume IV, Section E.8.5, further describes uncertainties in the comparison of truck and rail transportation modes.

Comment (3993)
How can the agency reasonably foresee incident-free transportation of low-level mixed waste? (Chapter 6)

Response
The WM PEIS analysis of transportation-related impacts considers risk to worker and general populations from both routine operations (characterized as incident-free operation) and potential accidents. Because the risk assessments for each are fundamentally different, the analysis addresses them separately. The analysis of incident-free transportation is not intended to imply that a determination has been made that all transportation will be free of accidents, but that this portion of the analysis addresses only those risks associated with exposure from routine operations. (See Volume IV, Appendix E, Section E.5.1.1). The probability of accident and the associated risks, both from radiological exposure and from vehicle-related, nonradiological exposure are addressed separately. (See Appendix E, Section E.5.1.2.)

Comment (4006)
DOE cannot reasonably expect risk of accident to the public during transport to cease to occur because DOE did not foresee accidents during transport as a problem. Transportation accident and incident of release rates, historically, are based upon number of miles traveled, not the types of material being transported.

Response
The EIS transportation risk analysis in Appendix E (Volume IV of the WM PEIS) shows that accident rates for nonradiological accidents (generally considered traffic accidents) are driven by miles traveled as the commentor stated. Appendix E of the WM PEIS contains a detailed transportation risk assessment.

Radiological and nonradiological causes contribute to the overall transportation risk. In general, the radiological risks from waste shipments (i.e., risks associated with the radioactive nature of the waste) tend to be less than or equal to the nonradiological risks (i.e., risks from traffic accidents, unrelated to the radioactive cargo). For high-level waste, the radiological and nonradiological risks are roughly equal. For the other wastes types, radiological risks are less than the nonradiological risks.

With respect to the radiological risk, by far the dominant component is exposure to external radiation during routine conditions. The accident component of the radiological risk (which takes into account probability and consequence) is generally very small. Accident risks are small because accidents are

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rare in general; most accidents would not involve significant releases of radioactive material; and the consequences of most accidents would not be severe.

Even though the overall accident risks are small, the consequences of the most severe credible transportation accidents (assuming one has occurred)--which are of very low probability--have been presented in the PEIS for each waste type to give the reader an indication of the maximum foreseeable accident.

Comment (4446)
No evidence was provided in the Draft PEIS Summary document to indicate whether or not the current actual locations of people in relation to waste transportation routes were considered in DOE's modeling. Along transportation routes around some sites, people might be located closer to roads, rail lines or pertinent service areas than at others. DOE should consider this site-specific information in evaluating the alternatives.

DOE should also summarize how risks to persons who may be driving in the same lane behind waste transportation trucks were evaluated, as well as exposure to people at rest stops, vehicle refueling facilities, etc., and the basis for the associated assumptions and their accuracy and conservatism.

Mitigating measures, such as dedicated, automated refueling, service and rest areas in isolated locations versus the use of existing areas should also be evaluated.

Response
As discussed in Section E.4.2.1 in Volume IV, representative routes (those consistent with current routing practices) are used for the transportation risk assessment because an actual determination of the route to be used could not be made until shipping plans can be prepared to accommodate such considerations as future road repair and construction. This WM PEIS could not provide an exhaustive examination of all potential locations of persons along the hundreds of routes analyzed. The range of potential exposure scenarios described in Section E.6.9 in Volume IV can be used to approximate such specific concerns as driving behind a shipment and people located at rest stops or refueling facilities.

As discussed in Section E.3.1 in Volume IV, the shipping packages used for radioactive materials are highly regulated in order to minimize risks to the public from external radiation and accidental releases. The external dose rates selected for use in the PEIS provide reasonable estimates for future shipments. They are based on historic data, where possible, as a function of waste type and packaging.

Routing regulations used to select representative shipment routes direct shipments away from highly populated areas to minimize exposure. Current practices are used in the analysis to provide the best risk estimates for the different alternatives. To provide conservative estimates of risk, the analysis does not take credit for mitigative measures, such as dedicated refueling stops. However, such measures would be considered and implemented, if appropriate, during the actual transportation of waste.

Comment (4476)
In Section 9.2 of the Draft WM PEIS Summary document, differences in cumulative fatalities for train versus truck transportation should be delineated, along with cancer risks to the maximally exposed individual in the general public, waste workers, and noninvolved workers.

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Response
Section 9.2 in Volume I of the WM PEIS Summary document has been revised to provide additional information about the estimated combined impacts of waste transportation. As shown in Volume I, Section 11.20 of the WM PEIS, shipping waste by truck would result in a combined total of between 12 and 69 potential fatalities from shipping low-level mixed waste, low-level waste, transuranic waste, and hazardous waste over the next 20 years, and for shipping high-level waste over the next 40 years, as shown in Volume IV, Appendix E, and Section 11.20. Shipping low-level mixed waste, low-level waste, transuranic waste, and high-level waste by rail, and hazardous waste by truck would result in a combined total of between 2 and 6 potential fatalities over the same periods.

Section 11.20 in Volume I of the WM PEIS provides details on the results of the cumulative impacts analysis for transportation. Table 11.20-1 lists combined impacts for the transportation of WM PEIS wastes by truck; Table 11.20-2 lists combined impacts for transportation by rail. The PEIS did not analyze rail transportation further because, historically, DOE has shipped most of its wastes and radioactive materials by truck.

The cumulative impacts analysis includes the transport of wastes and nonwaste radioactive materials. Table 11.20-4 lists the occupational and general population doses for the actions considered in the cumulative impacts analysis for transportation. The table also lists the total cumulative dose and total latent cancer fatalities for all actions.

For each waste type and alternative, Appendix E in Volume IV of the WM PEIS contains cumulative transportation risks to the public, to workers, and to maximally exposed individuals for both truck and rail transportation.

Comment (4486)
The only valid conclusion made on the basis of the analysis of impacts in the Draft WM PEIS is that trains should be used instead of trucks to transport radioactive waste, a finding that is not given the emphasis that it deserves.

Response
Although rail shipments appear to result in a lower number of expected fatalities in comparison to truck shipments, in general the risks from both types of transportation are small. Moreover, even though the estimated risks for rail transportation are lower than those estimated for truck transportation, there is no significant difference in the radiological risks between the two transport modes because of the uncertainties involved in the calculations. "Roadside residents" are not expected to receive a higher exposure for truck transport than for rail transport because most truck transportation is expected to occur over the interstate highway system where large setbacks from the roadside exist. On the other hand, the motoring public might receive a higher exposure from truck shipments than members of the public sharing the rail transportation routes. The risks of physical trauma fatalities directly related to traffic accidents suggest rail transport maybe slightly less hazardous than truck transport. Section 7.4.2 in Volume I of the WM PEIS was revised to incorporate this information. In addition, Volume IV, Section E.8.5, describes uncertainties in the comparison of truck and rail transportation modes.

5.2.4 Facility Accidents Risks

Comment (568)
The models used to estimate facility accident population risks might be inadequate for estimating acute fatalities from severe accidents that result in large releases of radioactivity. Depending on the assumptions used, doses to potential receptors could be overestimated or underestimated.

Response
Volume IV, Appendix F, of the WM PEIS provides detailed descriptions of methodologies used to estimate facility accidents. The facility accident analyses performed for the WM PEIS emphasized risks to public health from severe accidents. The first set of postulated initiating events included process operation failures leading to fires or vessel ruptures due to overpressurization. The next set, which are generally more dominant in terms of potential consequences, were so-called external events that could lead to fires and overpressurizations accompanied by breach of containment. The releases involved were sufficiently low and site boundaries sufficiently far that acute (sudden) offsite fatalities would not be likely. Therefore, only latent (effects not immediately visible that could appear later) were considered with GENII, one of the industry standard codes for atmospheric dose calculations that was used for the analyses. GENII is described in Table 5.1-1 in Volume I, Chapter 5, of the WM PEIS.

Severe accidents could lead to releases high enough to cause high radiation doses to site personnel close to the accident. However, operational fires and overpressurization events probably would be contained initially in the DOE Hazard Category 2 facilities assumed for treatment; therefore, workers would be shielded. Although breach of containment was assumed for many of these operational event sequences, the breach probably would occur sufficiently long after the initiation of the event that site personnel could take actions to protect themselves from exposure to radiation.

In the case of external events, the most serious potential acute fatality threat to site personnel would be the initiating event itself. While in theory high radiation doses could occur, emergency procedures would be implemented immediately and acute fatalities from radiation exposure would not be likely. Therefore, only latent cancer fatality calculations were performed.

Comment (569)
Facility accident health risks should address acute fatalities (e.g., resulting from injury to bone marrow, gastrointestinal tract, lungs) and latent cancer fatalities from short-term exposure to the released plume, and latent cancer fatalities from long-term exposure to deposited materials.

Response
DOE used conventional risk assessment methods to evaluate health risks associated with treatment facility accidents. The analysis did not predict any acute fatalities from radiological exposure for the facility accidents analyzed, with the exception of the transuranic waste treatment facility accident at WIPP under the Centralized Alternative, in which, as described in Section 8.4.3, waste management workers would be likely to receive acutely lethal doses of radiation. The analysis of latent cancers from acute exposures estimated offsite population and potential worker fatalities at the Hanford Site under the Centralized Alternative and for the offsite population of LANL and LLNL under Regionalized Alternative 2 for low-level waste (Section 7.4.3). Potential offsite population and worker fatalities at LANL under Regionalized Alternative 2 and potential worker fatalities at the Hanford Site, INEL, and WIPP for the Regionalized and Centralized Alternatives for transuranic waste

(Section 8.4.3) were also evaluated. Appendix D in Volume III and Appendix F in Volume IV present additional information on both acute and long-term exposure risks.

Comment (572)
It is possible that the PEIS facility accident and transportation accident analyses significantly underestimate risks because they consider potential exposure only through inhalation of small respirable particles. The dose contribution due to the larger dispersible particles (i.e., particles larger than 500 microns) from direct ingestion (through nose and mouth breathing), external radiation, and ingestion of foods (through soil and food contamination) has been shown to be substantially greater than those from small respirable particles under various release and exposure conditions.

Response
Although the commentor is theoretically correct, several factors mitigate the effects of such contamination:

- The terminal velocity of a particle 500 micrometers (Aerodynamic Equivalent Diameter [AED]) is approximately 7 centimeters per second; it would remain airborne 1.67 minutes and travel 7 meters. Particles in this size range could pose an inhalation hazard to those within the immediate vicinity of the event, but would not be likely to leave an intact structure.

- Although not anticipated under normal conditions, particles of this size range entering the respiratory system would be lodged in the upper tract, and action by the cilia would move them to the gastrointestinal tract. In fact, EPA no longer regulates particulate concentrations for sizes greater than 10 microns aerodynamic equivalent diameter due to the lack of health impacts. EPA focuses on sizes 10 microns or less for regulatory scrutiny. If the material were extremely soluble (probably passes through the gastrointestinal tract within 24 to 48 hours), the material could enter the circulatory system.

- Particles in the immediate vicinity of the event would be detectable and personnel would be aware of the event quickly. Appropriate emergency procedures and actions to mitigate or remediate the effects (such as fixation and removal) would be implemented within a short period. Access would be restricted. Those injured by the event would be evacuated as soon as possible and treated away from the event.

The material of concern must be soluble to enter the food chain. Most materials that present a significant biological hazard (e.g., oxides of heavy metals) are insoluble when released. Furthermore, food crops are not grown on DOE sites. For particles larger then 10 micrometers AED but less than 100 micrometers, transport distances of a kilometer or so are possible and deposition from the plume could result in surface contamination. At most DOE facilities involved with radioactive materials, the site boundaries are farther away than 1 kilometer. Diffusion or dispersion would significantly dilute the concentration and reduce the direct radiation hazard before the material of concern reaches the site boundary. The WM PEIS radiological transportation accident analysis takes more than the inhalation pathway into account, including external radiation and food ingestion, as described in Volume IV, Appendix E, Sections E.5.1.2.1 and E.5.1.2.2.

5.2.4 Facility Accidents Risks

The hazardous chemical accidents do not deal with particulates. The primary hazard is from vapors that deposit little, if any, on vegetation or the ground. Further, any vapor that does deposit will most likely evaporate over time before consumption becomes an issue.

Thus, although the commentor is correct with respect to the potential radiological hazard of larger particles, the actual hazard is much less due to the factors described above. With the high level of conservatism of the assumptions used to arrive at the source terms from the postulated events, DOE believes that it has not underestimated the risk from waste management facility accidents.

Comment (1550)
The bounding accident scenario associated with incineration is not believable.

Response
Chapters 6, 7 and 8 in Volume I present information about treatment facility accidents. Further details about the treatment facility accident scenarios are presented in Appendix F (Volume IV). The incineration technology used in the WM PEIS is conceptual. Incineration has a potential for accumulations and leaks of combustible gas, with a possibility for explosions. Although the explosion scenario is unlikely to occur, DOE used the conservative assumption that dispersion of radionuclides via an incinerator explosion could occur and, therefore, includes other credible accident scenarios.

Comment (2031)
The analysis should include a "worst case scenario" involving "risk of upset" by earthquake and or fire.

Response
Human health risks due to accidents caused by seismic events (earthquakes) and fires at conceptual facilities are evaluated in the WM PEIS in Sections 6.4.3, 7.4.3, 8.4.3, 9.4.3, and 10.4.3. Appendix F in Volume IV describes the accident analysis performed for the PEIS. DOE examined a full range of accidents, including accidents initiated by earthquakes and fire.

Comment (2136)
If nuclear waste were to spread as a result of an accident at BNL, people would not be able to escape it by leaving Long Island because the only escape routes are a road to the west, or by boat or plane.

Response
The WM PEIS evaluated the potential health risks resulting from a low-level mixed waste treatment facility accident at BNL. As discussed in Volume I, Section 6.4.3.2, releases of radionuclides for this accident scenario were estimated to produce a dose to the maximally exposed individual of the offsite population of 0.002 rem. This exposure is estimated to produce a risk of excess latent cancer fatality of about 1 in 1 million. The estimated collective dose to the offsite population living in the BNL 50-mile-radius region of influence was 20 person-rem. Less than one excess latent cancer fatality was estimated to result from this exposure. Additional details of the facility accident analyses are provided in Appendix F in Volume IV. Note that there are no credible waste management facility accident scenarios that would require the evacuation of Long Island.

To assure health and safety and emergency preparedness, DOE sites have emergency plans and equipment to respond to accidents and other emergencies. DOE requirements for emergency response

preparedness are contained in DOE Order 151.1. DOE provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to quickly respond to an accident and assist local emergency response personnel, if requested. Emergency response plans are required by State and local authorities to deal with any emergency situation. DOE, the U.S. Department of Transportation, and the Federal Emergency Management Agency can assist in review and modification of these plans if necessary. Anyone interested in knowing the details of the plan should contact DOE representatives at the site.

DOE participates with other Federal, State, and local authorities to sponsor and occasionally fund various radiological emergency response training courses throughout the United States. These courses are usually provided for the benefit of local, State, and Tribal authorities responsible for public safety and emergency response to natural disasters or man-made accidents. Funds for these training sessions come from Federal grants or direct allocation of tax dollars.

Comment (2203)
The PEIS should be revised to list all accident occurrences at Hanford over the past years.

Response
DOE considered past accidents in developing the accident scenarios and frequencies used in the WM PEIS analysis and used existing facility documentation and accident data for general guidance in developing source terms. DOE also used site-specific documentation to help identify the frequencies and potential risk importance of accident initiators affected by site characteristics. However, providing a complete list of past accidents involving waste management facilities, operations, or processes was beyond the scope of the facility accident analysis.

Appendix F in Volume IV of the WM PEIS provides a detailed explanation of the accident analysis performed for the PEIS. The facility accident analysis was performed in compliance with the most recent DOE guidance, considering the spectrum of accident sequences that could occur during activities covered by the PEIS and used a graded approach emphasizing the risk-dominant scenarios to facilitate discrimination among the PEIS alternatives.

Comment (2565)
Volume IV, Section F.2.6.1. How were the "relative treatability category inventories" weighted? Are there tables or references available?

Response
The paragraph in question has been revised to say, "The physical composition of MAR in storage was defined by volume weighting the treatment category inventories at each site." Further information is contained in the three volume technical report *Analysis of Accident Sequences and Source Terms at Waste Treatment and Storage Facilities for Waste Generated by U.S. Department of Energy Waste Management Operations*, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2566)
Volume IV, Section F.6.2.2, states that site waste inventories are expected to increase, or at least, not decrease over the next 10 years. Wouldn't selection of an alternative affect inventories?

5.2.4 Facility Accidents Risks

Response
Complex-wide treatment of waste would not begin until the end of the 10-year period assumed to be needed to conduct any additional sitewide and project-level NEPA analyses necessary, to design and construct or modify facilities, etc. (referred to in the PEIS as the 10-year construction period). During this time, site inventories are expected to remain the same or increase.

Comment (2567)
Volume IV, Section F.7.2, states that the hazardous waste constituents of concern were chosen from toxicological analyses. What types of toxicological analyses?

Response
DOE has revised Section F.7.2 to explain that the hazardous waste constituents of concern were chosen from the U.S. Department of Transportation list of poison inhalation hazards and from toxicological analyses for the determination of chemical wastes representative of potentially life-threatening health effects. Further detail on the toxicological analyses can be found in the report by Hartman, et al., which is referenced in Section F.7.2.

Comment (2573)
Please explain the following sentence, which appears on Page 20 of the Draft PEIS Summary document: "Since significant incineration data are available, public interest is heightened, and accidents were considered representative and bounding of other treatment processes."

Response
This passage was not intended to be a sentence, but appears to be one because of an editorial error. DOE corrected the error and the sentence in the Final WM PEIS (see Section 3.2.1, Summary document) clearly explains DOE's reasons for selecting thermal treatment for the facility accident analyses for four of the five waste types.

Comment (2608)
Why are there no storage facility accident analysis data for INEL (storage of canisters at INEL is a part of all but the No Action Alternative)? As many as 8,500 canisters will be produced and stored at INEL until a repository is opened.

Response
The basic decision in the WM PEIS concerning high-level waste is whether storage facilities for treated high-level waste should be constructed at the four high-level waste sites or whether larger storage facilities should be built at fewer sites. Under all alternatives, the treated high-level waste at INEL remains onsite. Storage facility accidents for INEL's immobilized high-level waste were not included because they would not differentiate between the different high-level waste alternatives.

Accidents involving high-level waste treatment and storage were analyzed in the SNF/INEL EIS, Volume II, Part A, Section 5.14.3. An updated analysis of storage facility accidents will be provided in the High-Level Waste Management EIS, scheduled to be completed by the end of the year 2009, per the agreement between the State of Idaho and DOE.

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Comment (2618)
Accident analyses were done only for the Regionalized Alternatives, with very significant consequences from low probability worst-case accidents. If similar analyses had been done for the other alternatives, it might have helped to discriminate between the alternatives.

The risk analysis of worst-case scenarios for hazardous waste storage facility accidents *under the Regionalized alternatives only* may not provide an accurate representation of true risk. It neglects important input parameters such as flight paths, population densities, prevailing meteorological conditions, seismic event frequencies, etc.

Response
Section 10.4.3 in Volume I of the WM PEIS describes the results of the hazardous waste storage facility accident analyses. As explained in this section, facility accidents were analyzed only under the Regionalized Alternatives because these alternatives have the largest estimated inventories of waste and, therefore, the largest potential consequences following an accident. DOE believes that analyzing only these alternatives should provide a screening-level estimate of the upper bound of potential risks under all alternatives.

Comment (2623)
Volume I, Chapter 11. Accidents with a common initiator, such as an earthquake, are not considered in this EIS and were not considered in the INEL Site Wide EIS. This needs to be done.

Response
The WM PEIS did consider accidents with a common initiator, such as a natural phenomenon, in the individual waste-type chapters (see, for example, Section 6.4.3) and in Appendix F (Volume III).

The WM PEIS did not consider the potential impacts of facility accidents with common initiating events in the combined and cumulative impact analysis presented in Chapter 11, because the impacts would not be additive and/or are too speculative (with regard to future accidents) to provide a meaningful analysis.

Comment (2647)
Is the supplemental analysis of transuranic waste treatment-related accidents available yet? (See Volume III, page D-223, paragraph 3.)

Response
The transuranic waste treatment facility accident analyses are included in Section 8.4.3 in Volume I, Appendix D in Volume III, and Appendix F in Volume IV of the Final WM PEIS.

Comment (2680)
Volume IV, Section F.2.2.1. What was the reason for removing storage of high-level waste from consideration in the analysis when it could cause immediate and appreciable effects?

Response
Section F.2.3.1 in the Final WM PEIS was revised to indicate that the only reasonable threats that could cause immediate and appreciable effects via nonairborne pathways are criticalities involving the

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various waste types, not stored volumes of high-level waste. DOE has restricted analyses of high-level waste accidents in the PEIS to those dealing only with interim storage of high-level waste canisters.

Comment (2683)
Just because all sites will achieve their maximum waste inventory, independent of the waste management alternative selected, does not mean that the nature (i.e., chemical and radiological composition) of such waste will be similarly unaffected (see Volume IV, Section F.2.2.3). Nor does it mean that the time to attainment of maximum inventory is independent of the alternative selected. Because the composition of the waste and the time-to-attainment of maximum inventory could have significant implications for the health-risk analysis, the discussion of the impact on material at risk from not analyzing storage prior to treatment (current storage) should be broadened. Will the uncertainties in the data that are reflected in estimates of absolute risk still cancel each other out in estimates of relative risk to provide "a sufficient and scrutable basis for discriminating among alternatives," as stated in Section F.1.1?

Response
It is true that the composition of waste and the time to attainment of maximum inventory could have some health-risk implications. However, these health risk implications might occur regardless of the waste management alternative DOE selects.

The WM PEIS assumes that all sites will store their wastes onsite for 10 years, during which time the construction of any required treatment or disposal facilities would have been completed. The amount of waste in storage at any given time is the sum of the waste that has been stored prior to the present, plus any waste generated up to the time in question, minus any waste sent offsite, treated, or disposed of. Therefore, the maximum amount of waste in storage occurs at the time immediately before any waste was sent offsite, treated, or disposed of (i.e., 10 years). This maximum storage volume is, therefore, independent of any alternatives, and analysis of current storage accidents was judged not to be relevant to the WM PEIS decisionmaking process. Therefore, uncertainties of the absolute risk from current storage will not provide a basis or measures for discriminating among the WM PEIS alternatives.

Comment (2685)
Volume IV, Section F.2.4.1.1. The assignment of damage fractions depends on the chemical forms of the material at risk. To include current storage wastes [wastes stored prior to treatment] could impact the calculation of the source term release fraction.

Response
DOE assumed that all sites will store their wastes and reach their maximum storage capacities before Department-wide treatment begins. Storage conditions are the same for all alternatives. As indicated in Section F.2.2.3, storage accidents are discussed (separately from treatment accidents) in each of the Volume I waste-type chapters based on information from recent safety analysis reports and NEPA documents.

Comment (2686)
Volume IV, Section F.2.4.1. The possibility of chemical-chemical interactions and/or the health effects of hazardous decomposition products do not appear to have been addressed.

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Response
Waste decomposition products, including chemical-chemical interactions, were considered in the accident screening process. Section F.2.7.2.2 in Volume IV of the WM PEIS states that explosion scenarios for packaged wastes can be postulated for low-level mixed waste, transuranic waste, and hazardous waste. Most low-level mixed waste accident analyses focus on storage of miscellaneous organic liquid waste, where blankets of inert gas serve to preclude ignition and detonation. Most transuranic waste analyses focus on the accumulation of hydrogen or methane from radiolysis of organics, with subsequent ignition and detonation. Inadvertent chemical reactions are considered for hazardous waste, but should be unlikely because waste sorting and segregation at the point of generation act to preclude combining reactive materials and oxidants. Post-processing storage is less of a problem than pretreatment storage because of the greater stability of the final forms (for example, grout).

Comment (3081)
In Table 7.4-15, under Centralized Alternative 5, at Hanford an offsite population dose of 0.1 person-rem is predicted to cause five cancer fatalities, while a worker dose of 1,500 person-rem is predicted to cause only 0.6 cancer fatality. Please explain.

Response
Table 7.4-15 in the Draft WM PEIS is now Table 7.4-16, Volume I, in the Final WM PEIS. DOE corrected the table to show that under Centralized Alternative 5 for Hanford, the offsite population dose would be approximately 10,000 person-rem [1E + 04].

Comment (3258)
The analysis of risks from the incineration of low-level waste and low-level mixed waste does not include the risks due to upset conditions. Upset conditions at incinerators are the largest contributor to risks and are common occurrences. There is also no analysis of the health impacts of the formation of products of incomplete combustion or metals emissions.

Response
Upset conditions are generally not considered accidents; they are considered "abnormal events," because their occurrence is expected during the life of the facility, and they usually do not result in substantial onsite or offsite consequences. DOE implements physical and administrative controls on facility operations and activities to minimize the likelihood and impacts of these events. Personnel are trained and drilled on how to respond to and mitigate potential releases during upset conditions.

A review of the various accidents associated with incineration is provided in Appendix C of the technical report *Analysis of Accident Sequences and Source Terms at Waste Treatment and Storage Facilities for Waste Generated by U.S. Department of Energy Waste Management Operations*, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS. This appendix indicates that incineration process upsets that have occurred historically did not result in substantial onsite or offsite impacts.

DOE also evaluated the effects of emissions from the incineration of hazardous waste, including those of combustion products. Section D.3.3.2 in Volume III describes special assumptions used in the hazardous waste risk analysis. This discussion notes that the source term for chlorinated organics, metals, and combustion products emitted in incinerator flue gases was developed from a set of RCRA

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trial burn data from a commercial facility that currently processes similar DOE-generated hazardous waste. Table D.3.3-2, which lists the constituents of the hazardous waste source term, includes dioxins and metals.

Comment (3388)
Volume III, Section D.3.3.8.1. Why does the earthquake accident scenario contain only noncarcinogens? Why would carcinogens (e.g., cadmium) be released in an airplane impact and *not* in an earthquake scenario or in the incinerator explosion scenario?

Response
The statement in Appendix D, Section D.3.3.8.1, that no carcinogens are assumed to be released in earthquake scenarios involving hazardous waste was inaccurate, and has been deleted from the PEIS. Carcinogens as well as noncarcinogens are assumed to be released.

Comment (3389)
Volume III, Section D.3.3.8.7. Why is there no cyanide in the incinerator explosion source term? Where (reference) is this scenario modeled?

Response
DOE revised Section D.3.3.8.7 to clarify why cyanide was not included in the incinerator explosion accident source term for hazardous waste treatment. During explosions, cyanide is converted to cyanate, which is less toxic. The incinerator explosion accident scenario is modeled in Appendix F in Volume IV. Additional supporting information is presented in *Analysis of Accident Sequences and Source Terms of Waste Treatment and Storage Facilities for Waste Generated by DOE Waste Management Operations*, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3674)
What is DOE's basis for stating that "the treatment of carcinogenic effects of exposures resulting from accidental chemical releases has added uncertainty because the carcinogenic risk is estimated for short-term (1-hour) exposures." A cleanup crew might have an exposure for well over 1 hour.

Response
The carcinogenic risk to an individual due to an accidental release of chemicals represents risk due to a once-in-a-lifetime exposure. There are no generally accepted values for carcinogenic risk due to acute exposures of that kind where the exposure might last on the order of minutes or hours or even days. Estimates in this WM PEIS of such acute carcinogenic risk are developed from established values accepted by EPA for long-term chronic exposure (resulting from exposures of many years). This extrapolation of health effects estimates from chronic exposures to acute exposures is controversial and adds additional uncertainty to the risk assessment.

In addition, the emergency responders who would clean up any spill would be trained and equipped to deal with any carcinogenic risk from chemicals resulting from the spill.

Comment (3779)
DOE needs to consider potential tornadoes in its facility design.

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Response
The WM PEIS is a national and programmatic study to assist DOE in formulating and implementing a strategy to manage its radioactive, mixed, and hazardous wastes. Due to its programmatic nature, the document assumes generic facility designs. The WM PEIS facility accident analyses described in Appendix F in Volume IV consider accidents caused by natural phenomena, including earthquakes and tornadoes. Questions of actual facility design relating to a specific site or project, and the potential impacts of natural phenomena (such as tornadoes) on those facilities, will be addressed in sitewide or project-level NEPA reviews.

Comment (3909)
DOE needs to explain the worst-case accident scenario, and if such an event were to occur, how the public would be notified.

Response
Section 6.4.3 in Volume I presents the summary results of a low-level mixed waste treatment facility accident. Maximum consequence accidents were investigated with details of the accident scenario, and the results of the analysis being presented in Appendix F. Determination of a maximum consequence requires assessment of both the likelihood and the severity of plausible accident scenarios that could present a significant health hazard to either the workforce or the public. The spectrum of accident scenarios includes all accidents important to risk, from low-frequency events with potentially high consequences (as typified by accident sequences associated with severe natural phenomena, such as earthquakes) to relatively high-frequency events with very low consequences (as typified by routine industrial accidents). Emergency response plans and procedures currently in place at the DOE sites would be updated if new waste management facilities were to be built.

Appendix F describes the analytical approach to treatment and storage facility accidents. The process used to develop maximum consequences is addressed in Section F.2.4 in Volume IV of the WM PEIS. Section E.5.1.2 describes the accident assessment method for transportation activities.

When events occur that represent a specific threat to workers or the public due to the release or potential release of significant quantities of radiological or hazardous material, an Operational Emergency is declared and classified as either an Alert, Site Area Emergency, or General Emergency, in order of increasing severity. Alert is the lowest classification of an Operational Emergency. As such, the minimum criteria for declaring an Alert represents the threshold level of radioactive release for which notifications of Operational Emergencies are required.

An Alert is declared when the radiation dose exceeds either "the applicable Protective Action Guide... at or beyond 30 meters from the point of release to the environment OR a site-specific criterion corresponding to a small fraction of the applicable Protective Action Guide...at or beyond the facility boundary or exclusion area boundary," and "it is not expected that the applicable Protective Action Guide...will be exceeded at or beyond the facility boundary or exclusion zone boundary" (see DOE Order 151.1, Chapter V, Section 3.a).

Increasing in severity, exceeding the Protective Action Guide at or beyond the facility boundary or exclusion zone boundary will result in the declaration of a Site Area Emergency and corresponding notifications to State and local emergency response organizations (see DOE Order 151.1, Chapter V, Section 3.b). Similar notifications are made when Protective Action Guides are expected to be

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exceeded at or beyond the site boundary resulting in the declaration of a General Emergency (see DOE Order 151.1, Chapter V, Section 3.c).

Protective Action Guides for releases of radioactive materials are specified in the EPA's *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* (EPA 400-R-92-001, October 1991). Notifications of Operational Emergencies involving releases of radioactive materials are made to State and local emergency response organizations within 15 minutes of the declaration of the emergency (see DOE Order 151.1, Chapter VIII, Section 4.a). The State and local emergency response organizations notify the public accordingly. DOE does not typically directly notify the public of radioactive releases, but notifies the public indirectly through notifications to State, Tribal, and local organizations. Additional guidance concerning emergency notifications is available in the Emergency Management Guide, *Interim Guidance for Notification* (7/18/92), which is currently being revised to correspond to DOE Order 151.1.

DOE does, however, recognize the need to provide accurate, candid, and timely information to site workers and the public during all emergencies, and requires the establishment of an Emergency Public Information Program. Requirements for this program are described in DOE Order 151.1, Chapter IX. Additional information concerning emergency public information is available in the Emergency Management Guide, *Guidance for Public Information* (6/26/92), which is currently being revised to correspond to DOE Order 151.1.

Comment (4002)
I do not wish to imply that the agency cannot and should not manage the waste management and environmental restoration of former nuclear defense sites scattered nationwide. DOE is the only agency with collective information from a forty year history that would allow accurate site characterization from past and present activities. DOE is inclined to be much more information friendly to the public than private corporations can reasonably be expected to be. Most importantly, DOE is the only Federal agency with extensive information and guidance procedures, when implemented, to effectively manage the total energy needs of the Nation for the present and future.

Response
Thank you for your comment.

Comment (37)
The statements regarding air quality impacts in Section 4.3.2 of the Summary document are contradictory.

Response
Section 4.3.2 of the WM PEIS Summary document discusses two general categories of air pollutants: criteria air pollutants and hazardous air pollutants. As discussed in Section 4.3.2 in Volume I, criteria air pollutants are carbon monoxide, sulfur dioxide, particulate matter, ozone, nitrogen dioxide, and lead. Hazardous air pollutants include radionuclides, and toxic air pollutants such as mercury, and beryllium. The statements in the Summary document that seem contradictory refer to different categories of air pollutants. The emissions of hazardous air pollutants are estimated to be below standards at every candidate waste management site. Emissions of certain criteria air pollutants could cause adverse air quality impacts at some sites.

Comment (512)
Concerning the Centralized Alternative for transuranic waste treatment at WIPP, the negative air impacts from incineration need to be reviewed, and the assumption(s) used clarified.

Response
Under the Centralized Alternative for transuranic waste, DOE assumed that all contact-handled transuranic waste would be sent to WIPP for thermal treatment to meet RCRA land disposal restrictions, and that remote-handled transuranic waste would be treated at the Hanford Site and ORR prior to shipment to WIPP for disposal. The air quality impacts (emissions) estimated for WIPP can be traced to two problematic waste streams: (1) the isotope americium-241 received from LANL and (2) plutonium-238 received from SRS. Both of these sites would experience similar impacts if transuranic waste is treated at their facilities. Discussions of the selection of transuranic waste treatment sites and details of the air quality analysis are contained in Volume I of the WM PEIS, Sections 8.3.5 and 8.5, respectively.

Comment (579)
There should be a concern about air emissions from nuclear materials until all positive controls and monitors are established and work effectively.

Response
DOE is committed to managing its nuclear materials and wastes to protect human health and the environment, which includes controlling air emissions from these materials. Air emissions data presented in WM PEIS Volume I, Table 4-4, for each candidate site indicate that the radiation dose from airborne radionuclides to a maximally exposed individual and to the population around each site are well within regulatory limits.

When DOE is constructing specific facilities, it would institute administrative controls and install state-of-the-art pollution control and monitoring equipment to limit air emissions from nuclear material.

Comment (1553)
The air quality section of the WM PEIS needs to examine airborne dust and emissions specific to the dry climate of New Mexico.

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Response
The WM PEIS evaluates air quality impacts for criteria pollutants, radionuclides, and other hazardous and toxic air pollutants. The WM PEIS does not evaluate fugitive dust emissions from construction and operation activities. These potential impacts are best evaluated sitewide and project-level NEPA analyses.

Comment (1720)
Volume I, Section 4.4.9. These pages state that the Eastern Tennessee-Southwestern Virginia interstate air quality region is an attainment area per EPA classification. For the hazardous waste treatment plans, what incremental impact would be experienced in air emissions because of increased incineration under the Decentralized and Regionalized Alternatives? (Table 10.3-3 and 10.3-7). Has the situation been studied to ensure that this region will still stay an attainment area for the alternatives considered. What would be the incremental increase in the cost structure, in equipment and employee training, to adequately prevent/contain additional emissions from incineration? Also, [the commentor does] not concur with the statement that the primary source of radionuclide emissions is the Toxic Substances Control Act Incinerator for the ORR. Please correct this statement.

Response
DOE is committed to managing its wastes to protect human health and the environment, including the regional air quality surrounding the Oak Ridge Reservation (ORR). Volume I, Section 10.5.2, of the WM PEIS addresses potential emissions impacts of criteria air pollutants from the operation of a treatment facility. Estimated emissions from the treatment facilities at ORR under the Regionalized Alternatives would be only slightly more than 10% of the PM_{10} air quality standard. The PM_{10} air quality standard would not be exceeded by this incremental increase.

Table 11-18 in Volume I indicates that projected air quality impacts from the combined waste management actions at ORR would require new permits for nitrogen dioxide, PM_{10}, and vinyl chloride emissions. Increases in these air pollutants would not change the attainment status of the region.

The statement, "...the primary source of radiological emissions is the Toxic Substances Control Act (TSCA) Incinerator," applies to the K-25 Site and is referenced from Volume 1 of the Oak Ridge Reservation Environmental Report for 1992, pp 3-13 and 3-14.

Comment (1745)
ORR shows an exceedance of 10% of the National Ambient Air Quality Standards (NAAQS) for and according to the text in Section 6.5.2. Table 6.5-3 lists PM_{10} and NO_2. This needs to be clarified.

Response
DOE corrected the text in Volume I, Section 6.5.2, of the WM PEIS. This section now states that no site was estimated to equal or exceed 10% of the National Ambient Air Quality Standards.

Comment (1750)
Volume I, Section 10.5.3. Vinyl chloride would exceed the EPA ambient air concentration guideline by 322% for ORR. Please address how Regionalized Alternative 2 for hazardous waste (could remain a viable alternative) given these numbers.

Response
The WM PEIS assumed the use of a number of generic technologies for the treatment of hazardous waste, which are described in Volume I, Section 10.2.2. The results of the hazardous waste air quality impact analysis listed in Table 10.5-3 indicate that the estimated emissions of vinyl chloride at ORR would be more than three times the standard under Regionalized Alternative 2. If DOE selected this alternative for the management of hazardous waste, it would ensure the use of a treatment system tailored for ORR that included additional control measures to reduce actual emissions of vinyl chloride to acceptable levels.

Comment (1775)
Section 5.3.2 of the Draft WM PEIS Summary document states that emissions of radionuclides were estimated to be below the applicable standards at every site. The same paragraph previously states that adverse air quality impacts could result at two facilities (PGDP and NTS), which appear to have less low-level waste than Hanford. Whose standards is DOE referring to and will air quality be impacted? Why will the standards be violated more at NTS and PGDP than at Hanford, which has more low-level waste?

Response
Section 5.3.2 of the Summary document was revised and now states that the management of low-level waste does not affect the air quality at most sites. However, decentralized treatment and disposal at BNL, decentralized or regionalized treatment and disposal at PGDP, or centralized disposal at NTS could cause adverse air quality impacts requiring additional emission control measures for criteria pollutants. Emissions of radionuclides were estimated to be below the applicable standards at every site.

Section 7.5 in Volume I describes the applicable standards used for air quality for the PEIS analysis. These standards would not be exceeded at Hanford because the region around the site is in an attainment area and, therefore, has less stringent emission standards.

Comment (1824)
Not enough information is provided on air quality impacts. Section 3.2.2 in the Summary document states that DOE evaluated impacts at each site, but no data are given. There are no emission levels or impacts given. Also, there are no details given on the new facilities or modifications to existing facilities that would be required for each alternative.

Response
The Summary document should have said that DOE evaluated impacts at each *major* site. The PEIS does not report potential impacts at nonmajor sites because they would be small. The focus of the PEIS is on major sites, as explained in the Summary document (Table 1.4-1) and in Volume I, Table 1.6-1.

Although the detail requested by the commentor is not included in the Summary document, for major sites, Section 5.4.2 in Volume I and Section C.4.2 in Volume III, describe the methods used to estimate potential impacts to air quality. Sections 6.5, 7.5, 8.5, 9.5 and 10.5 in Volume I and the Site Data Tables in Volume II describe the potential impacts from alternatives for the management of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. Chapter 11 in Volume I describes the potential combined and cumulative impacts on air quality. Additional detail is

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included in supporting technical reports. These technical reports are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2451)
A commentor provided the following comments with respect to Prevention of Significant Deterioration (PSD) and State of Idaho air pollution regulations.

Many PSD requirements were not specifically addressed in the EIS. For example, under the Centralized Alternative, incineration of all wastes might require a PSD permit. In that case, Best Available Control Technology (BACT) has to be considered in addition to incremental analysis, ambient monitoring, Air Quality Related Values (AQRVs) issues, Class I impact assessment, and analysis of the impact of growth in the area where the major facility would be located, etc. In Volume II, when comparing with a standard (Table II.1-13), National Ambient Air Quality Standards (NAAQS) might be the controlling factor at many sites; however, if PSD is triggered in any area, the most stringent standards are defined as PSD increments developed by EPA for Class I, II, and III areas for PM_{10}, sulfur dioxide, and nitrogen dioxide (PSD has been triggered at INEL).

In determining the PSD increment consumed (after the baseline date), the State of Idaho includes cumulative and contemporaneous emissions over the last 10 years from minor sources or area sources, in addition to major sources. If only cumulative and contemporaneous emissions from major sources (after the baseline date) are utilized, the PSD increment consumption will be underestimated.

The word "net" is missing from the description of emissions when a PSD analysis is performed. If the sum of contemporaneous emissions from modifications exceeds the significant level, a PSD review is required.

INEL has triggered PSD baseline dates for NO_x, SO_2, and particulate emissions. PSD regulations limit cumulative air quality degradation after the baseline date. The baseline conditions have not been analyzed and quantified. Therefore, analyses of impacts from proposed options were not prepared in a manner in which they can be compared with the applicable regulatory requirements.

DOE needs to address the impact on AQRVs in the Final PEIS. DOE should contact the National Park Service in identifying potential AQRVs.

All emission sources must comply with the visible emissions standards in Idaho in accordance with IDAPA 16.01.01.625.

The PEIS should include previous analysis of consumed increments at Craters of the Moon Wilderness Area. PSD baseline dates date back to 1981 for SO_2 and particulate emissions, and 1992 for NO_x.

Response
The reviewer's comments in regard to how and why PSD impact analyses are performed are correct. However, the actions discussed in the WM PEIS are programmatic in nature and are meant to be used as a screening-level analysis for determination of potential adverse impacts. The PEIS air quality analysis was meant to establish a baseline for comparison of all the DOE facilities for which actions are considered and to identify the sites and facilities that have potential areas of air quality concern.

DOE revised Volume III, Section C.4.2.1.3.1.1, to indicate that the air quality analysis should not be viewed as a refined PSD analysis, and that such an analysis is site-specific and would be performed prior to implementation of any waste management activity at a potential PSD site. DOE will comply with all applicable laws and regulations, including permitting requirements, in implementing its waste management activities.

Comment (2454)
The WM PEIS should analyze deposition-based pathways for emissions from technology alternatives, such as incineration. The effect, for example, of an incinerator on the ambient atmosphere is subject to emissions, stack parameters, and local meteorological conditions. These variables should be considered in the analysis. Modeling at the boundary of INEL instead of at grazing sites within INEL (and at other sites) would potentially lead to an underestimation of impacts from deposition-based pathways. This is an even greater potential problem when the Land Use Plan is considered and the site boundary shrinks.

Response
The WM PEIS used a deposition-based exposure analysis for human health risk analysis, in addition to an analysis of exposure based on inhalation. Volume I, Table 5.4-1, provides the exposure pathways for affected populations and individuals for air emissions from treatment activities and Figures 5.4-1 through 5.4-4 do the same for different receptor groups. Details are provided in Section D.2.4 in Volume III. The modeling used for the human health risk analysis was based on a number of factors, including those mentioned in the comment. Section D.2.7 in Volume III describes the modeling in greater detail.

Currently, grazing is allowed within the site boundary at some sites, but only in accordance with strict guidelines. For example, INEL allows sheep and cattle to graze within the site boundary, but to avoid the possibility of milk contamination, does not allow dairy cattle to graze. The grazing programs are strictly controlled and monitored to ensure the safety of the ranchers and livestock. At INEL, livestock are not allowed to graze within two miles of a nuclear facility.

Although impacts to grazing livestock were not specifically analyzed in the WM PEIS, impacts to an indicator mammal were included in ecological impacts analyses. These analyses found that major impacts to the indicator species from air deposition of contaminants are unlikely. Therefore, major impacts to other mammals, including livestock, are unlikely.

Impacts due to changes in the site boundary in association with implementation of the site land use plan would be evaluated in site-specific NEPA documents.

Comment (2455)
It is not clear whether background levels were considered in the analysis of air quality modeling for specific activities in the alternatives. Each site has a background air quality value and any additional activity should meet the Federal and/or State standards by summing up the ambient impact of the activity and the background.

Response
The air quality analysis was performed at a programmatic level, which is a less detailed level of analysis than suggested by the commentor. The goal of the analysis was to screen for major impacts and provide a means to compare air quality impacts across alternatives. Background levels were not considered in the

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presentation of the impacts analysis results. Background-level data are presented for each site, however, in the WM PEIS Affected Environment Technical Report, which is available in DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS. Due to the variability of data (differences in concentration periods, or lack of comparable data), DOE did not add background values to impact values in the belief that sites with data would be unfairly penalized over sites with no background data.

The analysis performed for the WM PEIS used trigger levels for permitting review for criteria pollutants, comparison to NAAQS concentrations (without background) for criteria pollutants, comparison to the 10 mrem per year NESHAP for radionuclides (without consideration of other DOE facilities), and comparison to the hazardous air pollutants and toxic air pollutants standards (without background). Impacts to air quality that include consideration of background conditions and other actions at the site are included in the combined and cumulative impacts section (Chapter 11 in Volume I of the WM PEIS).

Comment (2456)
If a facility cannot comply with the specific air quality regulatory standards and requirements, that alternative cannot be selected, despite any advantages of that facility over another facility. This would affect the other facilities and sometimes, a combination of alternatives would be the choice.

Response
The WM PEIS analysis is not intended to determine whether an action can or cannot comply with all applicable air quality regulations. The analysis only predicted areas of potential impact. There was no analysis of pollution control options or process parameter changes for the purpose of meeting regulations. The type of refined analysis necessary to determine compliance with regulations would be performed for a sitewide or project-level study.

Comment (2457)
Air quality and risk assessment have been evaluated together in the description in Volume III, Section C.4.2.1.2.1.2. The term "MEI" is used in radiological dose assessments; however, for hazardous air pollutants, it is not widely used.

Response
The air quality and health risk impacts assessments conducted for the WM PEIS used the concept of the maximally exposed individual (MEI) as one of the parameters evaluated to estimate potential impacts. The MEI is the hypothetical individual within the offsite population who has the highest exposure to airborne contaminants released from treatment and storage facilities. The MEI is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week for the 10- to 20-year period of treatment operations analyzed in the WM PEIS. The MEI concept is used in regulatory reporting of radionuclide releases by DOE. It is also used by EPA in its NESHAPs regulations (40 CFR 61) to evaluate potential exposure from releases of hazardous air pollutants including radionuclides.

Comment (2458)
The behavior (transport, reaction, deposition, etc.) of hazardous air pollutants in the atmosphere is different than the behavior of radionuclides. Therefore, receptor locations for radionuclides would be different than those for hazardous air pollutants. Also, the synergistic effect of these materials must be considered.

Response
The MEI concept is used in regulatory reporting of radionuclide releases by DOE. It is also used by EPA in its NESHAP regulations (40 CFR 61) to evaluate potential exposure from releases of hazardous air pollutants including radionuclides. The WM PEIS acknowledges the differences between radionuclide and chemical exposures and discusses these differences in Volume III, Section D.2.6.3.

The WM PEIS used air dispersion models to estimate the environmental fate of radionuclides and hazardous air pollutants released from waste management facilities. Volume I, Section 5.1.2, contains a short description of the models used. GENII was used to evaluate radionuclide fate and transport and ISC2 was used to evaluate hazardous air pollutants. Table 5.1-1 contains brief descriptions of these models; additional details are presented in Section D.2.7.1 in Volume III.

The transport and transformation of radionuclide and hazardous chemical contaminants in the atmosphere is based on the physical and chemical properties of each contaminant. The models used conservatively estimate potential exposure in that they do not account for degradation of chemical contaminants (e.g., volatile organic compounds, chlorinated organics) in the atmosphere. Although the behavior of individual contaminants will differ based on their properties, these differences are likely to be small given the conservative and simplifying assumptions used in the analyses.

The health risk impacts analysis did not consider the potential synergistic or antagonistic effects of exposure to both radionuclides and hazardous chemicals, because not enough information exists on these effects. For purposes of analysis, the carcinogenic effects of exposures to more than one radionuclide were assumed to be additive across radionuclides, and the effects of exposures to different potentially carcinogenic chemicals were assumed to be additive across chemicals.

Comment (2459)
In the air quality discussion, only boilers and incinerators were discussed. If there are other technologies being considered, the emission rates from these operations should be identified.

Response
The WM PEIS analysis was based on the uniform application of currently available treatment, storage, and disposal technologies at each of the 17 major waste sites. Thermal treatment (incineration) was used as a generic technology in the WM PEIS analysis to allow a relative comparison of potential impacts across sites. Other technologies could be considered at each of these waste sites. For potential offsite impacts, emissions from boilers and incinerators were considered to have the greatest potential for adverse impacts. Other treatment technologies such as solidification, compaction, and aqueous treatment do produce emissions. However these emissions would be low and would not distinguish among the WM PEIS alternatives.

The specific technologies used at a site to implement an alternative will depend on a number of factors that will be further evaluated at the site and project level.

Comment (2460)
The State of Idaho toxic air pollutant rules are based on annual and 24-hour concentrations. There is no indication whether these or other State concentration standards were used in the analysis.

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Response
As stated in Section 5.4.2 in Volume I of the WM PEIS, the estimated concentrations of toxic air pollutant concentrations were compared to applicable EPA or State ambient concentration guidelines. Section C.4.2.1.2.2.2 in Volume III provides further detail on the comparison process. The WM PEIS did not identify individual State regulations in the air quality impacts sections. The Idaho air toxics regulations are referenced in the WM PEIS Affected Environment Technical Report, but are not presented in table format due to the extensive list of compounds in the regulation.

At the time the Draft WM PEIS air quality analysis was conducted, the IDAPA 16.01.01.586 regulations were proposed and not yet final. Therefore, they were not used in the analysis. DOE recognizes that the regulations have now been accepted and are final. The impacts results in Sections 6.5.3, 8.5.3, and 10.5.3 in Volume I in the Final WM PEIS reflect comparison of air quality to the concentration limits in the final regulations.

Comment (2465)
The descriptions of meteorological data available for modeling, and how the data were used in air pollutant and radionuclide dispersion modeling are incomplete and inadequate. Historic DEQ critique and the Tiger Team report have documented that upper air data necessary to support dispersion modeling are not available from the INEL vicinity. The sources and uncertainties of upper air meteorological data used for modeling should be identified.

Response
The GENII model requires data concerning the direction, frequency, and stability of winds, as well as release parameters such as stack height, flow rate, and exit temperature. Upper atmosphere meteorological data are not required for the model. The joint frequency data used in the WM PEIS are documented in the PEIS Site Descriptions Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS.

Comment (2468)
The discussion of cumulative effects of airborne radiological and non-radiological emissions should include visibility impacts and the additive nature of dose impacts from radionuclide sources.

Response
The WM PEIS air quality analysis was performed at a programmatic level, which is a less detailed level of analysis than would be performed for a site-specific NEPA analysis. The goal of the analysis was to provide a means to compare air quality impacts across alternatives for the major sites. DOE revised Volume I, Sections 6.5.2, 8.5.2, 9.5.2, and 10.5.2 of the WM PEIS to indicate that potential waste management activities at sites within 100 kilometers (62.5 miles) of a Class I area were analyzed to determine whether there could be impacts on visibility from site emissions. Class I areas are national parks, recreational and wilderness areas, and other locations that have excellent air quality. Visibility impacts are not considered major impacts for all of the 17 major sites. DOE understands that all sources at INEL must comply with the applicable visibility standards. Sitewide or project-level NEPA reviews would include analyses of impacts to visibility, where appropriate.

Volume I, Chapter 11, presents the cumulative dose impacts for airborne radiological emissions and air quality impacts from waste management activities and other activities at the sites.

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Comment (2469)
Fugitive dust modeling impacts should differentiate between fugitives from temporary activities (generally not subject to air quality impact limits other than reasonable controls) and permanent fugitive sources or those subject to air quality impact limits.

Response
Impacts from fugitive dust emissions from temporary activities such as construction were not considered as part of the WM PEIS analysis. Fugitive dust emissions from soil disturbance would be site-specific. These emissions would be related to the size of the area disturbed, soil type, meteorological conditions, and soil moisture. These types of emissions are typical of large construction projects and can be readily controlled by standard erosion control measures. Therefore, fugitive dust emissions from construction are best evaluated in sitewide or project-level NEPA analyses.

Comment (2470)
All air transport and diffusion modeling was prepared with models using the gaussian plume dispersion method. This assumption is not appropriate for long transport distances or in situations where the flow direction changes. Gaussian models can seriously underestimate impacts in these scenarios. Applications of wind flow models such as MESODIF imply that gaussian model predictions tend to underestimate impacts at INEL boundary locations.

Response
The modeling techniques used for INEL and each of the major waste management sites were general in scope and were not intended to represent exact conditions at individual sites. The GENII and ISC2 models used for simulating atmospheric dispersion in the WM PEIS have been extensively tested and used in the field of risk assessment. The programmatic nature of the PEIS precludes the use of site-specific, data-intensive atmospheric models. If INEL is selected as part of an alternative action, DOE will perform site-specific refined modeling, including the use of a wind flow model.

Comment (2471)
With regard to air quality, impact and dose assessment methodology does not provide enough information to verify the accuracy and representative nature of predicted impacts or doses. Descriptions and efficiencies of air pollution control systems should be documented. Sample calculations on how the emission rates were estimated should be included or referenced.

Response
Additional information on the impact assessment methodologies, including the impact methods and results, is presented in the supporting technical reports. These technical reports are listed in Section 15.2 in Volume I and are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Pollution control assumptions for each waste type are also documented in the technical reports.

The sources used in estimating emissions in the WM PEIS include *Compilation of Air Pollutant Emission Factors, Volume II, Mobile Sources*, and the EPA-approved vehicle emissions models Mobile5a and PART5. These sources are cited in Section C.4.2.1.2.2 in Volume III, in which emissions estimation techniques, specific EPA models, and technical reports for calculating emission rates are described. Additional detail on the calculation of emissions from waste management facilities and transportation vehicles is included in the Impacts Methods and Results Technical Report.

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Comment (2481)
Volume I, Section 4.3.2, discusses compliance with primary and secondary national and State ambient air quality standards (AAQS) and lists the AAQS for criteria pollutants. In accordance with IDAPA 16.01.01.577, the State of Idaho has defined fluorine as a criteria pollutant, which is not addressed in the NAAQS in 40 CFR 50. Fluorine emissions are not quantified in Volume I, Section 4.3.2, or in Volume II, Table II-6.5-7.

Fluoride is a criteria pollutant under the State of Idaho Rules (IDAPA 16.01.01.577); this pollutant is not listed under criteria pollutants in Volume III, Section C.4.2.1.1.

Response
Section 4.3.2 in Volume I of the WM PEIS discusses the general approach to air quality and the affected environment. This section discusses only Federal criteria air pollutants, which are regulated at all the WM PEIS sites. State-established criteria pollutants, including Idaho's, are presented in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. DOE has modified the text of Section C.4.2.1.1 in Volume III to indicate that these are Federal criteria pollutants and that the State criteria pollutants are identified in the WM PEIS Affected Environment Technical Report.

There are no Idaho criteria pollutant standards for fluorine. However, fluoride is a State of Idaho regulated criteria pollutant and is listed as such in the WM PEIS Affected Environment Technical Report, in Volume I, Table 2.3-5. The compounds presented in Table II-6.5-7 in Volume II of the WM PEIS are those for which estimated emission rates were provided. No emissions of fluoride were identified during evaluation of the generic treatment facilities. Therefore, air quality impacts for fluoride were not estimated and are not presented.

Comment (2483)
The WM PEIS states that a region of influence (ROI) with a 50-mile radius was considered for analyzing potential air quality impacts. 40 CFR 52.21 states that no source may adversely impact the visibility in a Class 1 area. A source could be outside the 50-mile ROI radius and still adversely impact the visibility of a Class 1 area. Therefore, the analysis within the 50-mile ROI radius may not verify there is an absence of any adverse visibility impact in a Class 1 area.

In addition, the PEIS states that Class I areas are of special concern due to their proximity to national parks, wilderness areas, etc. Class I areas *are* national parks, recreational and wilderness areas, and other locations that have excellent air quality.

Response
DOE revised Volume I, Sections 6.5.2, 7.5.2, 8.5.2, 9.5.2, and 10.5.2 of the WM PEIS to indicate that potential waste management activities at sites within 100 kilometers (62.5 miles) of a Class I area were analyzed to determine whether there could be impacts on visibility from site emissions, as required by the regulations.

DOE also revised Volume I, Section 6.5.2, 7.5.2, 8.5.2, 9.5.2, and 10.5.2 to correct the definition of Class I areas.

Comment (2484)
Model receptor grid spacing is very large. Please consider more dense grid spacing in areas where high impacts are predicted.

Response
The air quality analysis was performed at a programmatic level, which is a less detailed level of analysis than would be performed for a project-level NEPA analysis. The goal of the analysis was to screen for major impacts and provide a means to compare air quality impacts across alternatives. DOE believes the receptor grid spacing is adequate for the nature of the analyses that were performed.

Comment (2501)
Volume I, Section 5.4, describes adverse air quality impacts. Because it is not clear if adverse air quality impacts are defined as a violation of an air quality standard, further clarification is required.

Response
Volume I, Section 5.4, states that compliance with regulatory standards is not necessarily an indication of the significance or severity of the environmental impacts. It goes on to explain that DOE chose a 10%-of-standard threshold to highlight the sites where criteria air pollutants could result in adverse air quality impacts. The discussion details DOE's rationale for doing so.

Section 5.4.2 discusses the WM PEIS air quality impacts analysis methodology. Additional details of the air quality impacts methodology are in Section C.4.2 in Volume III.

Comment (2516)
Volume I, Table 5.4-2, states that emissions of the hazardous and toxic air pollutants are negligible. For hazardous and toxic air pollutants emissions to be considered negligible, there must be verification that the toxic air pollutant standards in IDAPA 16.01.01.585 and .586 are not exceeded.

Response
The hazardous and toxic air pollutants considered negligible were from construction emissions, national transportation corridor emissions, and total national emissions. The types of air pollutants emitted during construction are generally particulates and emissions from construction vehicle engines, which are not hazardous and toxic air pollutants. If the construction area were contaminated, it is possible that there might be emissions of hazardous and/or toxic air pollutants. However, in the WM PEIS, precise locations of facilities are not considered. DOE assumes that the precise facility locations would be chosen to avoid contaminated areas.

Emissions along national transportation corridors and total national emissions are from transport vehicles. These are emissions of criteria pollutants and not hazardous or toxic air pollutants.

For operations and maintenance emissions, which might be significant, Volume I, Table 5.4-2 of the WM PEIS indicates that concentrations of hazardous and toxic air pollutants were compared to applicable State ambient concentration guidelines, including those mentioned by the commentor. DOE will comply with all applicable State regulations when implementing its waste management activities.

The Idaho air toxics regulations are referenced in the WM PEIS Affected Environment Technical Report, but are not presented in table format due to the extensive list of compounds in the regulation. At the time

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the WM PEIS air quality analysis was conducted, the IDAPA 16.01.01.586 regulations were proposed and not yet final. Therefore, they were not used in the analysis. DOE recognizes that the regulations have now been accepted and are final. The impacts results in the Final WM PEIS reflect comparison of air quality to the concentration limits in the final regulation. The WM PEIS Affected Environment Technical Report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2517)
Construction activities that result in fugitive particulate emissions from paved and unpaved roads are not addressed. Only emissions from fuel use (transportation, incineration, etc.) are estimated.

Response
The WM PEIS evaluates air quality impacts for criteria pollutants, radionuclides, and other hazardous and toxic air pollutants. The potential impacts of fugitive dust emissions from construction activities are best evaluated in sitewide or project-level NEPA analyses. While it is true that fugitive dust generated by construction activities would vary from site to site, these impacts can be readily mitigated and, therefore, would not play a significant role in DOE's decisionmaking process.

Comment (2518)
The WM PEIS states that the focus of the air quality analysis was on estimating potential emissions of criteria air pollutants. Does "emissions" refer to predicted concentrations or emission rates utilized in the analysis?

Response
In the WM PEIS, criteria air pollutant emission rates for construction, operation, and transportation were compared to applicable emission rate increments, which have the potential to trigger prevention of significant deterioration permitting. In addition, criteria air pollutant concentrations for operation were compared to the applicable National Ambient Air Quality Standards.

Comment (2519)
It is not clear whether the potentially detrimental effects of building downwash were included in the WM PEIS air quality analysis.

Response
The effects of building downwash were not addressed, as this would require more detailed information about the facility, particularly its precise location. This type of detailed analysis would be more appropriately addressed in sitewide or project-level NEPA reviews.

Comment (2520)
Volume I, Section 5.4.2, states that a distinction between prevention of significant deterioration (PSD) increment limits and significant emissions rates should be made. The former are what the predicted impacts should be compared to in order to ensure that PSD standards are met; the latter help determine, by a comparison with actual or proposed emissions, whether PSD review is required.

Response
DOE revised the text in Section 5.4.2 in Volume I to clarify the difference between PSD increments (concentration based values) and PSD significant emission levels (emission rates in tons per year).

Comment (2521)
Volume I, Section 5.4.2, states that the stratospheric ozone analysis was carried out at the alternative level. The definition of the specific alternative level should be included.

Response
DOE revised the text in Volume I, Section 5.4.2, to indicate that an analysis of impacts to the stratospheric ozone layer was performed using estimates of total emissions of ozone-depleting substances for each alternative.

Comment (2523)
In Volume I, Section 5.4.2, the NO_2 ambient air quality standard (and also possibly the PSD regulations) is based on health effects of NO_2, not on potential ozone formation; compliance with the NO_2 standard does not guarantee compliance with the ozone standard.

In addition, in Volume III, Section C.4.2.1.3.4: For ozone analysis, what model was used for the estimation of NO_x and VOC emissions?

Response
The PSD and General Conformity Rule regulations for volatile organic compounds are for control of ozone and it is the combination of volatile organic compounds and NO_x, not just NO_2 by itself, that forms ozone. DOE assumes that if volatile organic compounds and NO_x each meet their respective PSD, General Conformity Rule, and NAAQS levels, then it can be reasonably assumed that ozone production would be minimal. The statement in Section 5.4.2 of the WM PEIS is not meant to "guarantee" compliance with the standard, but only to demonstrate that the possibility of exceeding the standard should be minimal.

In addition, no model was used to predict ozone levels for the WM PEIS. DOE used estimated emissions of volatile organic compounds and NO_x from proposed actions as a qualitative tool to estimate compliance with the ozone standards.

Comment (2531)
Because New Source Performance Standards are cited on page 5-41 of the Draft WM PEIS, 40 CFR 60 should be referenced following 40 CFR 52.21.

Response
DOE added the requested reference to Volume I, Section 5.4.2.

Comment (2536)
Volume I, Section 6.5, seems to imply that only PSD regulations apply in attainment areas. In attainment (and unclassified) areas, PSD issues might or might not apply. PSD review is required:

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- If an operation defined as a designated facility is listed among the Designated PSD Source Categories in 40 CFR Part 52 and emits or has the potential to emit, after controls, equal to or more than 100 tons per year of any air pollutant;

- If an operation emits or has the potential to emit, after controls, equal to or more than 250 tons per year of any air pollutant.

PSD review is also required if proposed emissions from a modification to an existing major source are greater than the significant emission rates listed in 40 CFR 52.21 (b) (23).

Response
DOE revised Section 6.5 in Volume I to clarify that PSD regulations *might* apply in attainment areas, and that this would be determined by the PSD review process. The PSD review process would occur after waste management sites are selected and in parallel with sitewide or project-level NEPA analyses.

Comment (2538)
Volume I, Section 6.10.2.4.1. For adverse air quality impacts from ANL-E, restricting use during periods of stagnant meteorological conditions is mentioned. What is the definition of these stagnant conditions? For example, what meteorological variables, such as wind speeds and stability categories, are used to define stagnation events?

Response
Emissions from the operation of low-level waste and low-level mixed waste facilities at ANL-E would not exceed air quality standards. Mitigation measures, possibly including use restrictions during stagnant conditions, would be implemented for adverse air quality impacts. Stagnant meteorological conditions might include, for example, low wind speeds and strong atmospheric instability. However, because the analysis showed that operation of waste management facilities for low-level waste and low-level mixed waste would not exceed the applicable standards under any alternative at ANL-E, no mitigation measures are discussed specifically for that site.

Comment (2549)
Volume II, Table II.1-14. Dioxins and furans are significant hazardous air pollutants. These chemicals are not addressed in the WM PEIS. These hazardous air pollutants are formed during incineration, which is selected as a treatment method for managing wastes. Incinerators are also regulated by New Source Performance Standards. Also, what is the selection process for hazardous and toxic air pollutants in this table?

Response
Hazardous and toxic air pollutants included in Volume II, Table II.1-14, are those modeled to remain in the treatment plant emissions after destruction by the treatment process. As described in the supporting technical reports, dioxins and furans were included in the source terms for low-level mixed waste, transuranic waste, and hazardous waste because these waste types include hazardous constituents. Therefore, dioxins and furans are included in the health risk estimates for these waste types. Because specific molecular forms of the contaminants were not known, hexachlorodibenzo-p-dioxin and hexachlorobenzofuran were used as surrogates for all dioxins and furans. The technical reports are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

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Comment (2550)
Volume II, Table II-6.1-9, states that when emissions are below 1%, the quantity of zero is listed. It is not clear if the 1% for a specific emission is referenced to total emissions. If so, further clarification is necessary. Also, benzene emissions might be less than 1.0%; however, the emission limit, in accordance with IDAPA 16.01.01.586, is 8.0E-4 pounds per hour. Therefore, an emission rate listed as less than 1% could still exceed the emission rate listed in IDAPA 16.01.01.585 for that specific chemical.

Response
As described in the technical report *Waste Management Environmental and Socioeconomic Impacts Methods and Results*, the maximum offsite concentration for benzene was 1.32E-07 milligrams per cubic meter. This is less than 1% of the 3.8E-02-milligrams-per-meter standard. Table II-6.1-9 compares predicted concentrations to concentration standards, not emissions standards.

Comment (2556)
In Volume III, Section C.4.2.1.2.1.1, for nonattainment, the General Conformity Guidelines were considered. For permitting purposes, the most stringent standard is a significant contribution factor in the State of Idaho rules. Also, State rules require consideration of the application of the Lowest Achievable Emission Rate for major source/major modification.

Response
The goal of the WM PEIS air quality analysis was to screen for major impacts and provide a means to compare air quality impacts across alternatives. Sitewide and project-level NEPA analyses will consider specific State air quality rules and regulations. DOE will meet all applicable permitting requirements when implementing waste management decisions.

Comment (2557)
Volume III, Section C.4.2.1.2.2.2. New Source Performance Standards could be applicable for specific types and capacities of boilers. Also, in addition to criteria pollutant emission estimates, emissions of hazardous and toxic air pollutants must be estimated to verify compliance with IDAPA 16.01.01.585 and .586.

Response
New Source Performance Standards could be applicable to boilers that exceed a certain size or heat input rating. Emissions of hazardous and toxic air pollutants were estimated for incineration, but not from fuel use for boilers. The programmatic air quality analysis conducted for the WM PEIS is not meant to replace or represent the type of refined analysis required by New Source Performance Standards regulations. The air quality analysis was performed at a programmatic level, which is a less detailed level of analysis than would be performed for a site-specific NEPA analysis. The goal of the WM PEIS was to screen for major impacts and provide a means to compare air quality impacts across alternatives. Because the discussion cited by the commentor applies to all sites, individual States' requirements are not included. However, Section C.4.2.1.2.2.2 states that State guidelines were used, where appropriate, to compare estimated emissions of hazardous and toxic air pollutants from incinerators.

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Comment (2558)
Volume III, Section C.4.2.1.2.2, states the emission factors were derived from the third edition of AP-42. Two other editions, containing additional and updated emissions factors, have been published since the third edition of AP-42.

Response
The AP-42 referenced in the Draft WM PEIS is the fourth edition, not the third. The most recent fifth edition was not officially published by the EPA until after the WM PEIS air quality analysis had been completed. A review of the fifth edition indicates that there have been no changes to the emission rates used in the WM PEIS from the fourth to fifth editions.

Comment (2559)
Volume III, Table C.4-5. The values in the table are defined under "significant." If a facility exceeds the limit indicated in the table as a net emissions increase (actual emissions), the facility has to be permitted under major modification and is subject to PSD permitting. In the table, particulate (TSP) is incorrect. It should be particulate matter, which is defined as smaller than 100 micrometers in 40 CFR 51.100. For ozone, the 40 tons per year limit is controlled through volatile organic compounds.

Response
DOE corrected Table C.4-5 in response to this comment.

Comment (2560)
Volume III, Section C.4.2.1.3.1.2. All sources (new and modified) have to abide by NSPS whether or not they are located in nonattainment areas.

Response
Section C.4.2.1.3.1.2 pertains to nonattainment areas and is not meant to imply that these standards do not apply in attainment areas.

Comment (2574)
The Summary and Volume I state "The management of LLMW [or LLW or TRUW] does not affect the air quality at most sites." These absolute statements should be qualified, for example by inserting the word "significantly" or "appreciably," since treatment options, at least for low-level mixed waste and transuranic waste, are likely to include incineration, with non-zero air quality impact.

Response
The absolute statements in Sections 4.3.2, 5.3.2, 6.3.2, and 8.3.2 of the Summary concerning air quality impacts have been qualified to read, "The management of LLMW (or LLW, TRUW, or HW, respectively) would not cause the air quality limits to be approached or exceeded at most sites."

Sections 6.5, 7.5, 8.5, 9.5, and 10.5 in Volume I were revised to state "The management of LLMW (or LLW, TRUW, HLW or HW, respectively) would not appreciably affect the air quality at most sites."

Comment (2597)
Volume I, Section 4.3.1; Volume II, Table II-6.5-7. Volume I discusses National Emission Standards for Hazardous Air Pollutants (NESHAPs). The only NESHAPs addressed in Volume I or Volume III,

are radionuclides, while asbestos, beryllium, and mercury (other NESHAPs in 40 CFR 61) are not addressed.

Response
As reported in the WM PEIS Low-Level Mixed Waste Technical Report, emissions of mercury were included in the emissions source terms that were used in the WM PEIS air quality and health risk analyses. Emissions of asbestos and beryllium were estimated to be very low and, therefore, were not included in the air emissions estimates. Therefore, air quality and health risk results for asbestos and beryllium are not available. The text in Volume I, Section 5.4.2, and Volume III, has C.4.2, has been revised to clarify this. The Low-Level Waste Technical Report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS.

Comment (2818)
Referring to Section 4.3.2 of the Draft WM PEIS Summary document, a commentor stated, "It should also be noted that the management of low-level mixed waste (LLMW) via thermal treatment or incineration may impact air quality at the Idaho National Engineering Laboratory."

Response
Volume I, Section 6.5.2 of the WM PEIS, the maximum impact to air quality from low-level mixed waste management at INEL would be 45% of the PSD permitting increment for PM_{10}. Only sites that exhibit values near or exceeding 100% of the limits are discussed in the Summary document.

To make this clearer, DOE has revised the text in Section 4.3.2 of the Summary document. The text now states that the management of low-level mixed waste would not cause the air quality to approach or exceed the PSD permitting limit at most sites. Similar changes were made to Sections 5.3.2 and 6.3.2 of the Summary document.

Comment (2844)
According to Volume I, Table 5.4-3, radionuclide emissions were not evaluated for high-level waste. High-level waste air emissions should be included.

Response
Only storage of vitrified high-level waste canisters is within the scope of the WM PEIS. As indicated in Volume I, Sections 9.4.3 and 9.5, DOE expects that during normal storage operations there would be no emissions from high-level waste vitrified and stored in sealed stainless steel canisters. In addition, a high-efficiency particulate air filtration system would be used to filter the air from the storage building to ensure minimal releases of particulate radioactivity. Therefore, analysis of air quality impacts from emissions of hazardous air pollutants from high-level waste is not warranted. DOE modified the footnote to Table 5.4-5 to state that emissions of radionuclides and other hazardous constituents from the storage of vitrified high-level waste are assumed to be negligible.

Comment (2904)
The Air Quality portion in Volume I, Section 4.4.2, states that prevailing winds at BNL were from the south and southwest with a frequency of 12%. However, this gives the false impression that prevailing winds are from the south and southwest only. This is not the case. In fact, BNL's own 1993 Site Environmental Report states on page 5 that prevailing ground-level winds are from the southwest during the summer, from the northwest during the winter and "...about equally from these two

directions during the spring and fall." Accordingly, the statement in the WM PEIS must be corrected to account for this information. Furthermore, the most recent site data, as noted in the 1993 report, should be utilized.

Response
The WM PEIS provides the annual prevailing wind direction. Prevailing winds can also be calculated for other time periods including daily, monthly, and seasonally. The level of detail requested by the commentor is not required in a programmatic EIS, since this information is unlikely to significantly enhance decisionmaking. DOE used a single averaging period for all sites, to ensure consistency of analyses across sites.

Section 4.4.2 in Volume I is a summary of a more detailed information contained in Section 15.2 of the WM PEIS Affected Environment Technical Report. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2996)
Volume I, Section 7.5.2, notes a number of sites that would have low-level waste activities within 62 miles of a PSD Class I area. However, the discussion fails to include BNL, which is well within 62 miles of several significant Federal areas including the Fire Island National Seashore, Wertheim National Wildlife Refuge, Morton National Wildlife Refuge and the Federally designated Peconic Estuary. The discussion should make note of these facts.

Similarly, Section 6.5.2 in Volume I states that eight sites are located within 100 kilometers of a PSD area due to proximity of features including a national park, seashore, wildlife refuge, etc. This section also mistakenly omits BNL.

Response
Sections 6.5.2 and 7.5.2 of the WM PEIS were revised to include BNL as a site that might have low-level mixed waste and low-level waste activities within 62 miles of a PSD Class I area. Section 4.4.2 was revised to note that BNL is located within the Peconic Estuary System.

Comment (3025)
Exceeding regulatory limits for air quality, as stated in the WM PEIS, is not an acceptable option. Major waste management facilities and operations will have to file Notice of Construction and/or Prevention of Significant Deterioration permit applications before startup. These processes assure acceptable air quality levels to protect the public, even if facilities have to be redesigned.

Response
The WM PEIS used generic technologies to analyze potential environmental impacts at the sites. The application of generic technologies and simplifying operating assumptions resulted in the prediction of potentially significant impacts at some sites. This analysis is useful because it highlights potential problem sites, sites where mitigation might be required, or sites where construction and operation of waste management facilities could be more costly.

DOE will comply with all applicable environmental laws and regulations in constructing and operating its waste management facilities. Therefore, the discussion of air quality impacts in the Final WM PEIS acknowledges that air quality standards would not be exceeded under any circumstances.

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Comment (3061)
Volume I, Section 5.1.2, does not consider the air contaminant contribution that could result from actually remediating waste.

Response
As explained in Section 1.7.1 in Volume I, environmental restoration activities are outside the scope of the WM PEIS. Site-specific analyses will determine potential environmental and health effects of environmental restoration activities at each site. To the extent possible, the impacts of environmental restoration activities have been considered in the cumulative impacts analysis in Volume I, Chapter 11, of the WM PEIS.

Comment (3103)
Section C.4.2.1.2.2.2 does not clarify if DOE assumed that all the sites use natural gas and fuel oil, or if the analysis used the type of fuel available at each site. Hanford, for example, does not use natural gas.

Response
The availability of fuels at the sites was not considered. Volume III, Section C.3.1.1.2, states that "Fuel, Natural Gas or Liquid Propane Gas (in pounds)" represents the fuel needed to heat the building for one year, and was assumed to be natural gas. "Fuel, liquid (in gallons)" represents the fuel required to operate specific pieces of process equipment for one year. The fuel assumed for these calculations was standard diesel oil.

Comment (3104)
Section C.4.2.1.2.2.2 presents an inequitable comparison of worker vehicle use. It suggests that Hanford is more desirable for accepting wastes due to employees' efforts to reduce environmental impacts, e.g., by carpooling (decreasing worker trips by 19%). Also, the mileage figures (40 miles round trip) are too low for Hanford.

Response
The 40-mile per day round trip was assumed for every site. The one-way distance from the center of Richland to the center of the Hanford Site 200 Areas is approximately 20 miles. The reduced number of worker trips for Hanford was not meant to imply that Hanford is a more desirable site for waste management facilities. It was identified merely for purposes of providing an estimate of emissions. It would be preferable to include estimates of ridesharing for all DOE sites, but firm estimates for this type of activity were not available for sites other than Hanford.

Hanford is in an attainment area for all criteria pollutants. Therefore, under the applicable regulatory requirements, emissions from worker vehicle trips at Hanford and other DOE sites in attainment areas do not factor into the impacts analysis.

Comment (3192)
For low-level waste treatment and disposal under the Decentralized or Regionalized Alternatives, the potential adverse air quality impacts indicate that PGDP is not an appropriate treatment and disposal site.

5.3 Air Quality

Response
As shown in Tables 7.5-2 and 7.5-3 in Volume I, the air quality impacts from waste management operations and maintenance at PGDP are estimated not to exceed applicable standards. The greatest air quality impacts at PGDP would occur during construction, and would result from construction equipment emissions of NO_2. If PGDP were chosen as a treatment or disposal site for low-level waste, proper maintenance and elimination of unnecessary equipment idling could reduce these effects.

Comment (3857)
DOE needs to supply more information about vapor releases and particulate emissions at ANL-E. There could be a problem with particulates drifting through the communities. A resident of Downers Grove Township is concerned about breathing the air downwind of ANL-E, and the effects of contaminated particulates.

Response
The impacts of increased emissions of both criteria and hazardous air pollutants (including radionuclides) are estimated in the WM PEIS, as described in Section 5.4.2 in Volume I and Section C.4.2 in Volume III. The impacts of increased emissions of particulates were also evaluated.

As described in Sections 6.5, 7.5, and 8.5 in Volume I, the WM PEIS analysis finds no major adverse air impacts due to potential waste management actions at ANL-E. Actual waste management facilities would be equipped with the appropriate air pollution control equipment and would be constructed and operated in compliance with all applicable regulations.

Section 11.3 in Volume I describes combined and cumulative impacts at ANL-E. This section states that the radioactive releases from waste management and other future actions would not measurably increase the current levels of risks from radioactive releases. ANL-E would continue to be below the EPA standard of 10 millirems per year to the maximally exposed offsite individual. This section also states that while the expected atmospheric emissions of particulates and ozone-producing contaminants under the alternatives would increase the levels of these emissions, the increases would be below the regulated levels in the nonattainment region.

Comment (4450)
DOE should evaluate hazardous waste and high-level waste in the WM PEIS because hazardous waste and the electricity needed to treat, cool, and store high-level waste generate criteria air pollutants.

Response
The WM PEIS evaluated the impacts of criteria pollutant emissions from fuel burning for heating buildings, from incineration, from construction equipment, and from waste transport vehicle emissions.

The evaluation does not include emissions from the process of treating high-level waste because high-level waste treatment is outside the scope of the WM PEIS. However, to the extent possible, these emissions were considered in the cumulative impacts analysis for the appropriate sites (see Volume I, Chapter 11).

Criteria pollutant emissions from electric power generation were not included because electric power at the sites is supplied by commercial utilities. Indirect impacts from commercial power generation are not evaluated for many of the same reasons that impacts of commercial management of hazardous

waste were not analyzed. DOE assumed that, if power is available from the utility, the utility has taken the appropriate steps to supply the power, including the preparation of environmental permits and impact reports. Impacts to the power generation infrastructure were evaluated in the WM PEIS.

Comment (4455)
DOE's assertion that emissions of hazardous air pollutants, including radionuclides, were estimated to be below applicable standards at every site is inadequate because (1) the standards exclude radon, (2) they do not cover all toxic substances, and (3) the radionuclide standards are extremely loose in terms of the radionuclide exposures allowed (compared to standards that would limit cancer risks from all airborne exposures to less than one in one million, which happens to be a trigger value for reevaluation of regulatory limits for air toxics in the Clean Air Act of 1990). A 10 millirem limit would allow cancer risks of one in one thousand from a lifetime of exposure.

Furthermore, stating in the WM PEIS that emissions from certain alternatives could cause adverse air quality impacts does not provide enough information to understand the nature of the adverse impacts, differences in the probabilities, or degree of impacts among the alternatives. DOE should include details on what the adverse impacts are and how much adverse impact is expected.

Response
The comparison of estimated emissions to applicable standards is an established practice that is common in a variety of site assessment applications, including risk assessments for cleanup and NEPA reviews. The comparison of emission estimates to applicable standards is useful to give the public and decisionmakers a context for judging the significance of potential impacts. Additional details about potential adverse impacts associated with the exceedance of an existing standard would have been considered in the development and promulgation of the standard. The WM PEIS considers potential health and ecological risks associated with airborne releases from waste management facilities in the Health Risks and Ecological Resources Impacts sections of the waste-type chapters.

The air quality analysis evaluates compliance with standards for constituents regulated under air quality statutes. Unregulated constituents do not have emission or concentration limits and, therefore, DOE could not evaluate them for air quality impacts, although it did evaluate these constituents in terms of health risks if appropriate dose conversion or toxicity factors were available. Details about potential air quality impacts are provided in Chapters 6 through 10 in Volume I of the WM PEIS. Any sitewide or project-level NEPA documents would also evaluate air quality impacts.

Comments about the relative degree of protectiveness of existing standards are outside the scope of the WM PEIS.

Comment (4461)
How could transuranic waste be managed so that it would not affect the air quality at most or all sites? Which standards were exceeded at LANL and WIPP for treatment to land disposal restrictions, and by how much? What mitigating measures were considered to prevent such exceedances, and what were their impacts? If mitigation was not evaluated, DOE should evaluate it as part of the WM PEIS.

Response
As described in Section 8.5.3 in Volume I, the standard that DOE predicted transuranic waste treatment could exceed at LANL and WIPP is the 10 mrem per year NESHAP standard. This section also states

that treatment of transuranic waste would require additional control measures to reduce emissions to acceptable levels. Potential mitigation measures that DOE could implement to control or reduce human health risks and environmental impacts at each site are summarized in Chapter 12 in Volume I. These measures would be considered in greater detail in sitewide or project-level NEPA reviews conducted prior to decisions to construct waste management facilities at particular locations at DOE sites. The extent to which risks and impacts can be reduced or eliminated depends on conditions at individual DOE sites.

Treatment of transuranic waste to land disposal restrictions produced the greatest impacts to air quality of the three treatment options evaluated (WIPP waste acceptance criteria, reduced gas generation, and land disposal restrictions) due to the use of thermal treatment (incineration) for volume reduction and destruction of hazardous constituents. Incineration does not destroy radionuclides. The other treatment methods were not predicted to exceed air quality standards.

Comment (4516)
The 10% thresholds used by DOE to determine if air quality impacts could be significant seem to be based on an arbitrary percentage; this is not a well thought out method to reliably screen out insignificant impacts from further analysis.

EPA procedures for determining when detailed air quality impacts analysis is required are in the October 1990 EPA (Draft) *New Source Review Workshop Manual*, and should be used for this purpose instead of the 10% threshold. The draft manual includes guidance on prevention of significant deterioration (PSD) and nonattainment area permitting, and is published by the EPA Office of Air Quality Planning and Standards. Although the manual is labeled a draft, it is the procedure actually being used by EPA and many State agencies.

The manual includes specific procedures for determining when emissions are low enough to not cause significant environmental impacts and require further analysis.

The procedures used in the WM PEIS should be documentably consistent with (or more conservative than) the procedures in applicable EPA regulations and guidelines. The Draft WM PEIS fails to provide an adequate analysis of the reliability of the 10% of threshold procedure for screening out insignificant impacts, without also inappropriately screening out what could be significant impacts.

Response
The analysis in the WM PEIS was performed to obtain a relative comparison of air quality impacts from the various alternatives, rather than to determine compliance or develop operational plans and procedures. Before the approval of any waste management facility, detailed air quality analysis would be performed in which individual criteria air pollutant concentrations from the facility would be calculated for comparison with the National Ambient Air Quality Standards, using approved methods.

Section C.4.2 in Volume III of the WM PEIS describes the methods that DOE used in the air quality impact analysis.

Comment (4542)
In addition to prevention of significant deterioration (PSD) increments, DOE should consider in the WM PEIS limits on impacts in EPA regulations (especially in areas exceeding the standards), along with emission offset requirements.

Response
The air quality analysis in the WM PEIS compared emissions in attainment regions to the PSD increments, and compared emissions in nonattainment regions to general conformity rule *de minimis* levels.

Emission offsets would be evaluated in sitewide or project-level NEPA documents if air quality standards are predicted to be exceeded.

Comment (4543)
DOE should justify the assumption in Section 5.4.2 of the Draft WM PEIS that transportation would not significantly contribute to hazardous air contaminants during routine operations. Drums of hazardous waste are often not properly sealed (rates of improper sealing around 1% have been reported).

Response
Significant emissions of hazardous air pollutants from improperly sealed drums during transport are unlikely. An improper sealing rate of 1% would mean that 1 hazardous waste drum in 100 was improperly sealed. Most drums contain chemicals that are not volatile. In an entire year (fiscal year 1992), only 63 shipments contained chemicals that were poisonous by inhalation (i.e., volatile and toxic). Slow leaks of such chemicals would have very small hazard zones because the leak rates would be very low. The scenario of a leak is more akin to an accidental release scenario, in which the concern is for human health risk and not air quality. The transportation and facility accidents analyzed in the WM PEIS address the impacts of such leaks.

Comment (4549)
DOE should evaluate the impacts of dust, radionuclides, and vapors from material handling and disposal of waste.

Response
According to the resource use estimates prepared to support the WM PEIS, significant quantities of hazardous materials would not be handled as part of the waste management activities. DOE would perform any materials handling that does occur in accordance with Occupational Safety and Health Administration requirements and manufacturer recommendations. Therefore, the air quality impacts of emissions from materials handling are likely to be of lesser significance. Human health impacts from materials handling are evaluated in the health risk section of each waste-type chapter (Chapters 6 through 10) in Volume I.

Fugitive dust would be generated during land clearing. This dust would be minimized by the implementation of standard dust suppression measures. Impacts from fugitive dust would be similar to impacts from commercial activities that involve clearing land (e.g., road construction, construction of housing developments, etc.). These impacts would be site-specific and, therefore, are not appropriate for programmatic decisionmaking.

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Low-level mixed waste would be treated to remove, destroy, or immobilize hazardous constituents before they are sent to the disposal facility. In addition, most low-level mixed waste and low-level waste would be grouted or polymerized before disposal. Therefore, there would be no significant air emissions of radionuclides or hazardous constituents from the disposal facility.

Comment (155)
The assumption made for Hanford that the only significant exposure pathway is through surface water is wrong. The main pathway for exposure is groundwater.

Response
As stated by the commentor, the primary water-borne pathway for the movement of contaminants at Hanford is through groundwater. However, this groundwater eventually discharges to the Columbia River, where exposure to the public can also occur. As described in the Draft and Final WM PEIS in Volume I, Section 5.4.1.3, and Volume III, Appendix D, the primary exposure pathway analyzed for a disposal unit is the groundwater pathway. Health risks were estimated for a hypothetical farm family living 300 meters (984 feet) downgradient from the disposal facility.

Comment (166)
Failure of old storage tanks could be a much worse hazard to streams and groundwater than the incinerator accident that was the focus of the WM PEIS analysis.

Response
DOE assumes that the commentor is concerned about low-level mixed waste or low-level waste storage, since the storage of liquid high-level waste is outside the scope of the WM PEIS, there is little liquid transuranic waste stored at DOE sites, and hazardous waste is accumulated for no more than 90 days before being processed for treatment or disposal.

There are several reasons why storage tank failure was not specifically modeled in the WM PEIS risk analysis. First, as stated in Volume I, Section 6.4.3, the PEIS does not analyze accidents for current waste storage because the maximum waste volumes would accumulate (leading to a maximum potential accidental release) independent of alternatives. Therefore, releases due to storage facility accidents would not help to discriminate among PEIS alternatives. Second, the PEIS addresses the issue of risks due to groundwater contamination in Volume I, Sections 6.4.1.8 and 6.4.1.9. In the groundwater scenario, the likely source for groundwater contamination is failed waste disposal cells. The failure of low-level mixed waste storage tanks (most stored liquid radioactive waste is low-level mixed waste) is a less likely cause of groundwater contamination because low-level mixed waste tanks are typically inside secondary containment structures and are regularly inspected, in accordance with RCRA requirements. Potential environmental impacts from waste storage accidents are provided in sitewide or project-level safety analysis reports or NEPA documentation.

Comment (374)
I am very concerned about what BNL is dumping into the Peconic River right now. Any release of wastes from BNL could "wreak environmental havoc" on the Peconic River and other water resources.

Response
The current conditions at BNL are summarized in Volume I, Section 4.4.2, of the WM PEIS. Additional details are presented in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Section 2.15.2.1 of the WM PEIS Affected Environment Technical Report states that BNL has five National Pollutant Discharge Elimination System (NPDES) permitted outfalls to recharge basins and one NPDES permitted outfall to the Peconic River. Wastewater is discharged at an average rate of 3.8 million liters (1 million gallons) per day. Permit compliance for all NPDES outfalls was 99.9% in

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1991. Discharges to the Peconic River met all radioactive discharge limits. Only iron, pH, and 1,1,1-trichloroethane exceeded permit limits on a few occasions.

More recently, in 1995 BNL implemented a new State Pollutant Discharge Elimination System (SPDES) Permit that provides for additional monitoring and more stringent discharge standards. During 1995, BNL's compliance record was similar to that of 1991. They exceeded their permit requirements on several occasions. The majority of these exceedances were due to failure to reduce biological oxygen demand and total suspended solids by 85%. The effluent concentrations of these parameters complied with discharge standards. This was a result of the dilute nature of BNL's sewage influent to their sewage treatment plant. The new SPDES Permit reduced the silver limit from 50 micrograms per liter to 15 micrograms per liter. Two exceedances of the silver limitation occurred in March 1995 (17 micrograms per liter) and November 1995 (15.2 micrograms per liter). BNL has taken actions to reduce silver bearing wastes by replacing photo-developing operations in two buildings with digital photographic equipment.

In addition to outfall monitoring, the Peconic River is monitored for radioactive and nonradioactive parameters at three onsite and four offsite locations. Carmans River is also sampled as a background location. In 1991, all radionuclide concentrations were within applicable limits and did not exceed 10% of the State and Federal Drinking Water Standards. All nonradioactive analyses were consistent with the offsite control location and with historical data except for toluene, 1,1,1-trichloroethane, and xylene. The exceedances for toluene and xylene are probably associated with a non-BNL source.

So far as new waste management facility discharges are concerned, DOE did not attempt to evaluate the potential effects of waste management facility effluents on surface water quality and aquatic ecosystems at any site in the WM PEIS because any credible analysis would require knowing exactly where on the site the waste management facilities would be located and where effluents would discharge, and the specific locations of the facilities are not being determined in the PEIS. Sitewide and project-level NEPA reviews would address the potential for those effects.

Comment (410)
It is not acceptable to me or my family that drinking water could be contaminated with radioactive waste.

Response
DOE agrees that contamination of drinking water resulting from WM PEIS decisions would be unacceptable. DOE would construct and operate its proposed waste management facilities in compliance with applicable regulations, minimizing the potential for contamination. Before disposing of these wastes at any site, DOE would perform detailed sitewide or project-level NEPA analyses of potential effects of disposal to human health and the environment.

Comment (1323)
The protection of water resources is of great importance. Groundwater impacts need to be considered in the WM PEIS.

Response
The environmental impacts described in this PEIS address the range of natural and human resource issues pertinent to the alternatives under consideration in this PEIS. This includes evaluating impacts to water resources.

Impacts evaluated for water resources include impacts on water availability due to water use and wastewater discharge from managing low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste and impacts from disposal of low-level mixed waste and low-level waste on groundwater quality. The WM PEIS evaluates impacts to groundwater quality caused by the migration of radionuclides and other hazardous chemicals that could leach from disposal facilities over time. The PEIS employed several analytical models to gauge the impacts on groundwater at a hypothetical well 300 meters (984 feet) from the center of the disposal facility. Estimated concentrations of groundwater contamination generated by the models were then compared to standards for drinking water. Section 5.4.3 in Volume I and Section C.4.3.4 in Volume III also provide a qualitative discussion of other potential impacts to water resources.

The Final WM PEIS has been revised to incorporate air analysis of the potential for collective risk from waste disposal. Section 5.4.1.2.3 in Volume I of the WM PEIS describes the methodology used in the analysis, which involves consideration of a number of site-specific parameters. The results of this risk vulnerability screening analysis for low-level mixed waste and low-level waste disposal are presented in Volume I, Sections 6.4.1.9 and 7.4.1.8, respectively.

Comment (1822)
We have no comments or concerns for water quality impacts in relation to the generalities of this project; however, a more detailed EIS addressing the specific impacts to the Norfolk Naval Shipyard would allow for specific comments.

Response
If the decisions described in the WM PEIS Record of Decision would substantially change the way low-level mixed waste is managed at the Norfolk Naval Shipyard, additional NEPA reviews would be necessary. Site-specific water quality issues would be considered during such reviews.

Comment (2528)
Volume I, Section 5.4.3.3, states, "Process waste waters from waste treatment facilities would be discharged to existing wastewater treatment facilities, where possible." This sentence doesn't make sense.

Response
DOE revised the sentence in Section 5.4.3.3 in Volume I to state that aqueous wastes from the waste treatment facilities would be conveyed to existing wastewater treatment facilities, where possible.

Comment (2864)
The WM PEIS must do more than identify sole-source aquifers. It must discuss in greater detail the potential impact on such aquifers. State designations of wild and scenic rivers also should be included.

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Response
The water quality analysis in the WM PEIS compares predicted contaminant concentrations from waste disposal to drinking water standards or their equivalent. This is a conservative approach and is done regardless of whether the groundwater is a current or potential source of drinking water. Comparison to drinking water standards would be protective of sole-source aquifers, since EPA guidance requires that contamination in a sole-source aquifer not exceed drinking water standards. In any event, if disposal over a sole-source aquifer is required, DOE would meet all requirements for such disposal.

DOE would conduct sitewide or project-level NEPA reviews before constructing any disposal facility. In addition, a detailed disposal performance assessment would be prepared that would evaluate the performance of the disposal facilities over time, and would assist DOE in complying with all applicable regulations, including those pertaining to waste disposal over a sole-source aquifer.

State designations of wild and scenic rivers were included in the WM PEIS analysis.

Comment (2940)
The logic that since groundwater is used as the source of water and, therefore, surface water resources are not affected, is flawed. Volume I, Section 5.4.3, states that groundwater is used as the source of water supply at BNL and, therefore, surface water resources would not be affected by water withdrawals at this site. Using groundwater as a source of water can indeed influence surface-water bodies, where the aquifer(s) in question are shallow (as at BNL). Many of the surface waters on Long Island are groundwater fed and significant drawdown of the water table by pumping operations for public water supply, sewage treatment, and other purposes has in many cases resulted in the drying of streambeds or the alteration of streamflow. In addition, due to the nature of the Snake River Plain Aquifer, with discharge from the aquifer forming a major source of water in the Snake River at points in the south-central portion of Idaho below Milner Dam, any and all groundwater usage at INEL results in some impact to surface waters. Since surface water and groundwater are interconnected, explain how any action that affects one would not affect the other. This impact might or might not be small, but it should not be disregarded.

Response
Section 5.4.3 in Volume I of the WM PEIS lists several assumptions used in evaluating potential impacts to water resources. These assumptions include the relationships of surface water and groundwater withdrawals at various sites for water use requirements. Although it is true that at many sites surface water and groundwater are interconnected, impacts to groundwater resources are likely to be small as a result of surface water withdrawals at these sites, and vice versa. The text in question was revised to recognize the interconnection of the groundwater and surface water resources.

The WM PEIS Environmental and Socioeconomic Impacts Methods and Results Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS, provides more information on potential impacts to water resources at the sites.

Comment (2950)
Without a complete discussion of the "hypothetical" technologies involved, the veracity of the water resources analysis is impossible to ascertain.

Response
The generic technologies used in the WM PEIS analysis of impacts from waste management activities are described in a series of technical reports. These technical reports are listed in Section 15.2 in Volume I, and are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2951)
At BNL, it is becoming more apparent that discharges to the Peconic River, a discharging stream at many times and for some distance beyond the site boundaries, has caused a portion of the site's environmental contamination. Because a stream or river has the potential for much quicker transport than groundwater, with concurrently much less degradation of radionuclides or organics, it seems reckless to so readily discount this mode of transport (given at least one site with high groundwater where stream transport has caused environmental contamination beyond the site boundaries).

Response
Section 5.4.3 in Volume I of the WM PEIS states that seepage of contaminated groundwater from disposal facilities could contaminate surface water. This would be expected to occur at sites with shallow groundwater, and surface water bodies that are fed by groundwater discharge (springs). Where contaminated groundwater discharges to the surface, dilution in "clean" surface waters would cause concentrations of contaminants in surface water to be lower than concentrations in groundwater. Therefore, the groundwater pathway was assumed to be the major pathway for movement of contaminants beyond the disposal facility boundary, and was the pathway that was examined in detail.

The analysis was performed using a hypothetical well located 300 meters (984 feet) downgradient from the center of the disposal facility. Since the 300-meter well would be located between the disposal unit and any surface water discharge point, contaminants would reach the well in less time and at higher concentrations than at a surface water spring. Therefore, a farm family using groundwater from the 300-meter well would have a greater risk of adverse health effects than a family using surface water.

Section 5.4.3 in Volume I and Section C.4.3.4.10 in Volume III have been revised to provide a more detailed discussion of the potential vulnerability of sites to surface water impacts from waste management actions. DOE believes that because specific locations of waste management facilities on the sites will not be selected based on the WM PEIS, a detailed surface water quality analysis is more appropriate in sitewide or project-level NEPA reviews.

Comment (2980)
As construction activities for a sewage treatment plant upgrade at BNL have called for the dewatering of over 1 million gallons per day of organics and tritium contaminated groundwater, the WM PEIS analysis does not fully anticipate all possible water resource impacts from construction activities. Section 5.4.3 and Tables 6.6-1 and 7.6-1 and underlying analyses should be adjusted for possible dewatering activities.

Response
BNL no longer plans to conduct dewatering for construction of improvements at the sewage treatment plant. Note, however, that the quality of the water that would have been discharged by dewatering would have met all applicable effluent quality standards.

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Comment (3106)
The fifth assumption in Section C.4.3.3 (fifth bullet) is not valid for the Hanford Site because (1) existing sanitary treatment plants do not have the capacity to treat additional sanitary waste; (2) existing process treatment plants might not be able to treat the wastewater generated by these treatment facilities; and (3) State regulations are not considered.

Response
The WM PEIS does not include sanitary wastewater treatment capability in the waste management facilities that could be constructed at each site. Therefore, it was assumed that sanitary wastes would be discharged to existing treatment facilities. Impacts to sanitary wastewater treatment plants at the sites are evaluated in Volume I, Sections 6.12, 7.12, 8.12, 9.12, and 10.12. These sections note that Hanford has little excess wastewater treatment capacity.

The WM PEIS assumes that additional process wastewater treatment capability will be included in the waste management facilities that could be constructed at each site such that effluent will comply with all applicable Federal and State regulations. Existing sanitary or process wastewater treatment facilities will be used if capacity is available.

This clarification of the WM PEIS treatment of sanitary wastewater plants and process wastewater plants was added to Section C.4.3.3 in Volume III.

Comment (3107)
The eighth and tenth assumptions in Section C.4.3.3 suggest that wastewaters would not be discharged to surface water or groundwater. However, since the construction of evaporation facilities is not mentioned, it appears these discharges were inadvertently ignored.

Response
DOE corrected Section C.4.3.3 in Volume III to say that surface water resources would not be affected by effluent discharges at Hanford, INEL, LANL, LLNL Site-300, NTS, Pantex, or WIPP, because generally, wastewaters are discharged to dry stream beds or man-made ponds, and not to natural-flowing surface water bodies.

Comment (3109)
State regulations on the discharge of process wastewater differ, and should be evaluated and considered.

Response
DOE will comply with all applicable State standards at sites, once these sites are selected. DOE did not evaluate the impacts of wastewater discharges on surface water resources. Section 5.4.3 in Volume I and Section C.4.3.4.10 in Volume III have been revised to provide more detailed discussions of the potential vulnerability of sites to surface water impacts from waste management actions. DOE believes that because specific locations of waste management facilities on the sites will not be selected based on the WM PEIS, a detailed surface water quality analysis is more appropriate in sitewide or project-level NEPA reviews.

Comment (3345)
Water contamination constitutes irreparable damage unless DOE can prove that the water can be made pure and clean again.

Response
DOE will comply with all applicable regulations for waste management including DOE Orders that require that releases be maintained as-low-as reasonably achievable (ALARA). This will help to ensure that significant impacts to water quality do not occur.

As described in Chapter 12, if any adverse impacts do occur, mitigation measures can be used to reduce impacts to water quality. The measures could include (1) changing the engineering design to increase recycle and reuse of water within the facility (e.g., zero discharge facility design), (2) limiting the disposal of problem isotopes or storing waste containing problem isotopes until radioactive decay decreases their concentrations, (3) changing the waste form (e.g., vitrification) to reduce leaching, and (4) changing disposal facility design to provide greater isolation.

Also, as described in Appendix H, DOE is involved in the development of advanced technologies that could further reduce emissions to the environment, and facilitate cleanup of accidental releases. DOE expects that future technological breakthroughs will reduce emissions from waste management activities.

Comment (3593)
Nowhere in the WM PEIS are exact calculations on current surface water quality or groundwater quality at the sites stated--a pertinent and vital aspect of evaluating special exposure pathways with respect to subsistence consumption of fish, game, or native plants. We have only found general statements on surface water and groundwater contamination (e.g., Chapter 4) Also, potential impacts on groundwater in the WM PEIS focus more on "availability" not adequately on quality or impacts from regulated and unregulated releases. We feel DOE has avoided fully assessing and documenting such impacts and calculations on both groundwater and surface water because publication of such figures would lead to self-implication of just how out of compliance DOE is under the applicable statutory laws and regulations.

These figures must be fully assessed and documented in order to make informed decisions in regards to any and all aspects of "waste management" of DOE's nuclear and hazardous materials inventory and future inventories. Avoidance of fully assessing the current state of a primary media--water--and potential impacts, would be blatant noncompliance with the purposes and regulations of NEPA. "Assumptions" of current water quality are not acceptable and both surface water and groundwater must be determined before any commitment of resources.

Response
In the WM PEIS, DOE did not specifically address impacts to aquatic life or to subsistence fishermen and hunters at the sites because of the array of assumptions that would have to be made about site-specific variables involved in such an analysis and because the analysis would require identifying specific locations of proposed waste management facilities on sites, which is not part of the programmatic decisionmaking. Sitewide and project-level NEPA reviews would be the appropriate context for this type of analysis. Further, based on the programmatic analysis of land requirements at the sites to implement any of the waste management alternatives, DOE believes it will have sufficient

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flexibility to avoid or minimize any environmental or human health impacts, including any potentially disproportionate high and adverse impacts to Native Americans, minorities, or low-income populations, through selection of different waste management technologies or facility location.

Due to the programmatic nature of this study and in order to facilitate the comparison among potential programmatic sites, the WM PEIS water resources analysis is generic in character. The methodology pertaining to water quality impacts from disposal of low-level mixed waste and low-level waste is provided in Section 5.4.3.2 in Volume I.

Groundwater quality could be affected in the future if there is a loss of institutional control at disposal sites and subsequent deterioration of disposal facility integrity. Contaminants could then leach into groundwater. DOE analyzed this possible effect used the modeling for the human health risk assessment. The transport and fate of disposed radionuclides, and hazardous constituents were estimated using the Disposal Unit Source Term (DUST) and Multimedia Environment Pollutant Assessment System (MEPAS) models that tracked the contaminants as they moved from the disposal location to the point of exposure for a hypothetical farm family drawing water from a well 300 meters (984 feet) downgradient of the center of the disposal facility. DOE will further evaluate the performance of disposal facilities at each site in detail through DOE's performance assessment process. If significant groundwater contamination were predicted by the performance assessment process, changes in the waste acceptance criteria would be made to limit disposal of the waste predicted to cause the significant groundwater contamination. The waste would require further treatment prior to disposal, would be disposed of at another DOE site where the waste meets the waste acceptance criteria, or would be stored until a method was found to treat or dispose of the waste.

While the primary water-related impacts from waste management activities are likely to be through groundwater, nevertheless, there might be sites at which waste management activities could cause surface water impacts. Based on a comparison of selected environmental data at the sites, the vulnerability of the sites to surface-water impacts was estimated. These data include (1) precipitation; (2) the characteristics of major surface-water bodies near the site such as distance to the site and flow rate; (3) the presence of groundwater discharge to surface-water bodies near the site; and (4) the presence of nearby surface-water supply intakes downstream from the site. This vulnerability is found in Section C.4.3.4.10 in Volume III. Impacts on surface-water resources and drinking-water supplies would be examined in more detail after the waste management facility locations on the sites are selected.

Chapter 4 of the WM PEIS provides information to characterize the pertinent environmental conditions (including water resources) at sites potentially affected by implementation of the various waste management alternatives. Additional information is provided in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (4451)
Water quality criteria and air pollution from groundwater are pertinent to groundwater if the groundwater is brought to the surface and used for irrigation. Compliance issues and the environmental impacts of such groundwater usage should be included in the WM PEIS.

5.4 Water Resources

Response
Drinking water criteria were used to evaluate the impacts of concentrations of radionuclides and chemicals in groundwater used as a source of drinking water. The hypothetical farm family scenario also considers the use of groundwater contaminated from waste disposal for irrigation. However, the impacts of groundwater used for irrigation or groundwater recharge to surface water on surface water quality were not evaluated. Air quality impacts due to emissions of hazardous air pollutants during groundwater use also were not evaluated. DOE believes that the contributions of irrigation water from a single farm to adverse air quality would be negligible.

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Comment (179)
Because Site 300 is at a higher elevation than the City of Tracy and the area is subject to significant seismic activity, there is a strong concern that storage containers could leak and contaminate the aquifer that supplies the City's drinking water. A water shortage could result if the City of Tracy's aquifer becomes contaminated by wastes stored at Site 300. DOE should be aware that the City of Tracy has three high-capacity water wells that are located approximately 3 miles from Site 300.

Response
As described in Sections 6.3.5 and 7.3.5 in Volume I of the WM PEIS, DOE selected 16 candidate low-level mixed waste and low-level waste disposal sites for evaluation based on a screening it performed to be consistent with the States under the Federal Facility Compliance Act. The screening applied three exclusionary criteria, one of which was that the waste disposal facility could not be within 200 feet of a seismic fault. Section 4.4.6 in Volume I does mention major earthquake faults in the LLNL area. A supporting document, the WM PEIS Affected Environment Technical Report, contains more detailed information on seismic activity near LLNL. This report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Appendix F in Volume IV of the PEIS describes the accident scenarios caused by seismic events (earthquakes) at the sites during which exposure to chemical or radiological constituents of the waste could occur. Facility accident results for low-level mixed waste are presented in Volume I, Sections 6.4.3 (low-level mixed waste), 7.4.3 (low-level waste), and 8.4.3 (transuranic water). Additional information on accident scenarios and health risks from accidents initiated by earthquakes is provided in Appendix F (Volume IV) and Appendix D, (Volume III) respectively. Thus, DOE decisionmakers have information in the PEIS to account for seismic activity in the vicinity of LLNL when deciding on the preferred alternative.

Wastes would be managed in compliance with all regulatory requirements. Any waste storage facility located at LLNL would be built with sufficient containment and would be carefully monitored. In addition, no liquid low-level mixed waste or low-level waste would be disposed of. Under normal operations, wastes would not come in contact with surface water, groundwater, or soils. Spilled wastes would be cleaned up in accordance with all applicable regulations. Furthermore, LLNL would be equipped with sufficient safety and emergency response capabilities to minimize the potential for leaks to contaminate surface water and groundwater.

The potential for a mixed waste facility at Site 300 to cause contamination of the water-supply aquifer tapped by the Tracy municipal water supply wells is extremely remote. The municipal water supply wells in Tracy tap water within the Tulare Formation. This unit is absent from Site 300. Groundwater below Site 300 occurs in the Neroly and Cierbo Formations. These units, where present below Tracy, are significantly deeper than the overlying Tulare Formation. There appears to be no subsurface pathway for pollutants in groundwater at Site 300 to enter the Tulare Formation, and from there the Tracy wells. In addition, the Tracy municipal water supply wells are 3 to 5 miles from Site 300. Pollutants would be appreciably attenuated in transport. Also, all surface water at Site 300 drains to Corral Hollow Creek. This creek ultimately drains to the San Joaquin River in the south Tracy area. The creek flows intermittently and only along certain parts of its length; it has little to no baseflow. Therefore, surface water is unlikely to be a major pathway for contamination to reach the Tracy water supply wells.

5.4.1 Groundwater

Sections 6.6.2 and 7.6.2 in Volume I of the WM PEIS showed that hypothetical leaks of wastes from disposal units at LLNL would present a low-risk to users of groundwater, even those who use water from a hypothetical well 300 meters (984 feet) immediately downgradient from the center of the disposal facility.

If DOE selected a particular site for a new waste treatment, storage, or disposal facility as a result of the WM PEIS analysis, it would prepare additional sitewide or project-level NEPA reviews. The specific design basis and exact location of the waste management facility would be identified in that document, which would consider potential earthquake impacts. DOE would design, construct, operate, and maintain waste management facilities in accordance with appropriate local seismic standards.

Comment (577)
Nuclear waste storage could contaminate the sole-source aquifer that supplies drinking water to residents around BNL. Contamination of the drinking water would increase the already high incidence of breast cancer on Long Island.

Response
The WM PEIS evaluates impacts to groundwater quality caused by the migration of radionuclides and other hazardous chemicals that could leach from low-level waste and low-level mixed waste disposal facilities over time. The PEIS employed several analytical models to gauge the impacts on groundwater at a hypothetical well 300 meters (984 feet) from the center of the disposal facility. Estimated concentrations of groundwater contamination generated by the models were then compared to standards for drinking water.

As described in Sections 6.6.2 and 7.6.2 in Volume I, the WM PEIS water quality analysis indicated that disposal of low-level mixed waste and low-level waste at BNL would not cause groundwater concentrations to exceed drinking water standards that were used as an indication of acceptable groundwater quality. This was true of all waste management alternatives studied.

Note that the WM PEIS health risk analysis considers site baseline risk only as a component of cumulative impacts. In Chapter 11 (Volume I of the WM PEIS), baseline risk is considered as the potential effect of existing site-related actions on population exposure and risk. The analysis does not include regional epidemiological or health statistics information, such as the rate of cancer incidence on Long Island. The estimated risks of the proposed waste management actions at BNL must be considered as excess latent cancer incidence or fatality risks that would be added to the existing baseline. The estimated incremental risks from the disposal of low-level mixed waste and low-level waste at BNL are presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I, respectively.

The potential relationship between cancer rates on Long Island and BNL site activities is currently under independent investigation by a number of local organizations through funding provided by the National Cancer Institute. In addition, Suffolk County has named an independent group to analyze the influence of BNL actions on public health in communities surrounding the site.

Any new disposal facility at BNL would be designed and located in accordance with all applicable regulations. In addition, best management practices for stormwater management would be implemented to ensure that significant quantities of potentially contaminated runoff would not reach the river. DOE would perform sitewide or project-level NEPA reviews before constructing any disposal

5.4.1 Groundwater

facility. In addition, a detailed disposal performance assessment would be prepared that would evaluate the performance of the disposal facilities over time, and would assist DOE in complying with all applicable regulations, including those pertaining to waste disposal over a sole-source aquifer.

Comment (1556)
Table II-9.2-10 lists radioactive concentrations in groundwater for disposal at NTS. The table does not list tritium.

Response
Tritium was included as a component of the waste that DOE assumed would be disposed of at NTS. As discussed in Section 5.4.3.2 in Volume I of the WM PEIS, DOE evaluated impacts to groundwater quality caused by the migration of radionuclides that leach from disposal facilities over time. DOE calculated concentrations of radionuclides at a hypothetical groundwater well 300 meters (984 feet) from the center of the disposal facility. The analysis accounted for radioactive decay during the time period between disposing of the wastes and loss of containment. Radionuclides such as tritium with short half-lives would tend to decay to acceptable levels before they reached the hypothetical well. Radionuclide concentrations in the groundwater were then compared to DOE or EPA drinking water standards. Table II-9.2-10 in Volume II does not list tritium because this nuclide would not be present at the hypothetical well. In fact, because of the very low infiltration rates at NTS, no contaminant would be present above acceptable levels.

Comment (1727)
Since groundwater can be a pathway for exposure to contaminants, RFETS, which has a high water table, is a poor site for disposal activities.

Response
As described in Section D.3.2.2 in Volume III of the WM PEIS, for all disposal scenarios, it is assumed that shallow land burial will be used at installations west of the Mississippi River and tumulus (aboveground vault) disposal will be used at eastern installations. The exceptions are RFETS, which disposes in tumulus vaults, and SRS, which disposes in belowground vaults. Aboveground disposal was assumed at RFETS after consideration of the high water table at the site.

As described in Sections 6.6.2 and 7.6.2 in Volume I, the WM PEIS water quality analysis indicated that disposal of low-level mixed waste and low-level waste at RFETS would not cause groundwater concentrations of radionuclides to exceed or even approach drinking water standards that were used as an indication of acceptable groundwater quality. This was true of all waste management alternatives studied. Groundwater concentrations of hazardous constituents could exceed drinking water standards under the Decentralized Alternative and Regionalized Alternative 1 for low-level mixed waste.

DOE, would conduct detailed performance assessments of disposal units before disposing of low-level mixed waste or low-level waste at RFETS. Potential spills or accidental leakages would be minimized by incorporating the following options into the decisionmaking process: modifying the design of generic disposal facilities (used in the PEIS analysis) to fit site-specific conditions; modifying waste form requirements; optimizing the location of a facility on the site; and imposing waste acceptance criteria.

5.4.1 Groundwater

Comment (1746)
Expand Tables 6.6-3 and 6.6-4 to identify, for each radionuclide in the tables, whether the standard for a particular radionuclide exceeds a DOE Derived Concentration Guideline or exceeds gross alpha or gross beta limits of the Safe Drinking Water Act.

Response
To improve their readability, the tables in Chapters 6 and 7 in Volume I of the WM PEIS do not contain information about specific drinking water standards. However, this information is included in Volume III, Section C.4.3.5, which describes the methods used to assess water quality impacts. Footnotes to the tables in Chapters 6 and 7 in Volume I refer to Appendix C in Volume III for a description of the drinking water standards.

Comment (2064)
The WM PEIS is incomplete in its discussion of water quality issues. Chapter 5 notes that only water quality impacts violating greater than 25% of the applicable standards were analyzed in more detail. The WM PEIS goes on to note that given the 400% uncertainty associated with modeling groundwater impacts, all 25% or greater effects could exceed the standards. This would seem to call for additional discussion of what is a reasonable estimate of the potential for impacts to exceed applicable standards and under what conditions this might occur.

Response
To focus the water quality impacts presentations in Volume I, Chapters 6 and 7, on potentially significant effects, DOE chose a 25%-of-comparison criteria to highlight sites where waste disposal could result in adverse water quality impacts. The 25% threshold reduced the large number of analyses shown in the Site Data Tables (see Volume II) to a manageable number for presentation in Chapters 6 and 7. Levels greater than or equal to 1% of the comparison criteria are listed in the Site Data Tables. The analysis is further focused because the accompanying text discusses primarily the impacts of concentrations that approach or exceed the water quality criteria.

Section D.4.2 in Volume III describes the uncertainties associated with groundwater transport of contaminants from disposal sites to the water well used by the hypothetical farm family. DOE has revised Section D.4.2.1, which now states that the most reasonable estimate of the uncertainty in the risk predictions in the PEIS for the disposal sites was expected to be approximately one to two orders of magnitude. DOE revised Volume III, Section C.4.3.5, and Volume I, Section 5.4, to remove the incorrect reference to the uncertainty of 400%.

Comment (2449)
Potential impacts on the Snake River Plain Aquifer should be considered in discriminating between alternatives. If there are ongoing activities that contribute to groundwater contamination, they should be included in the WM PEIS. If there are no ongoing activities contributing to groundwater contamination, that fact should be stated to alleviate concerns related to groundwater contamination.

Response
Existing environmental conditions at INEL are summarized in Section 4.4.5 in Volume I the WM PEIS. Additional detail about the affected environment at INEL is presented in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in

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Section 1.9 in Volume I of the Final WM PEIS. Also see the SNF/INEL PEIS for detailed information on groundwater contamination at INEL.

Potential impacts of the waste management alternatives on the Snake River Plain Aquifer are evaluated in the water resources impacts sections of the WM PEIS. These include Sections 6.6, 7.6, 8.6, 9.6 and 10.6 in Volume I.

The cumulative impacts of waste management actions when added to past, present, and reasonably foreseeable future actions are presented in Section 11.7 in Volume I. DOE added a description of potential cumulative impacts to groundwater quality to Chapter 11 of the Final WM PEIS.

The DOE Workgroup that is responding to Defense Nuclear Facilities Safety Board Recommendation 94-2 is moving forward with plans to revise DOE performance assessments for radioactive waste disposal sites to include existing contamination and ongoing activities that contribute to groundwater contamination.

Comment (2537)
Referring to Volume I, Section 6.6.2, a commentor asked, "Why are treatment and disposal assumed in the analysis that do not meet EPA standards and so will not be used in practice?"

Response
Any new DOE waste treatment and disposal facilities will meet all regulatory requirements. In fact, the generic waste treatment, storage, and disposal facilities assumed for the WM PEIS were modeled after existing facilities that meet all regulatory requirements. Conservative assumptions about the performance of these facilities and their treatment and disposal processes, along with conservative environmental transport and fate modeling, produced results in the WM PEIS that tend to overestimate impacts.

Volume I, Section 6.6.2.2, explains that the modeled concentrations of hazardous constituents in the groundwater from disposal of low-level mixed waste are largely due to assumptions on the routing of wastes through the treatment system. As shown in the low-level mixed waste flow diagram (Figure 6.2-1), some wastes containing solvents were assumed to bypass the thermal treatment processes. It was also assumed that the solvents in these wastes were not destroyed, but instead, ended up in the disposal facility. Some of these wastes contain solvents in large enough concentrations to cause problems when they are disposed of. In this case, therefore, the routing of waste would cause the problem and not whether the treatment or disposal facilities meet regulatory requirements.

Comment (2562)
One might conclude from the discussion in Volume III, Section C.4.3.2, that it is okay to contaminate groundwater up to the drinking water standards. *Any* contamination of the groundwater is unacceptable, although it may be unavoidable. What the authors may have intended to say is that contaminants *below* the drinking water standards present a low risk to health. Contamination at the drinking water standard is at the threshold where an unacceptable risk to health is present.

Response
DOE changed the referenced sentence in Section C.4.3.2 to say that since the drinking water standards adequately protect human health, concentrations of contaminants in groundwater at or below these levels present a low risk to health.

Comment (2564)
In Volume II, Table II-6.1-13, it is assumed that during normal waste storage operations no water would be allowed to come in contact with the wastes and, that during normal waste treatment operations, no direct releases to groundwater would occur. Then what would be the source for the seepage of contaminated groundwater mentioned in Volume III, Section C.4.3.3, and what would be the source for the contaminants identified at 80 to 100% of drinking water standards in Table II-6.1-13? Groundwaters contaminated to 80 to 100% of the drinking water standard are not acceptable. What are these values based on?

Response
Table II-6.1-13 in Volume II of the WM PEIS is titled "INEL-LLMW - Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)." The contaminants originated from disposal of low-level mixed waste at INEL. Revised analyses performed for the Final WM PEIS show no values greater than 10% of the drinking water standard from low-level mixed waste disposal at INEL.

In addition, Section 6.6.2.2 in Volume I states that the modeled concentrations of hazardous constituents in the groundwater from disposal of low-level mixed waste are largely due to assumptions on the routing of wastes through the treatment system. As shown in the low-level mixed waste flow diagram (Figure 6.2-1), some wastes containing solvents were assumed to bypass the thermal treatment processes. It was further assumed that the solvents in these wastes were not destroyed, but instead, ended up in the disposal facility. Some of these wastes contain solvents in large enough concentrations to cause problems when disposed of. In practice, low-level mixed waste to be disposed of would meet EPA standards for treatment and disposal and, therefore, should not produce major impacts to groundwater quality.

Treatment and storage of wastes would not be expected to affect groundwater quality. Only disposal would be expected to affect groundwater in a localized area beneath the disposal unit. The release of contaminants from the disposal unit could occur in the future as the disposal units degrade.

Comment (2935)
Referring to Volume I, Section 5.4, a commentor stated, "absent a discussion of appropriate technologies, the reasonableness of DOE's analysis of leachate quality and subsequent downgradient water quality is impossible to check."

Response
Section 5.4.3 in Volume I of the WM PEIS presents a summary of information on the groundwater quality methodology. More detailed information is presented in Section C.4.3 in Volume III. The groundwater quality information was obtained as an offshoot of the health risk analysis. Therefore, detailed information on the conduct of the modeling is presented in Appendix D in Volume III and the WM PEIS human health risk technical reports. Supporting technical reports are listed in Section 15.2

5.4.1 Groundwater

in Volume I and are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2944)
Given the operating record of DOE sites to date, it does not seem necessary to wait for a loss of institutional control for the development of facility deterioration and the onset of impacts to groundwater. Does DOE have specific guarantees that facilities will be operated more responsibly? Will DOE defend the past 10 years of operating history at BNL without reservations, for example? The past 5 years?

Response
DOE waste management facilities will be constructed, operated, maintained, and closed in compliance with all applicable regulatory requirements. This includes requirements of the Atomic Energy Act for radioactive wastes, and the Resource Conservation and Recovery Act and/or Toxic Substances Control Act for hazardous wastes.

As described in Section 6.2.3 in Volume I, two types of disposal were analyzed in the WM PEIS: engineered disposal and shallow land burial. However, when disposing of small quantities of waste (i.e., less than 700 cubic meters per year), aboveground silos were assumed. All of the of low-level mixed waste disposal facilities assumed in the PEIS were designed to meet all applicable RCRA disposal requirements.

The PEIS evaluated above-grade engineered disposal at BNL. These types of facilities utilize concrete to maintain facility integrity. As described in Section 6.4.1.2 in Volume I, DOE assumed that above-grade engineered disposal facility integrity would be maintained for 300 years. Although leakage from the disposal facility could occur prior to closure, as stated in Section C.4.3.5 in Volume III of the PEIS, impacts from leakage during operations and institutional control are unlikely because leachate and groundwater monitoring are likely to detect any leak before significant degradation of groundwater quality could occur.

DOE is committed to remediating environmental impacts from past operations at BNL. Information on environmental restoration activities at BNL can be obtained by contacting BNL's Office of Environmental Restoration.

DOE is also committed to assuring that the operation of BNL is conducted in a manner that is protective of public health and the environment. Providing funding for infrastructure maintenance, requiring that all operations have appropriate environmental permits, and analyzing the potential environmental impacts of proposed actions, such as those covered by this PEIS, are examples of DOE's commitment.

Comment (2981)
In Volume I, Sections 5.4.3, 6.6.2, and 7.6.2, the assumption that no releases will occur pre-closure, and that groundwater flow is insufficient to transport radionuclides 300 meters before large attenuation of radioactive rates occur is not well supported. Releases of radionuclides have been common at BNL prior to closure of facilities, and groundwater has been estimated to transport particles 300 meters in as little as 3 to 4 years on Long Island. This should be acknowledged as another site-specific element tending to make BNL less favorable for disposal activities.

Response
As stated in Section 6.2.3, two types of disposal were analyzed in the WM PEIS: engineered disposal and shallow land burial. However, when disposing of small quantities of waste (i.e., less than 700 cubic meters per year), aboveground silos were assumed. All of the low-level mixed waste disposal facilities would be designed to meet all applicable RCRA disposal requirements.

The PEIS evaluated aboveground engineered disposal at BNL. These types of facilities utilize concrete to maintain facility integrity. As described in Section 6.4.1.2, the PEIS assumed that aboveground engineered disposal facility integrity would be maintained for 300 years. Although leakage from the disposal facility might occur prior to closure, as stated in Section C.4.3.5 (in Volume III, impacts from leakage during operations and institutional control are unlikely, since leachate and groundwater monitoring are likely to detect the leak before significant degradation of groundwater quality could occur.

In addition, the radioactive decay discussed in the WM PEIS occurs in two places: within the disposal unit, and during transport through the groundwater. The PEIS assumes that the disposal unit would remain intact for 300 years. Therefore, most of the radioactive decay would occur while the wastes are confined to the disposal unit, rather than during transport through the groundwater. As stated in Section 6.6.2 in Volume I, disposal of contact-handled low-level mixed waste at BNL would not result in exceedance of 25% of the drinking water standard for radionuclides or hazardous constituents.

Comment (2983)
A commentor is "uncomfortable" with the apparent degree of certainty expressed concerning the release of organic contaminants to the environment. Not enough information has been provided to independently verify the WM PEIS conclusions and estimates. The necessity for many assumptions in any such analysis renders the analysis "little better than an educated guess gussied up by a great many essentially meaningless equations." The commentor stated that, nonetheless, the results reported here in Table 6.6-5 support the commentor's position that BNL is an inappropriate site for disposal of radioactive and/or hazardous wastes. The WM PEIS guesses that BNL will exceed drinking water standards for several organic compounds in any release scenario. BNL's sensitive location in the Deep Recharge Zone for sole-source aquifers, its sensitive location in a protected ecosystem, and the large population in the BNL region of influence reinforces the necessity for avoiding including BNL in any disposal plan.

Response
Summary information on the groundwater quality methodology is presented in Section 5.4.3.2 in Volume I of the WM PEIS. More detailed information is presented in Section C.4.3.5 in Volume III. The groundwater quality information was obtained as an offshoot of the health risk analysis. Therefore, detailed information on the conduct of the modeling is presented in Appendix D in Volume III and in the WM PEIS human health risk technical reports. The technical reports are listed in Section 15.2 in Volume I and are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The WM PEIS used generally accepted, verified models for leaching and groundwater transport. The methods used in the PEIS were reviewed before being implemented. Note that most DOE sites had modeled exceedances of drinking water standards for hazardous constituents in the Draft PEIS. As explained in Section 6.6.2.2 in Volume I, the modeled concentrations of hazardous constituents in the

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groundwater from disposal of low-level mixed waste are largely due to assumptions on the routing of wastes through the treatment system. As shown in the low-level mixed waste flow diagram (Figure 6.2-1), some wastes containing solvents were assumed to bypass the thermal treatment processes. It was further assumed that the solvents in these wastes were not destroyed, but instead, ended up in the disposal facility. Some of these wastes contain solvents in large enough concentrations to cause problems when they are disposed of. In practice, low-level mixed waste to be disposed of would meet EPA standards for treatment and disposal and, therefore, should not produce major impacts to groundwater quality. Revised analyses performed for the Final WM PEIS show that no values would exceed the drinking water standards from disposal of low-level mixed waste or low-level waste at BNL.

If BNL were selected to host new waste management facilities, sitewide or project-level NEPA reviews would consider this issue.

Comment (2984)
The basis for determining the leaching of radioactive elements as reported in Tables 6.6-3 and 6.6-4 is not clear. A commentor expressed serious reservations regarding the use of models to determine these estimates and also stated that it is not apparent how else an estimate could be constructed. BNL already experiences contamination problems from strontium and tritium. This should be recognized in the analysis, despite DOE's contention that no leaching will occur pre-closure. In any case, because BNL is not an appropriate site to consider for the disposal of hazardous and/or radioactive wastes, the number of treatment and disposal sites under the Decentralized Alternative should be appropriately decreased in each table to account for BNL's removal from the sites in that option.

Response
The WM PEIS used generally accepted, verified models for leaching and groundwater transport. The methods used in the PEIS were reviewed before being implemented. As described in Section 5.1.2 in Volume I and Appendix D in Volume III, the Disposal Unit Source Term Model (DUST) was used to determine the flux rates out of the disposal facility for each contaminant. A detailed description of how DUST was used is presented in the technical report titled *DOE Public and Onsite Population Health Risk Evaluation Methodology for Assessing Risks Associated with Environmental Restoration and Waste Management.* The technical reports are listed in Section 15.2 in Volume I and can be reviewed at the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Note that most DOE sites had modeled exceedances of drinking water standards for hazardous constituents in the Draft PEIS. As explained in Section 6.6.2.2 in Volume I, the modeled concentrations of hazardous constituents in the groundwater from disposal of low-level mixed waste are largely due to assumptions on the routing of wastes through the treatment system. As shown in the low-level mixed waste flow diagram (Figure 6.2-1), some wastes containing solvents were assumed to bypass the thermal treatment processes. It was further assumed that the solvents in these wastes were not destroyed, but instead, ended up in the disposal facility. Some of these wastes contain solvents in large enough concentrations to cause problems when they are disposed of. In practice, low-level mixed waste to be disposed of would meet EPA standards for treatment and disposal and, therefore, should not produce major impacts to groundwater quality. Revised analyses performed for the Final WM PEIS show that no values would exceed the drinking water standards from disposal of low-level mixed waste or low-level waste at BNL.

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The WM PEIS Affected Environment Technical Report contains more information on current groundwater contamination at BNL. Section 2.15.2.2 of the technical report states that in 1991, groundwater at the site was monitored at 81 wells, including 17 offsite private wells, for radioactive parameters and at 71 wells for nonradioactive parameters. The only average radionuclide concentrations that exceeded concentration limits were gross beta (175% of the standard) and strontium-90 (1,104% of the standard). The high radionuclide concentrations occurred onsite near the landfill areas and the Hazardous Waste Management Facility. For nonradioactive parameters, 1,1,1-trichloroethane, 1,2-dichloroethane, iron, nitrate, pH, tetrachloroethylene, and trichloroethylene were found at concentrations above New York State Drinking Water Standards. The high concentrations occurred onsite near the central portions of the site, the landfill areas, the Hazardous Waste Management Facility, and the Spray Aeration Project areas. All other parameters were within limits. Some groundwater contamination has migrated offsite at concentrations exceeding New York State Drinking Water Standards. The full extent of offsite contamination is currently being evaluated under an Interagency Agreement between the New York State Department of Environmental Conservation, EPA, and DOE.

Comment (3075)
In the water quality impacts sections of Chapters 6, 7, 8, and 9, the WM PEIS uses only DOE or EPA standards. In some cases, Washington State standards are more stringent than EPA standards, and in most cases, are more stringent than DOE standards. The WM PEIS should use State standards for States in which standards are more stringent than DOE or EPA standards.

Response
The WM PEIS used Federal water quality standards that could be applied uniformly across all DOE sites. State standards would be more appropriately considered in sitewide or project-level NEPA reviews.

Comment (3084)
In Volume I, Table 7.16-1, under "Groundwater Impacts from Disposal," the total of entries under the columns "# of sites that meet standards" and "# of sites that require additional constraints to meet standards" should be the number of disposal sites needed for each alternative.

Response
In general, the entries in the two columns should equal the total number of disposal sites associated with the alternative. This is not always true, however, because under some alternatives not all disposal sites actually receive waste. For example, under the Decentralized Alternative for low-level waste, 16 sites could receive wastes for disposal. The Draft WM PEIS showed only 12 sites with low-level waste inventories; therefore, only 12 sites would have disposed of low-level waste under the Decentralized Alternative. Although the Draft PEIS reported no low-level waste volumes at some sites, newer waste-volume data show low-level waste inventories at BNL, NTS, and WVDP. Therefore, 15 sites would dispose of waste management low-level waste. New data from the 1995 Integrated Data Base reported no waste management low-level waste generated or stored at FEMP. Therefore, FEMP would dispose of no waste management low-level waste under the Decentralized Alternative. Appendix I in Volume IV of the WM PEIS provides a comparison of the latest waste volumes reported by DOE to the waste volumes used in the Draft WM PEIS. Note that FEMP is currently included in the DOE Environmental Restoration Program, and that FEMP could dispose of environmental restoration low-level waste.

5.4.1 Groundwater

Comment (4491)
While information on groundwater pathways and potential exposure from subsequent use was collected to support the human health impacts analysis in the Draft PEIS, it was not used to any significant extent to assess human health impacts from existing sites.

Response
Information on existing groundwater quality at the sites is summarized in Chapter 4 in Volume I of the WM PEIS. More detailed information is presented in the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Chapter 11 in Volume I uses the information on existing groundwater contamination to estimate potential cumulative impacts of the waste management actions when combined with existing activities and reasonably foreseeable future actions. Human health risks associated with groundwater contamination are discussed in terms of water quality exceedances at existing sites. The tables in Chapter 11 indicate the potential for human health risk by providing the contaminants that would exceed drinking waster standards at each site. These drinking water standards are set at levels to protect human health.

Comment (4519)
A considerable amount of information is known about the hydrogeology of the different proposed waste disposal sites. Some sites have prevailing hydrogeology that is much more difficult to monitor, at which groundwater is more difficult to contain, or that allows quicker and more unpredictable transportation of waste from leaking disposal sites through the soil and groundwater to offsite receptors than other sites. These factors are very important when deciding where to locate disposal facilities.

Appropriate modeling and qualitative evaluation of the suitability of sites for minimizing transport of groundwater plumes and for monitoring containment and transport of contaminants in groundwater should be performed before DOE makes decisions on which sites to use for landfills and other subsurface disposal facilities.

Response
The hypothetical farm family disposal risk analysis has been supplemented in the Final WM PEIS with an assessment of the potential vulnerability of sites to present risks to offsite populations from disposal of low-level mixed waste and low-level waste.

To supplement the quantitative estimates of individual disposal risks presented in Sections 6.4.1.8 and 7.4.1.7 in Volume I, DOE performed statistical analyses of site environmental characteristics. These analyses produced groupings of sites by relative vulnerability, rather than quantitative estimates of person-rem doses and potential cancer fatalities. Section 5.4.1.2.3 in Volume I and Section C.4.1.2 in Volume III contain additional details about the methods and results of the analyses.

5.4.2 Surface Water

Comment (474)
The WM PEIS is inaccurate in that it fails to consider the potential effects to the Clinch River of waste activities conducted at Oak Ridge National Laboratory (ORNL). Given that several scenarios suggest the possibility that more than 50,000 curies could be discharged into the river, the effects of such an event should be discussed in this document.

Response
Of the accident scenarios evaluated in the ecological resources impacts sections of the WM PEIS, an accident involving low-level waste resulted in the largest curie release. Section 7.7.5 in Volume I states that an estimated 30,000 curies of radioactivity, including nearly 15,000 curies of cobalt-60, would be released into surface water during a truck transportation accident. Such a release would produce adverse impacts on aquatic populations on 385 meters of a second-order stream and 1 meter of a fourth-order stream; larger streams are expected to be unaffected. Therefore, a body of water the size of the Clinch River should not be significantly affected. Section 7.7.5 further states that DOE also evaluated the potential impacts of the spill under the assumption that all released material partitioned to sediment. Since low-level waste typically includes a large fraction of insoluble material, this scenario probably is a more accurate model of the potential consequences of a low-level waste transportation accident. The results of the sediment deposition scenario analysis suggest that more than 2,000 metric tons of sediment could be contaminated to a level requiring remediation.

The WM PEIS does not evaluate potential health risks resulting from accidental releases to surface waters. To analyze the potential consequences of such releases, large amounts of site-specific data (e.g., location, size and flow of receiving water body; locations and numbers of individuals; and potential exposure pathways) would be required. Such analyses are better addressed in sitewide and project-level NEPA reviews.

The PEIS assumes that the actual risks from a spill or leak of wastes will be reduced or mitigated by (1) dilution in the receiving water body, (2) remedial actions taken to contain or remove the contaminants, and/or (3) the relatively small number of individuals potentially exposed. Finally, the true risk might be limited by the potential frequency of occurrence of the accident or initiating event. That is, an accident could have the potential to adversely impact the health of a relatively large number of individuals if it occurred, but the actual probability of occurrence could be very small.

Comment (1598)
DOE should consider that the Delta Mendota Canal and California aqueduct are within 5 or 6 miles of LLNL Site 300.

Response
Although not specifically analyzed in the WM PEIS, operations at Site 300 would be unlikely to affect any features at a distance of 5 or 6 miles. Because wastewater is not discharged to natural-flowing surface water at Site 300, it is unlikely that surface-water resources would be significantly affected by discharges from the site. Volume III, Section D.2.3.1, provides supporting information that airborne deposition of contamination onto these aqueducts would not result in significant human health risk.

Comment (2085)
Volume I, Section 5.4.3 of the WM PEIS states that, if possible, no new waste management facilities would be located in floodplain areas. We recommend that the Final WM PEIS recognize the

5.4.2 Surface Water

requirements of 40 CFR 264.18(b), which requires that any RCRA-permitted facility in a 100-year floodplain be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood, unless the owner or operator can demonstrate to EPA's satisfaction that procedures are in effect that will cause the waste to be removed safely, before flood waters can reach the facility, to a location where the wastes will not be vulnerable to flood waters.

If possible, it would be helpful if the Final WM PEIS could identify what facilities could potentially seek a permit to site RCRA-permitted facilities in a 100-year floodplain, as well as the procedures DOE will institute to ensure compliance with 40 CFR 264.18(b), including alternative RCRA facilities (either Federally or privately owned) outside the 100-year floodplain that would accept RCRA wastes in a short time frame.

Response
Sections 5.4.3.3 in Volume I of the WM PEIS states that, if possible, waste management facilities would be located outside a 100-year floodplain. In any case, the waste management facilities would be sited, designed, and constructed in compliance with 40 CFR 264.18(b). Note that the design and siting of the disposal facilities would require sitewide or project-level NEPA reviews that would further assist DOE in complying with floodplain restrictions. Also, any DOE proposed action in a floodplain would be assessed, with public notice and comment, under 10 CFR Part 1022.

Sections 5.4.3.3 in Volume I and Section C.4.3.4 in Volume III of the WM PEIS have been revised to incorporate a reference to the floodplain location standards in 40 CFR 264 that apply to low-level mixed waste, transuranic waste, and hazardous waste management facilities.

Comment (2202)
There are safety concerns relating to waste stored in an earthquake zone in a river bottom. PGDP is located near the Ohio River, from which Cairo, Illinois, draws its drinking water.

Response
Although Cairo, Illinois, does obtain its water from the Ohio River, this city is located approximately 50 kilometers (30 miles) downstream from PGDP.

Accidents initiated by earthquakes at treatment facilities were included in the WM PEIS, assuming generic facility characteristics, and were estimated to produce minimal risks. See Volume I, Sections 6.4.3 and 7.4.3. Storage facility accidents were estimated to result in an estimated radiation-induced incremental cancer fatality risk to the maximally exposed individual of about 5E-06 to 2E-03. The accident frequencies ranged from greater than 1E-02 per year for the low-consequence accidents to less than 1E-06 per year for the high-consequence accidents. Additional information on accident scenarios and health risks from accidents initiated by earthquakes is provided in Appendix F (Volume IV) and Appendix D (Volume III), respectively.

Comment (2526)
Volume I, Section 5.4.3, states, "Most of the potentially contaminated stormwater runoff would be contained within onsite stormwater collection ponds. The stormwater runoff would evaporate and infiltrate into the ground." Holding runoff onsite and allowing it to infiltrate into the ground could aid in the mobilization and movement of contaminates. A better method would be to ensure that runoff is never contaminated in the first place and then channel it away from the disposal facility.

Response
The text in question in the WM PEIS refers to stormwater contamination due to air emissions from waste treatment facilities and not to stormwater runoff at waste disposal facilities. The paragraph (now in Section 5.4.3.3) states, that stormwater runoff would be routinely monitored and any discharges would be in compliance with site-specific permit limits. Controls would be implemented at each site to minimize the potential for contaminated stormwater runoff. Impacts from stormwater runoff are expected to be minor, but are highly site-specific and would depend on the design of the stormwater management system, meteorologic conditions, topography, soil type, and the affected surface water body at the site. These impacts could be evaluated in more detail in sitewide or project-level NEPA documents if necessary. The Final WM PEIS was revised to include a qualitative analysis of the vulnerability of the DOE sites to surface water impacts. This new text is located in Section 5.4.3.3 in Volume I and Section C.4.3.4.10 in Volume III.

Comment (2527)
Volume I, Section 5.4.3, states that waste is discharged to dry steam beds and playas. If the authors are referring to the Big Lost River system, it is not always dry. If they are referring to something else, then this section needs to be clarified.

Response
Section 5.4.3.3 in Volume I and Section C.4.3.3 in Volume II now state that surface water resources would not be affected by effluent discharges at INEL because *generally*, wastewaters are discharged to dry stream beds or man-made ponds.

Section 2.3.2.1 of the WM PEIS Affected Environment Technical Report contains more detailed information on surface water resources at INEL. The technical report states that INEL has only one potential discharge to the Big Lost River and, therefore, has sought one National Pollutant Discharge Elimination System (NPDES) permit. At INEL, sanitary wastewater is piped to treatment facilities before being discharged into drainfields or ponds. Process wastewaters are treated and either conveyed to sanitary waste treatment facilities or discharged into ponds. INEL does have an NPDES permit for stormwater discharges and permits from the State of Idaho for discharges to the sanitary wastewater percolation ponds. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2802)
BNL contains part of the headwaters of the Peconic River. The Peconic River has been designated as a New York State Wild, Scenic and Recreational River pursuant to ECL 15-2715. Much of its banks have received special zoning considerations due to this designation. The siting of radioactive and/or hazardous waste disposal facilities in such a river's headwater region is inappropriate.

Response
If DOE selects BNL as a disposal site, the facility would be designed, located, and operated in accordance with all applicable regulations. In addition, best management practices for stormwater management would be implemented to ensure that no significant quantities of potentially contaminated runoff would reach the river. Sitewide or project-level NEPA reviews would consider adjacent land use, ecological factors, and pertinent State and local regulations, and land-use plans.

5.4.2 Surface Water

Comment (2946)
If the BNL wastewater treatment plant is to be used for the treatment of hazardous liquids, there is a known point of discharge to a known body of water. The exceptions to the programmatic assumed state of affairs should be noted in Volume I, Section 5.4.3.

Response
Sanitary wastewater treatment plants will not be used for primary treatment of hazardous wastes. Only non-hazardous wastewaters could be discharged to sanitary plants for treatment. Since the WM PEIS decision process will not select specific locations for waste management facilities on the sites or specific technologies, it is premature to examine impacts at specific locations on the sites. Sitewide or project-level NEPA reviews would consider this and other site-specific issues.

Comment (3364)
Why does the EIS pass over the impacts of emissions on surface water? How are the impacts on surface water any more site-specific dependent than any other impact? Considering that ingestion of radionuclides increases their risk, any internal routes of ingestion need careful analysis. The WM PEIS should consider the impacts of storage and disposal activities on surface water and stormwater runoff.

Response
Section 5.4.1.3 in Volume I states that the potential exists for human exposure to radiological and chemical contaminants in the surface water. Receptors can be exposed through use of contaminated surface water for drinking, bathing, swimming, or irrigation. Ingestion of fish or shellfish taken from contaminated surface waters could be another source of contaminants through bioaccumulation of the contaminants in the tissues of these organisms. Potential pathways for surface water contamination from waste management practices include deposition of contaminants released to the atmosphere on surface water bodies, overland runoff to surface waters, releases of contaminants in aqueous effluents from treatment and storage facilities, and recharge of surface waters by groundwaters potentially contaminated through waste disposal practices.

Of the potential surface water contamination pathways, only deposition of airborne contaminants is amenable to quantitative analysis without information about the exact location or technology employed for waste treatment, storage, or disposal on a given site. Preliminary estimates described in Section D.2.3.1 in Volume III for the Columbia and Clinch Rivers indicated that the potential dose received from ingestion of surface water contaminated by deposition of airborne contaminants were thousand to millions of times lower than that received from inhalation in a gaseous plume of hazardous or radioactive material.

Other potential pathways of surface water contamination can be controlled or are more affected by the technical design and relative location of the waste management facilities with respect to the location of surface water bodies. Releases of contaminants in aqueous effluents from treatment and storage facilities are expected to be small because process wastewaters from these facilities would be discharged to aqueous waste treatment facilities. After treatment, wastewaters would be recycled or discharged from these plants. All wastewaters, including stormwaters, would be discharged in compliance with site-specific DOE, National Pollutant Discharge Elimination System (NPDES), or industrial wastewater discharge limits, which are established based upon consideration of the potential health and environmental effects of contamination of the receiving body.

5.4.2 Surface Water

Disposal facilities could eventually degrade and release contaminants to the groundwater. Resultant contamination of surface water from the groundwater depends on the specific location of the disposal facility with respect to the surface water; however, dilution of the contaminants in "clean" surface waters is likely to result in surface-water concentrations that are much lower than the concentrations in the groundwater.

Since the WM PEIS does not attempt to select locations for waste management facilities on sites or technologies, there would be a high degree of uncertainty associated with any quantitative surface water pathway exposure estimates. Consequently, the WM PEIS did not conduct a detailed evaluation of this pathway. Surface water pathway analyses would be conducted as part of sitewide or project-level NEPA reviews, as appropriate.

As stated in Section 5.4.3.3 in Volume I, the aqueous wastewaters that are currently being managed at the sites are not part of the WM PEIS. The WM PEIS includes only those aqueous wastes generated by the hypothetical facilities analyzed as part of the WM PEIS alternatives. These waste management facilities were assumed to be very efficient in water use. Process wastewater would be treated according to regulatory and permit requirements and recycled to the extent practicable, with little liquid effluent discharge. Therefore, there is little process wastewater that would be discharged to surface waters after treatment. Since process wastewater treatment would continue at the sites where it presently occurs, and the volumes of process wastewater treated at each site would vary only slightly between alternatives, the effects of process wastewater treatment on surface water and groundwater quality are already accounted for in the affected environment section. Therefore, impacts from these activities are not expected to be major, and would not influence the choice of alternatives. If necessary, these impacts would be evaluated in sitewide or project-level NEPA documents.

Some impacts on water resources were assumed to be minimal at all sites or at particular sites regardless of which waste type and alternative are being considered. To focus the analysis on significant environmental impacts that could influence the choice of alternatives, these potential minimal effects are discussed in Section 5.4.3.3 in Volume I and Section C.4.3.4 in Volume III and are not addressed in the waste-type chapters. This includes impacts to floodplains, impacts from runoff and sedimentation, impacts from wastewater discharges, and impacts from routine transportation and transportation accidents. Further evaluations of these potential effects might be conducted as part of sitewide or project-level NEPA reviews.

Releases of hazardous constituents to surface waters from routine operation of waste management facilities were assumed to be limited because of treatment and recycling of wastewaters. Releases to surface waters could result from accidents at waste management facilities or from transportation accidents. The WM PEIS assumes that the impacts from a spill or leak of wastes will be reduced or mitigated by (1) dilution in the receiving water body, (2) remedial actions taken to contain or remove the contaminants, and/or (3) the relatively small number of individuals potentially exposed. Finally, the impacts could be limited by the potential frequency of occurrence of the accident or initiating event. That is, an accident could have the potential to adversely impact a relatively large area of surface water if it occurred, but the actual probability of occurrence would be very small.

The Final WM PEIS was revised to include a qualitative analysis of the vulnerability of the DOE sites to surface-water impacts. This new text is located in Section 5.4.3.3 in Volume I and Section C.4.3.4.10 in Volume III.

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Comment (4527)
DOE should explain the expectation in the Draft WM PEIS that releases of contaminants in aqueous effluents would be "small" or "insignificant," and define "small" or "insignificant." Wastewater treatment facilities are never 100% effective, and would not be effective for tritium. Either the standards would have to be documented to "a-priori assure" negligible impacts (assuming minimal compliance to all applicable standards simultaneously), or an analysis would be needed of wastewater impacts on a site- and process-specific basis. DOE should consider that aqueous discharges from the WVDP high-level waste treatment facilities are sent to aqueous waste treatment facilities and, nevertheless, the impacts of the water pollution and associated contamination of fish exceed the impacts of airborne radionuclide releases, according to the WVDP site safety report.

Response
Sections 5.4.3.3 in Volume I and C.4.3.4.10 in Volume III have been revised to provide more detailed discussions of the potential vulnerability of sites to surface-water impacts from waste management actions.

Comment (4529)
The WM PEIS is intended to provide input for future configurations of waste management facilities, including DOE installations at which such facilities would be located. However, without also evaluating the likely range of impacts from surface-water pathways, modeling of the impacts of airborne contamination is not a suitable method for making decisions on configurations or installations at which to locate waste treatment facilities. All exposure estimates in the WM PEIS suffer from a high degree of uncertainty. While the WM PEIS analysis would not indicate where on specific installations specific facilities are located, it could be used to indicate at which installations and configurations of installations the facilities would be located. The impacts of such facilities could be highest for surface-water pathways from such facilities.

Response
Section 5.4.3.3 in Volume I and C.4.3.4.10 in Volume III have been revised to provide a more detailed discussion of the potential vulnerability of sites to surface water impacts from waste management actions.

Section 5.4.1.3 in Volume I states that the potential exists for human exposure to radiological and chemical contaminants in the surface water. Receptors can be exposed through use of contaminated surface water for drinking, bathing, swimming, or irrigation. Ingestion of fish or shellfish taken from contaminated surface waters could be another source of contaminants through bioaccumulation of the contaminants in the tissues of these organisms. Potential pathways for surface water contamination from waste management practices include deposition of contaminants released to the atmosphere on surface water bodies, overland runoff to surface waters, releases of contaminants in aqueous effluents from treatment and storage facilities, and recharge of surface waters by groundwaters potentially contaminated through waste disposal practices.

Of the potential surface water contamination pathways, only deposition of airborne contaminants is amenable to quantitative analysis without information about the exact location or technology employed for waste treatment, storage, or disposal on a given site. Preliminary estimates described in Section D.2.3.1 in Volume III for the Columbia and Clinch Rivers indicated that the potential dose received from ingestion of surface water contaminated by deposition of airborne contaminants would be

thousands to millions of times lower than that received from inhalation in a gaseous plume of hazardous or radioactive material.

Other potential pathways of surface water contamination can be controlled or are more affected by the technical design and relative location of the waste management facilities with respect to the location of surface water bodies. Releases of contaminants in aqueous effluents from treatment and storage facilities are expected to be small because process wastewaters from these facilities would be discharged to aqueous waste treatment facilities. After treatment, wastewaters would be recycled or discharged from these plants. All wastewaters, including stormwaters, would be discharged in compliance with site-specific DOE, National Pollutant Discharge Elimination System, or industrial wastewater discharge limits, which are established based upon consideration of the potential health and environmental effects of contamination of the receiving body.

Disposal facilities could eventually degrade and release contaminants to the groundwater. Resultant contamination of surface water from the groundwater depends on the specific location of the disposal facility with respect to the surface water; however, dilution of the contaminants in "clean" surface waters is likely to result in surface-water concentrations that are much lower than the concentrations in the groundwater.

Since the WM PEIS does not attempt to select locations for waste management facilities on sites or technologies, there would be a high degree of uncertainty associated with any quantitative surface water pathway exposure estimates. Consequently, the WM PEIS did not conduct a detailed evaluation of this pathway. Surface water pathway analyses would be conducted as part of sitewide or project-level NEPA reviews, as appropriate.

5.5 Ecological Resources

Comment (19)
Radiation exposure to the environment is a concern.

Response
DOE analyzed the impacts to terrestrial biota from the radioactive and hazardous components of the treated wastes and found that there would be no significant impacts from waste treatment activities at any of the candidate sites during normal operations. DOE also analyzed impacts to aquatic ecosystems from transportation accidents involving releases of radioactive materials and found that, in the unlikely event of such a release, aquatic species could be adversely affected, but the long-term effects should be limited by the emergency response measures taken to mitigate the effects of the accident.

Each DOE site has an emergency spill response system and emergency procedures that depend on the characteristics of the material spilled. For example, there are different emergency procedures for radiological, chemical, and petroleum hazards. In general, a site's fire response unit is responsible for mitigation and the waste management unit is responsible for cleanup. DOE's Radiological Assistance Program provides rapid assistance in the event of a radiological spill anywhere in the United States. The Radiological Assistance Program teams provide assessment and monitoring capabilities.

Comment (100)
Commentors are concerned about the impacts to endangered species and natural resource areas from waste treatment, storage, and disposal activities at LLNL.

Response
Sitewide or project-level NEPA reviews would include a detailed assessment of impacts to endangered species and natural resource areas based on site-specific resources and conditions.

DOE considers sensitive ecosystems and habitats when designing and siting projects and complies with the laws and regulations that protect wildlife resources, including those that protect threatened and endangered species, to ensure the impacts of proposed activities are minimal.

DOE did not conduct a detailed assessment of impacts to endangered species and natural resources in the WM PEIS because it has not proposed specific locations for waste management facilities at the sites. DOE did conduct a screening analysis of the potential for waste management activities to directly affect wildlife through exposure to facility emissions and to affect sensitive habitats and species based on land requirements. The screening analysis indicated that no wildlife effects are expected from facility emissions and that, since the land required for facility construction would be a small fraction of the available nonsensitive lands, DOE would be able to avoid direct impacts. Furthermore, DOE would have sufficient flexibility in locating the waste management facilities to avoid indirect impacts to sensitive habitats, such as might result from construction noise or building access roads.

Comment (1559)
DOE should establish a buffer zone under the land-use analysis to protect sensitive habitats.

Response
The WM PEIS cannot quantify the precise impacts of waste management facilities on ecological resources because DOE has not yet identified the locations of the facilities on the sites. However, based on projected land requirements, DOE analyzed the potential for proposed waste management

activities to affect sensitive habitats and species. The analysis indicated that the land required for the construction of waste management facilities would be a small fraction of available nonsensitive lands, which would enable DOE to avoid direct impacts to sensitive lands. Further, DOE would have enough flexibility in locating facilities to avoid indirect impacts, such as those that could result from building access roads. Sitewide or project-level NEPA analyses will examine potential impacts based on site-specific environmental conditions.

Comment (1796)
A commentor is concerned about the shipment of DOE-managed waste through North Carolina because of the potential for effects on trees from accidental spills and the increased potential for fire in State forests as a result of faulty exhaust systems or accidents.

Response
The WM PEIS does not evaluate potential impacts to trees or other components of terrestrial ecosystems from transportation accidents. The severity of impacts on terrestrial ecosystems would depend largely on the type of waste involved, the amount of waste released, the location of ecological receptors in relation to the location of the accident, and the prevailing meteorological conditions at the time of the accident. Specific ecosystem components affected would vary based on the characteristics of the wastes, but should be localized, with effects limited by emergency response cleanup. Low-level mixed waste, low-level waste, and hazardous waste are more likely to have such localized effects. As described in the WM PEIS transportation impacts assessment for human health risk and for aquatic resources (Sections 5.4.1 and 5.4.4), potential acute toxic effects from short-term releases of radionuclides and hazardous chemicals contained in the waste are likely to be more important than chronic toxic effects, which should be limited by the emergency response measures taken to mitigate the effects of the accident. Due to the strength of the packaging used for the transportation of transuranic and high-level waste, it would be highly unlikely that even a small portion of a shipment inventory would be released after a transportation accident.

In-depth assessment of these types of incidents would require knowledge of the specific characteristics of the wastes being shipped, the specific shipment route being used, and the probability of an accident occurring on the route in question; detailed assumptions about waste release fractions, accident severity, and ecosystem components likely to be affected; and comprehensive data on radionuclide and chemical-specific toxicity levels to those components. This type of detailed risk assessment is not feasible in the context of the programmatic evaluation of alternatives for the WM PEIS. However, DOE recognizes that, in general, the likelihood of accidents that might cause ecological effects would be directly related to the number of shipments and the distances traveled, which is consistent with the findings of the human health risk assessment of waste transportation. Thus, the Centralized Alternatives would have the highest likelihood and the Decentralized Alternatives the lowest likelihood of causing these effects.

DOE did not evaluate the potential for accidents or faulty exhaust systems to cause forest fires. DOE shipments would be a small fraction of total shipments of hazardous materials and an extremely small fraction of commercial transport in the region in general, and the frequency of forest fires should not substantially increase.

5.5 Ecological Resources

Comment (1797)
There is concern about potential effects of releases of radioactive materials on vegetation and about the potential for bioaccumulation of radioactive materials in the food chain.

Response
The WM PEIS does include an evaluation of the potential toxic effects of radioactive and hazardous chemical contaminants released from waste treatment facilities to a representative terrestrial receptor. As described in Section 5.4.4 in Volume I, DOE conducted a screening analysis of the impacts of airborne releases of contaminants to terrestrial animals living in the vicinity of such facilities. The analysis estimated doses of contaminants deposited downwind on soils over the assumed 10-year operational period of the facility. The model estimated uptake from the soils to vegetation and subsequent transfer in a terrestrial food chain leading to the exposure of a small mammal (a representative terrestrial receptor). The analysis then compared internal and external doses to available toxicity benchmarks. The results indicated that emissions from low-level mixed, low-level, transuranic, and hazardous waste treatment facilities would be expected to produce minimal impacts to terrestrial receptor populations. The effects of contaminant releases on plant species were not evaluated, as these effects were also considered to be minimal. High-level waste was not evaluated in the same way because the treatment of high-level waste is outside the scope of the WM PEIS, and no releases are expected from stored canisters of vitrified high-level waste.

Comment (2077)
The document concentrates on human risk due to exposure to radionuclides and hazardous wastes. It should identify and discuss the potential ecological impacts to sensitive species or habitats. The PEIS does not discuss impacts to the ecology very well.

Response
WM PEIS Sections 5.4.4 (Volume I) and C.4.4 (Volume III) describe the methods DOE used to analyze impacts to ecological resources. The analysis consisted of evaluating the impacts of the construction of new treatment, storage, and disposal facilities on the existing nonsensitive terrestrial habitats, the toxicity of contaminants released from waste treatment facilities to a model terrestrial receptor, and the toxicity to aquatic organisms of spills of waste shipments during transportation. Sections 6.7, 7.7, 8.7, 9.7, and 10.7 describe these impacts for low-level mixed, low-level, transuranic, high-level, and hazardous wastes, respectively.

Because of the programmatic nature of the WM PEIS, DOE could not conduct a detailed assessment of the impacts of waste management facilities on ecological resources. This would require identification of the proposed locations of the facilities on the sites and a more detailed description of facility design, which DOE has not yet done.

DOE did conduct a screening-level evaluation of the potential for site clearing and excavation to affect nearby sensitive habitats, including wetlands and designated critical habitats of Federally and State-listed endangered and threatened species, based on the assumption that the likelihood of such effects occurring would be roughly proportional to the ratio of the waste management acreage required compared to the acreage of nonsensitive land onsite. The premise was that the smaller the fraction of available nonsensitive lands required for construction of waste management facilities, the greater DOE's flexibility in locating the facility to avoid affecting nearby sensitive habitats. The analysis, therefore, compared total waste management facility acreage requirements for each waste type under

each alternative at each site having sensitive habitats with the amount of available, nonsensitive land area at each site. The available land area was determined from site development plans and Site Environmental Reports as either the amount of land specifically designated for waste management facility development or the amount of land remaining after subtracting from the site's total acreage the acreages of wetlands, wildlife management areas, topographic features, existing roads and structures, cultural properties, and other areas and features that would make development unfeasible.

The analysis in each waste-type chapter (6 through 10) presents percentage figures for sites and alternatives under which waste management land requirements equal or exceed 1% of the available land. These are noted as situations that pose a greater likelihood of affecting nearby sensitive habitats. Sitewide or project-level analyses would evaluate whether these impacts would occur, and their extent and severity. Generally, the PEIS analysis showed that, at all of the sites, the land required for construction of waste management facilities would be a small fraction of available nonsensitive lands, which would enable DOE to avoid direct impacts to sensitive habitats. Furthermore, DOE would have enough flexibility in selecting specific locations for waste management facilities on sites to avoid indirect impacts, such as those that could result from construction noise or building access roads.

The ecological impacts analysis in the WM PEIS does not determine the likelihood and severity of effects on sensitive species, including Federally and State-listed endangered and threatened species, because DOE has not proposed specific waste management facility locations at the various sites. As stated in Section 5.4.4 in Volume I, these species-specific evaluations and assessments of impacts to natural resources would be conducted as part of sitewide or project-level NEPA reviews. However, the WM PEIS does identify sensitive species that might be affected by the proposed waste management facilities at each site. Chapter 4 identifies the sensitive species known to occur, or with the potential to occur, at or in the vicinity of each of the 17 major DOE sites, and provides a summary table of the Federally and State-listed endangered or threatened species at the 17 major sites. The waste type chapters (6 through 10) list in tabular form the numbers of Federally and State-listed endangered and threatened species that could be affected at each site under each alternative.

Comment (2199)
DOE should consult with the Fish and Wildlife Service regarding Section 7 of the Endangered Species Act. There are endangered species being affected by the activities at PGDP.

Response
DOE is committed to full compliance with all environmental laws and regulations, including the Endangered Species Act. In accordance with those laws, DOE establishes comprehensive consultation agreements with responsible agencies such as the Fish and Wildlife Service to ensure compliance. Currently, PGDP's waste management activities are not affecting endangered species and sensitive habitats.

The WM PEIS does not quantify impacts to threatened or endangered species and other natural resources because DOE has not yet proposed the locations of sites for waste management facilities, on which it would base its evaluations.

Sitewide and project-level NEPA reviews would evaluate specific impacts to endangered species and sensitive habitats. DOE did qualitatively analyze potential impacts to sensitive species and habitats based on land requirements. That analysis indicated that the land required for facility construction

would be a small fraction of available nonsensitive lands, which would enable DOE to avoid direct impacts. Further, DOE would have enough flexibility in siting waste management facilities that it would also avoid indirect impacts to sensitive habitats, such as those that could result from road-building activities.

Comment (2851)
According to Volume I, Section 6.7.3, DOE examined sites with "the highest projected emissions." Toxicity to terrestrial wildlife was based on radionuclides that comprise "80% of the total volume of all radionuclides." Radionuclide emissions need to be evaluated in terms of dose and risk, not in terms of volumes or quantities. Volume (cubic meters) and quantity (curies) are not meaningful screening or evaluation criteria. The dose delivered by a quantity or volume of emissions is determined by the specific nature of the radionuclides involved. Were wildlife other than terrestrial organisms evaluated?

Response
DOE revised Section 6.7.3 of the WM PEIS to clarify the discussion of the 80% limit. The ecological resources impacts assessment included analysis of the potential toxic effects of airborne contaminants released from waste treatment and storage facilities on terrestrial organisms. Non-terrestrial wildlife were not included among the receptors that were modeled for routine facility operations. However, aquatic receptor impacts were evaluated for a transportation accident scenario, as described in Section 5.4.4 in Volume I.

The ecotoxicity risk assessment for routine operation of waste treatment facilities examined potential toxicity to terrestrial receptors following deposition of airborne contaminants to soils and contaminant uptake in terrestrial food chains. All nonvolatile hazardous chemicals expected to be released from the facilities were included in the analysis; volatile hazardous chemicals are not expected to be significantly redeposited to surface soils. The radionuclide contaminants expected to be contained in the facility airborne emissions were also evaluated. However, only the radionuclides that would contribute up to 80% of the total released activity were included in the analysis. The remaining activity would be contributed by trace emissions of a large number of radionuclides. Not including each of these minor radionuclides should not compromise the validity of the analysis, given the conservative assumptions used to characterize the scenario. For example, airborne contaminants deposited to surface soils were assumed to accumulate over the 10- to 20-year period of facility operation, with no loss due to leaching, runoff, or decay. This assumption should account for most or all of the uncertainty associated with limiting the analysis to 80% of the activity. An exception might be radionuclides that contribute trace amounts of released activity, but are taken up in terrestrial foodchains on a highly selective basis. A detailed analysis of the potential for these types of effects is not feasible within the scope of the general screening methodology of the WM PEIS programmatic impacts assessment, but would be done, if considered warranted, in sitewide or project-level NEPA reviews.

The results of the ecotoxicity risk analysis presented in Section 6.7.3, 7.7.3, and 8.7.3, indicate that body burden exposures of the model terrestrial receptor were all approximately a factor of 10 lower than concentrations expected to produce toxic effects. Given these results, DOE does not believe that the use of a limit on the radionuclide contaminants included in the analysis is problematic.

Comment (2853)
Section 7.7.5 in Volume I should define "significant impacts" to surface waters.

Response
The ecological resources impacts analysis conducted for the WM PEIS included evaluation of the potential impacts of a waste shipment transportation accident on aquatic ecosystems. As described in Section C.4.4.2.2 in Volume III, acute toxicity to aquatic biota is assumed to occur when combined internal and external doses are estimated to exceed 1 rad per day, an exposure level thought by the National Council on Radiation Protection and Measurements to be protective of aquatic populations. Because doses could exceed 1 rad per day, DOE revised Volume I, Section 7.7.5, of the PEIS to clarify that the release of the shipment of low-level waste to surface waters could adversely affect aquatic populations living in a second-order stream for 385 meters downstream of the release and for 1 meter downstream in a fourth-order stream. The term "significant impacts" was revised in the Final WM PEIS to "adverse impact."

Comment (2954)
The assumptions used in Section 5.4.4 are much too simplistic. Much has been written about the effects of habitat fragmentation and the needs of many species (including sensitive flora and fauna) for large segments of undisturbed habitat. (For example, in arid climate areas such as the Hanford Site, site clearing allows the invasion of exotic plant species, further degrading additional habitat surrounding a site.) The facile comparison here of "acres required for a facility to available acres" does not account for this large body of knowledge. This section should be revised to account for such research results. The Section 4.4.4 description of the Hanford land-use is incorrect. Only 77,000 acres was set aside as an arid land ecology reserve. Another 89,000 acres (Wahluke Slope) is managed by the U.S. Fish and Wildlife Service and Washington Department of Fish and Wildlife as a National Wildlife Refuge and Wildlife Area, respectively.

Response
Volume I, Section 5.4.4, of the WM PEIS describes the methodology used to assess the potential impacts on ecological resources from site clearing for the construction of new waste management facilities. Since DOE has not yet proposed locations on the sites for new facilities, a screening-level analysis was conducted to evaluate the potential for waste management actions to cause habitat loss and indirect effects on sensitive habitats. The potential was based on the percentage of available land area required for the facilities--with available land area consisting of only nonsensitive habitat. Because in all cases DOE determined that sufficient nonsensitive land was available, this screening-level analysis was considered sufficient for the programmatic review.

More detailed assessments of habitat impacts would require additional site-specific information, particularly the proposed location of the new facilities on the site in relation to existing available land and sensitive habitats. Sitewide or project-level NEPA reviews would include these types of analyses. However, the WM PEIS estimates of the land area required for construction of new facilities are generally small in comparison to estimates of total available land area. In addition, the sites already contain developed areas; not all habitat is pristine. The land required for construction of new waste management facilities could well be located in areas that are already disturbed or developed and that are only marginally useful as habitat for indigenous species.

DOE revised the text in Section 4.4.4 in Volume I of the WM PEIS to include the correct acreage for the arid land ecology reserve and the wildlife refuge identified in the comment.

5.5 Ecological Resources

Comment (2956)
The "Toxicity From Exposure to Contaminants" portion in Volume I, Section 5.4.4, recent research documenting genetic changes in the regions contaminated by the Chernobyl accident should be incorporated to more fully discuss this issue.

Response
As described in Section 5.4.4 in Volume I, the ecological resources impacts analysis considered the potential effects of exposure to radionuclides and hazardous chemicals released from waste treatment facilities on terrestrial receptors. This analysis evaluated the toxicity of radiological contaminants by comparing estimated total internal and external doses to a benchmark value of 100 mrad per day established by the International Atomic Energy Agency and listed in DOE Order 5400.5. No-observable-adverse-effect levels were used as benchmarks for chemical contaminants.

In addition, the Chernobyl accident resulted in different types of radiation exposures (acute gamma radiation) as well as radiation exposure levels far in excess of any exposures anticipated by operation of waste management facilities at DOE sites. Therefore, the effects produced by this accident are not comparable to the potential effects resulting from waste management activities.

Comment (2987)
The generic analysis of ecological resources impacts for low-level mixed waste and low-level waste provided in Sections 6.7 and 7.7, respectively, may be true for sites nationwide in general; however, it is not applicable to BNL, in particular.

Response
As presented in the Volume II Site Data Tables, at BNL, a maximum of 1.6 acres would be required for low-level mixed waste facilities and 2.8 acres for low-level waste facilities. At BNL, even given the commentor's suggested revisions to the BNL available land estimates, sufficient land is available at BNL to implement the proposed waste management actions. The small amount of land required for the low-level mixed waste and low-level waste facilities at BNL should give DOE a great degree of flexibility in making facility location decisions. Mitigation measures would also be used to ensure that site clearing and facility operation would not affect nearby sensitive habitats. As stated in Sections 6.7.1 and 7.7.1 in Volume I, site clearing for the construction of low-level mixed waste and low-level waste facilities would require no more than 55 and 86 acres at any site, respectively.

As stated in Sections 6.7.3 and 7.7.3, the maximum estimated total doses of radionuclides released from the operation of low-level mixed waste and low-level waste treatment sites are about one-tenth those of potential concern for ecotoxicity. Therefore, impacts to terrestrial receptor populations are expected to be minimal.

Comment (3069)
Section 5.4.4 ties the impacts to ecological resources to an inadequate concept for land-use impact thresholds. In the subsequent analysis, this concept does not allow for discrimination between alternatives.

Response
Volume I, Section 5.4.4.1, of the WM PEIS describes the evaluation of habitat effects in the ecological resources impacts analysis. At this level of analysis, the potential for direct effects on habitats can be

compared among alternatives because habitat loss would be a direct consequence of land clearing to build waste management facilities. The amount of land required for the waste management facilities is determined by the amount of waste to be processed under each alternative. In general, land requirements, and any resulting land-use or ecological resources impacts, are estimated to be small as compared to the amount of land available to build facilities across all alternatives. Available land is land designated for waste management activities not supporting sensitive habitats or sensitive species including endangered and threatened species. Furthermore, these relatively limited requirements would give DOE the flexibility to avoid indirect impacts to nearby sensitive habitats or species by selecting the specific location of the facilities. Nevertheless, the WM PEIS analysis is a screening-level assessment conducted to identify the potential for impacts. Site-specific analyses would evaluate the extent and severity of any potential land-use and ecological resources impacts once specific facility locations are proposed.

Comment (3095)
Volume I, Section 12.2, does not mention the impacts of site clearing on habitat. Site clearing causes fragmentation of wildlife corridors and blocks of habitat, thus diminishing habitat value for sensitive flora and fauna. For example, in arid-climate areas such as the Hanford Site, site clearing allows the invasion of exotic plant species, further degrading additional habitat surrounding the site.

Response
Since the WM PEIS does not specify the locations of waste management facilities on the sites, impacts such as habitat fragmentation could not be evaluated at this time. Sitewide and project-level NEPA reviews would more appropriately evaluate these impacts.

Comment (3112)
Section C.4.4.1.2, states that the total disturbed area includes 10-foot buffer zones around the facilities. However, the WM PEIS assumes a 25-foot lay-down area for facilities construction. This area will not be usable habitat.

Response
The habitat impacts assessment was based on the land area that would be disturbed during facility construction. This area was estimated to be the plant area plus a 25-foot buffer zone plus a parking area. The WM PEIS analysis used the area disturbed for construction, assuming that once the area was disturbed it would not be reclaimed as suitable habitat, given its close proximity to the waste management facilities. DOE revised the discussion of habitat impacts included in Volume III, Section C.4.4.1.2, to indicate that 25-foot buffer zones were considered in the analysis.

Comment (3177)
The EIS dismisses the need to analyze specific sites in detail based on the planned small size of the proposed facilities as compared to the total size of the various sites. At Hanford, the potential facility locations are all in areas of priority habitat, as identified by the State of Washington and the National Biological Survey.

Response
About 6 percent of the Hanford Site has been used for defense production and waste management purposes. Because much of the Hanford Site has been undisturbed for nearly 50 years, the Site contains one of the largest remaining relatively undisturbed shrub-steppe habitat areas in Washington

5.5 Ecological Resources

State. Shrub-steppe habitat is vegetation that flourishes on arid lands in areas with extreme temperature ranges. Shrub-steppe is considered a priority habitat by Washington State because of its importance to sensitive wildlife. About one-half of the land located on the Hanford Site has been designated as an ecological study area or wildlife refuge. These areas include the Fitzner Eberhardt Arid Lands Ecology Reserve located south and west of the 200 Areas and areas north of the Columbia River.

Much of the defense production activity occurred in the 200 Areas and, therefore, much of the land in the 200 Areas is disturbed. The 200 Areas also are the location of large low-level waste burial grounds. The 200 Areas and the surrounding Central Plateau have been identified as potential exclusive-use waste management areas to support the Hanford Site's waste management and environmental restoration programs. Because of past disturbances in the 200 Areas, the shrub-steppe habitat, wildlife typically found in the shrub-steppe habitat, and archaeological sites are limited.

Based on projected land requirements, DOE analyzed the potential for proposed waste management activities to affect sensitive habitats and species. The analysis indicated that the land required for the construction of waste management facilities would be a small fraction of available nonsensitive lands, which would enable DOE to avoid direct impacts to sensitive lands. Further, DOE would have enough flexibility in locating facilities on sites to avoid indirect impacts, such as those that could result from building access roads.

DOE revised Section 4.4.4 in Volume I to identify the presence of priority habitats at Hanford as referred to in the comment. Section 5.4.4.1 of the WM PEIS describes the methodology used to evaluate habitat impacts. The habitat impact analysis is a screening-level assessment conducted to identify potential impacts. The methodology does not dismiss the need to analyze sites in detail. Rather, it indicates that, because the specific locations of the proposed waste management facilities at the various sites have not been identified, sitewide and project-level reviews could be required to evaluate the extent and severity of any potential impacts. State and Federal habitat designations would be taken into account at that time. Also, the siting of any future facility at Hanford would take into account the findings of the Hanford Future Site Uses Working Group, which is composed of local stakeholders, as well as Federal, State, and local government agencies, and the Hanford Remedial Action EIS and Comprehensive Land Use Plan.

Comment (3366)
The analysis of the effects on threatened and endangered species is totally inadequate. This major action requires formal consultation under Section 7 of the Endangered Species Act. What is the cumulative impact on threatened and endangered species' reproductive systems from continued exposure and probable increases in such exposures? Simply listing the threatened and endangered species while stating that potential impacts to them cannot be predicted is not an adequate method for comparing alternatives.

Response
Volume I, Section 5.4.4, states that the ecological impacts analysis in the WM PEIS does not determine the likelihood and severity of effects on sensitive species, including Federally and State-listed endangered and threatened species, because DOE has not proposed specific locations for waste management facilities at the sites. Detailed ecological impacts evaluations would be conducted as part of any necessary sitewide or project-level NEPA reviews, including any consultations required under the Endangered Species Act. However, the WM PEIS analysis does provide information to

decisionmakers concerning the sensitive species that could be affected by the proposed waste management facilities at each site.

Volume I, Section 5.4.4, of the WM PEIS now states, "In addition to impacts through disturbance of habitat, sensitive species could be affected by exposure to contaminants released from waste treatment and storage facilities." These impacts are expected to be similar to those estimated for nonsensitive species, as described previously in this section (see discussion under the heading "Toxicity from Exposure to Contaminants"). However, unlike for nonsensitive species, estimated adverse impacts to a single organism could have a significance for the entire population. Therefore, careful consideration of potential actions to mitigate toxic effects to sensitive species is required. Potential toxicity effects on sensitive species can be fully addressed only in sitewide or project-level NEPA analyses.

Comment (3564)
Site data tables should address ecological impacts (e.g., habitat destruction, degradation). The arid-climate sites will be affected much more than sites that receive adequate precipitation. (Table II.1-3).

Response
Arid-climate sites could be more sensitive in terms of waste management construction activities. However, DOE did not perform an analysis of the impact on arid-climate sites versus wet-climate sites for the WM PEIS. Impacts to ecological resources are qualitatively addressed in terms of land-use requirements, the overall acreage of land available at each site, and the degree of flexibility DOE would have in selecting waste management facility locations to avoid indirect impacts to sensitive habitats. The Site Data Tables in Volume II do contain information regarding the number of acres required for waste management facility construction under each alternative and the percentage of available land this would constitute. DOE concluded from this analysis that the limited land requirements for waste management facilities should enable DOE to minimize any impacts to sensitive habitats at all sites, although some non-sensitive habitats may be affected. Furthermore, potential effects to ecological resources at arid-climate or wet-climate sites would be assessed in sitewide or project-level NEPA reviews.

Comment (4574)
A commentor is concerned about the spread of waste materials via wildlife at ANL-E.

Response
DOE did not evaluate the potential for spread of radionuclides or chemicals in wildlife, but did evaluate multiple pathways of human exposure for airborne contaminants using an agricultural food chain (including livestock). This analysis showed the relative risks of the alternatives for the waste types. Sitewide or project-level analyses would address wildlife dispersal of contaminants if that pathway was considered important for ecological or human health effects analysis.

5.6 Socioeconomics

Comment (1510)
Los Alamos benefits economically from the presence of LANL. Other communities around LANL suffer or see no benefit.

Response
Total LANL site employment in 1994 was 6,199. Table 2.5-16 of the WM PEIS Affected Environment Technical Report lists LANL employee data for 1994 for Los Alamos, Rio Arriba, and Santa Fe Counties. Together, Rio Arriba and Santa Fe Counties housed 2,389 LANL site employees, or 36.5% of the site workforce; so there are benefits to these communities in terms of the earnings of these workers and the value of their spending in their local economies. Additional benefits could accrue from future waste management actions at LANL because additional labor (254 to 1,741 employees for all waste types managed at LANL; see Table 11.9-2) would be required for facility construction and operation and many of those workers would likely spend a portion of their incomes in Rio Arriba and Santa Fe Counties.

DOE is addressing specific socioeconomic issues, including employment benefits, as well as concomitant adverse environmental and socioeconomic impacts in the LANL Site Wide EIS.

Comment (1722)
Socioeconomic conditions discussed in Volume I, Chapter 4 and Section 5.4.6, are based on 1990 and 1991 information. There have been many changes in levels of general employment, site employment, and per capita income since then. Information should be more current.

Response
The WM PEIS is a broad programmatic analysis. DOE believes that the data from the 1990 U.S. Census and the other documents from which it built its socioeconomic analysis provide the most consistent database for the broad, programmatic nature of the study. DOE would provide more detailed socioeconomic information and impacts analysis where appropriate in sitewide and project-level NEPA reviews.

Comment (2086)
A commentor is concerned that people will lose their jobs at the Portsmouth Plant when treatment operations begin.

Response
As shown in Tables II-13.1-13 and II-13.2-11 in Volume II of the WM PEIS, jobs are projected to increase at the Portsmouth Plant to support waste management facility construction and operation under all low-level mixed waste and low-level waste alternatives. Jobs in the Portsmouth region are also expected to increase. Changes in waste management activities are not expected to appreciably change employment related to other activities at the Portsmouth Plant.

Comment (2346)
Volume I, Chapter 10, appears to contain conflicting statements. In one place it reads "HW alternatives would only minimally benefit regional and national economies." In another it reads "None of the HW Alternatives substantially affect the national economy."

Response
DOE draws a distinction between minimal and substantial benefits. However, DOE revised statements in the WM PEIS about the economic benefits of alternatives to make it clear that the alternatives would only minimally benefit the national economy.

Comment (2351)
The WM PEIS states that none of the alternatives would affect the national economy. (This is found in the comparison of alternatives.) I believe taxes would be affected at the national level.

Response
The WM PEIS economic analysis determined that the proposed waste management actions would cause no effects on jobs or personal income on a national basis. The impact of required expenditures on taxes as a function of DOE's portion of the Federal budget were not evaluated because they are determined by the U.S. Congress and are, therefore, outside the scope of the PEIS.

Comment (2473)
The PEIS compares the effect of implementing the waste management alternatives to the employment at INEL and in the region of influence (ROI) for the baseline year of 1990. Site employment in 1990 is set at 11,813 and total ROI employment at 99,692. In evaluating the socioeconomic impact of the waste management alternatives, DOE's choice of the baseline year is crucial because of the job reductions that have occurred at INEL since 1990 (down to approximately 8,620 in 1995). Use of 1990 as the baseline year in the Draft WM PEIS has three problems.

First, different baseline years are cited in different parts of the Draft WM PEIS. In the Draft WM PEIS Summary document, the baseline year is set in 1990. In contrast, in Volume I of the WM PEIS, the baseline year is set in 1992. Finally, in Volume II of the WM PEIS, the employment and personal income changes in the ROI due to the implementation of the various alternatives are compared to the 1990 baseline year. However, in the same section, changes in site employment at INEL are compared to the 1991 site employment. Workforce reductions at INEL since 1992 were not incorporated.

Second, the choice of either 1990 or 1992 as the baseline year does not mesh with the 1995 baseline year used in the Final INEL Site Wide EIS for Environmental Restoration and Waste Management. There is no justification for using a 1990-1992 baseline employment of 11,813 that no longer exists; especially when the base period for the WM PEIS is 1996 to 2015.

Third, the use of 1990 or 1992 as the baseline year underestimates the effects of the management alternatives on employment at INEL. Because the projected 1995 employment is smaller than the 1991 employment, the percent changes increase. Simply adopting a realistic baseline year shows that Regionalized Alternative 3 *alone* could have a major impact on INEL employment levels.

Response
The WM PEIS did not evaluate changes in site employment *per se* or workforce reduction effects under different waste management alternatives, but rather, evaluated changes in regional employment caused by expenditures for waste management facility construction and operation. This part of the economic analysis used county-level employment and income data from the 1990 Census.

5.6 Socioeconomics

No separate trend analysis was done for site employment alone. However, site employment changes were used as an index for evaluating the potential for impacts to site transportation infrastructure. The baseline for this infrastructure analysis was the employment level from the Site Environmental Reports of 1992. DOE did not change the site employment figure to the lower 1995 level because the INEL transportation infrastructure, including roads, signs, and traffic signals, assumed to have the capacity to accommodate the higher 1992 site employment level is still in place. Therefore, using the lower 1995 employment level to calculate the percent increase in employment as an index of increased transportation infrastructure load would overestimate the potential for transportation infrastructure impacts.

Different baseline years were used in the WM PEIS because different elements of the analysis used data from different sources. The economic and population impacts analyses were based on data from the most recent census year, which was 1990. The analyses of other environmental resources at the sites was based on the most recent Site Environmental Reports from 1992.

Comment (2474)
The socioeconomic consequences for INEL and its ROI depend on which combination of alternatives is chosen for the various waste types. For INEL, there are hundreds of possible combinations of alternatives across all the waste types. It is difficult, if not impossible, to make a realistic forecast of the impact on INEL or its ROI until DOE expresses a specific preference for all five waste types.

Response
There are many possible combinations of alternatives across all the waste types for INEL, as well as for other sites. For this reason, the minimum and maximum values for each impact parameter, including socioeconomic effects, were identified for each site for each waste type. These values were summed to determine the combined minimum and maximum impacts. This information is provided by site in Volume I, Chapter 11, under combined waste management impacts.

Because the factors that influence the socioeconomic consequences of the proposed alternatives are multiple and complex, it is not possible to predict precise outcomes at each site for the proposed waste management alternatives. These are subject to multiple internal and external influences such as site priorities, local social conditions, Records of Decision, etc. However, estimates can be made by comparing certain characteristics of the alternatives with existing conditions of the local affected communities. The result is not intended as an absolute statement of definitive outcomes, but serves as a basis for comparing the potential effects of one alternative with another.

At INEL, the socioeconomic impacts of the combined waste-type alternatives (Table 11.7-1) include a 1.44% to a 7.35% increase in jobs in the region and a population increase ranging from 0.59% to 4.92%. DOE expects the effects of the combined preferred alternatives to fall within these ranges.

Comment (2475)
Given the possibility of employment increases at the levels projected in the WM PEIS for pending DOE actions and the possibility of construction overlap, it is vital that the State of Idaho obtain a time line for all pending DOE actions at INEL. Although only a projected time line, it would give the State and the region of influence the information necessary to prepare for periods of inflated or deflated employment at INEL.

Response
DOE revised the WM PEIS to include a more comprehensive analysis of cumulative impacts. Section 11.2 in Volume I notes that site employment levels are considered in the cumulative impacts analysis. The cumulative impacts analysis considers impacts from all reasonably foreseeable past, present, and future DOE actions at DOE sites.

The economic impacts subsections in each waste-type chapter discuss the potential employment impacts. Included are the assumptions regarding the number of years for which there would be construction and operations jobs for waste management activities. The WM PEIS analysis does not include specific assumptions about the time at which actual construction or operations activities begin or end at individual sites. Except for the use of general time frames for activity, no assumptions are made with respect to peak or off-years for employment. These are presented without reference to the year in which they occur, since the specific years are not known.

Although DOE recognizes that the potential cumulative socioeconomic effect of rapid or cyclical changes in employment are important, it was not feasible to characterize each of the sites affected in the detail necessary to create a year-by-year projection of employment. These scheduling decisions would be made at the site-level when analyzing specific waste management projects. Projected decline or expansion of individual site activity is not a component part of any of the alternatives considered; therefore, delineated project schedules for other projects were not included as a part of this evaluation. However, overall effects are considered as aggregate effects in the cumulative impacts analysis.

Comment (2479)
No rationale is given for selection of the 15% criterion for a major impact on site employment or for the 1% criterion for indicating a "significant potential for creating change to the social environment." If, in fact, pending DOE actions would subject employment at INEL and its region of influence to a yo-yo effect, the adverse effects on the infrastructure could be much worse than a simple 15% increase in employment at INEL over a number of years. It is one thing to provide for moderate increases in elementary school age children over a number of years; it is another to accommodate extended periods of temporary but unexpected sharp increases and decreases. The latter is far more disruptive than the former. The DOE criteria for significant impacts fails to address this problem.

Response
The WM PEIS does not directly analyze potential increases in site employment, but does use site employment as the basis for analyzing of other effects. The 15% criteria was used as an index to represent the level of increased site employment at which impacts to onsite transportation infrastructure would potentially increase. It was not intended to be a projection of increased employment under the waste management alternatives. Detailed methodologies for transportation infrastructure impacts are presented in Section C.4.9 in Volume III.

The potential for cyclical (yo-yo) effects related to changing employment requirements during the life of a project was recognized by DOE in the analysis for its potential to result in sharp and sudden population increases in the regions of influence. In addition to average annual employment figures, the potential highest peak employment was calculated for each site under each alternative to determine any potential effect on regional population due to site activity. These figures are presented and discussed in Sections 6.8, 7.8, 8.8, 9.8, and 10.8 in Volume I. Further details can be found in the WM PEIS

5.6 Socioeconomics

Environmental and Socioeconomic Impacts Methods and Results Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Detailed methodologies for socioeconomic and population effects are presented in Sections C.4.5 and C.4.6 in Volume III of the WM PEIS. Additional supporting material is presented in Sections 6.5 and 6.6 of the WM PEIS Environmental and Socioeconomic Impacts Methods and Results Technical Report. DOE revised the discussion in Section 5.4.6.1 in Volume I of the WM PEIS to clarify the use of the 1% criterion for creating change in the social environment. The 1% criterion was based on the assumption of a minimum 1% surplus capacity in public service delivery systems, infrastructure, and other health and welfare services.

Comment (2488)
Volume I, Section 4.3.6 states, "When examined on an individual county basis, with the ROIs, DOE and contractor employment was in all cases less than 9.5% of the total county employment." Is this true for Bonneville County, Idaho? Seventy-seven percent of the INEL workforce resides in that county. Also see Section 4.4.5.

Response
DOE deleted the reference to the relationship of DOE and contractor employment to individual county employment across all regions of influence. This information was not required as a baseline for the analysis, and was not utilized. Regions of influence were defined according to the criteria presented in Section 5.4.5 in Volume I and Section C.4.6.1 in Volume III. The counties that together account for at least 90% of a sites' workforce are those considered to comprise the sites' socioeconomic region of influence. Bannock, Bingham, Bonneville, Butte, Clark, and Jefferson counties together comprise INEL's region of influence.

Comment (2498)
Madison County, Idaho, is not included in the INEL socioeconomic region of influence.

Response
Although a potential for impact to Madison County is considered in the analysis, Madison did not meet the criteria for inclusion in the INEL socioeconomic region of influence. Regions of influence were defined according to the criteria presented in Section 5.4.5 in Volume I and Section C.4.6.1 in Volume III. The site-level region of influence was defined to include host and/or contiguous counties and any counties within the region containing at least 90% of the work force. The WM PEIS Affected Environment Technical Report, Sections 2.3.5 and 4.4.5, contain additional detail.

Comment (3113)
The WM PEIS economic analysis only considers increases in spending. It does not consider decreases in spending as activities are shifted from the individual sites to a regional or central site.

Response
In general, the No Action Alternative for each waste type represents the baseline for comparison of alternatives. Employment, income, and industry output under No Action can be assumed to be part of the 1990 regional economies of the 17 major sites. Any alternatives under which expenditures induce employment, income, and industry output greater than the No Action figures at a site would cause

growth in that sites' economy. Any alternatives under which expenditures induce changes lower than those of the No Action expenditures would diminish the sites' regional economy. In general, because expenditures under No Action are minimal (some waste management activity is required under all alternatives), alternatives that would diminish any regional economy are the exception.

5.7 Land Use

Comment (177)
A decision to store nuclear and hazardous waste at LLNL Site 300 would greatly interfere with the long-term land management decisions planned for the City of Tracy, California.

Response
As described in DOE's *Charting the Course - the Future Uses Report*, current uses at LLNL Site 300, including research and development, industrial, institutional, and administrative/technical uses, will be continued. Most of Site 300 is undeveloped and is available for compatible experimentation and testing. Additional areas for possible development to support site missions have been delineated. Therefore, alternatives evaluated in the WM PEIS are generally consistent with future land-use at LLNL Site 300.

Subsequent to a programmatic decision to manage waste at LLNL, DOE would perform a sitewide or project-level NEPA analysis that would consider local and regional planning issues. The development of Site 300-specific NEPA documentation will include consultation with local community and regional planning entities, including the City of Tracy.

Comment (523)
DOE needs to clarify how current and future land-use scenarios at INEL will be affected by WM PEIS decisions.

Response
The WM PEIS land-use analysis evaluates the potential land area requirements for the proposed treatment, storage, and disposal facilities against the potentially available land at each candidate site. As described in DOE's *Charting the Course - The Future Use Report*, INEL's future use recommendations, generated by an internal site team with local, regional, State, Tribal, and public input, generally support continuing current site land use with the central developed area being used as an industrial/commercial area and the surrounding area serving as a buffer and for grazing. The industrial/commercial use category consists of worker-based facilities such as research and development facilities, support uses, and storage and disposal facilities. Therefore, alternatives evaluated in the WM PEIS are consistent with future land-use at INEL.

Potential land-use conflicts or restrictions at specific INEL locations would be addressed in sitewide or project-level analyses. Volume I, Section 1.8.1, of the WM PEIS discusses the relationship between the WM PEIS and current project-level documents that address specific land-use decisions.

Comment (2188)
DOE failed to factor in any value for using land and resources in the Northwest for disposal. The WM PEIS says the cost of volume reduction is not worthwhile, in comparison to the cost savings from disposal. In other words, it is cheaper not to reduce the volume. The law requires DOE to consider the irreversibility of the commitment of resources, and the use of land is one of them.

Response
When land is used for treatment, storage, or disposal facilities its value for other purposes may be lost or diminished. NEPA mandates that an EIS address any adverse environmental effects that cannot be avoided if the proposal is implemented. Volume I, Sections 12.3 through 12.5, of the WM PEIS addresses unavoidable adverse impacts, the relationship between short-term uses of the environment

and maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources, including land, that could result when DOE implements its waste management strategy.

DOE revised Volume I, Sections 6.14, 7.14, 8.14, 9.14, and 10.14, and Volume III, Section C.3.2.1.4, to indicate that it would be too speculative to attempt to factor in the long-term value of land.

Comment (2319)
The PEIS should address the land area for disposal at Hanford.

Response
Although DOE will select sites for waste management activities based on the WM PEIS, it will not select specific locations for waste management facilities at any site. The area considered for construction of waste management facilities, including disposal facilities, at Hanford is the 6,000-acre Central Plateau, designated in Hanford's site development plan for waste management use. The acreage requirements estimated in the PEIS for waste management facilities at Hanford for all waste types combined in Volume I, Section 11.6.2, including any low-level waste or low-level mixed waste disposal facilities, constitute only a small portion (from 6.5 to 178 acres) of this 6,000-acre area (see Table 11.6-1). Again, the specific locations of the disposal units on the Hanford Central Plateau have not been chosen. However, DOE believes, based on these estimates, that sufficient land is available to support construction of any necessary waste management facilities on the Central Plateau.

Comment (2489)
Volume I, Section 4.3.8, describes how land availability was determined for 54 DOE sites nationwide and provides a table that presents total acreage and estimated available acreage at the 17 major DOE sites (Table 4-8). DOE determined available acreage by subtracting land currently used and unavailable land from the total acreage.

The Draft PEIS does not document what conclusions were reached from each of the steps in the assessment of available land, nor which references were utilized to reach those conclusions. The PEIS should include sections in the land-use assessment portion of the document discussing the following items, in detail, for each facility:

- Total site acreage and current land use at the facility;
- Land set aside for cultural resources, sensitive species, wetlands, floodplains, buffer zones, etc.;
- Land determined to be unsuitable for future development due to seismic, volcanic, or other geological constraints (such as superficial materials and availability of water);
- Anticipated future land uses and zoning;
- Projected decontamination and decommissioning activities;
- Population densities;
- Public Land Orders, Memoranda of Understanding, and other agreements affecting land use at the site;
- Recreational uses;
- Contaminated areas and areas expected to be restored to conditions suitable for new development.

5.7 Land Use

Response
The WM PEIS is a programmatic document that will lead to nationwide decisions on where to treat, store, and dispose of wastes. DOE used the land-use information in the WM PEIS solely to determine if sufficient land would be available for waste management facility construction at the sites and to determine if facility construction would be compatible with DOE's site planning. The WM PEIS was revised to include new waste management-designated acreage numbers for several sites, as well as more detailed information on site activity and proposed land uses.

DOE sitewide or project-level NEPA analyses would also consider local and regional planning issues, in addition to any incompatible land-uses either on or adjacent to the sites. Consideration of Site-Specific Advisory Board land-use plans would be an integral part of those analyses. However, because the WM PEIS does not address site or regional land-use decisionmaking, DOE did not evaluate Site-Specific Advisory Board plans in the PEIS land-use impacts analysis.

Information used in the land-use assessment portion of the PEIS was summarized from the WM PEIS Affected Environment Technical Report, which contains the details of the land-use information and sources. The report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the WM PEIS.

Comment (2529)
DOE did not perform a detailed land-use analysis because at all sites considered in the WM PEIS land-use requirements would be below 1% of the estimated land available. This approach provides a very narrow assessment of impacts from future DOE actions. A programmatic analysis of impacts should also consider the cumulative impacts of that program on actions taken by other programs within the Department. As an example, the maximum estimated land needs at INEL, under all alternatives, are 121 acres (Section 11.5), far below the 1% threshold. However, "other," generally unspecified, actions at INEL are expected to affect a maximum of 1,096 additional acres. This would easily exceed the Draft WM PEIS 1% screening threshold and require a detailed land-use impact analysis for the site.

Response
Chapter 11 in Volume I of the WM PEIS describes the cumulative impacts analysis for all sites analyzed in the WM PEIS. The analysis also includes the results of combined impacts, which would result from locating more than one waste facility at a site. The 1% threshold for land use is a screening level used for programmatic analysis of the waste management requirements only. The combined alternatives would affect between 28 and 121 acres of land at INEL, while other actions could affect another 1,059 acres. Although existing operations, the combined alternatives, and other actions would only cumulatively affect a maximum of about 2% of the suitable acreage at INEL, any land to be disturbed might require detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts. Sitewide or project-level NEPA reviews would consider land-use impacts, including cumulative impacts, in more detail.

Comment (2812)
It is sometimes difficult to assess potential future use of DOE facilities (some of which span multiple counties) using local development plans. These facilities are often the primary livelihood of the community. If available, the site-specific land-use plans approved by the citizens groups chartered by the Federal Advisory Committee Act (e.g., the Site-Specific Advisory Boards) would be preferable.

Response
Local and regional development plans are one factor in assessing the future use of DOE facilities. Sitewide or project-level NEPA reviews would address local and regional planning issues in addition to any incompatible land uses either on or adjacent to the sites. Consideration of Site-Specific Advisory Board land use studies and advice would be an integral part of those analyses. Until final selection of alternatives and the subsequent identification of proposed specific locations on sites, consideration of adjacent land use is not possible. DOE is committed to working with local governments to clarify planning expectations and evaluate future uses of sites and contiguous areas.

Comment (2819)
Volume I, Table 7.13-2, Acres Disturbed During Construction, [in the cultural resources section of the Draft WM PEIS] does not include BNL, even though earlier tables and figures (Tables 3.4-2, 3.6-2, 7.3-2, 7.4-7, and 7.4-10, and Figure 7.3-2) indicate that disposal and/or treatment facilities would be required at BNL.

Response
Table 7.13-2 has been removed since, as explained in Volume I, Section 5.4.10, the number of acres disturbed is less important than the exact location of a facility in determining impacts to cultural resources. These impacts will be considered in sitewide or project-level NEPA reviews.

Comment (2888)
DOE did not perform a detailed analysis of land use impacts at INEL. The WM PEIS "screens" INEL from a detailed analysis based on assumptions regarding land availability for future development. However, the basis for those assumptions is not adequately documented. In addition, the PEIS does not assess cumulative land-use impacts arising from current uses, future spent nuclear fuel management uses, and future waste management activities. Further, it does not indicate if land-use impacts would be temporary or permanent. To conduct a meaningful evaluation of land use impacts, the Final WM PEIS should present site-specific information for the various sites. Waste disposal at INEL will have to be in accordance with the INEL Land Use Plan.

Response
The WM PEIS is a programmatic document that provides information for policy-related decisions. The SNF/INEL PEIS discusses INEL site-specific information in detail, including land use, in Volume II, Part A.

No attempt was made in the WM PEIS to identify or select the actual locations of proposed waste management facilities on sites. The land-use analysis available at the programmatic level is a comparison of land available to land required. DOE did not attempt to determine the acceptability or suitability of available land beyond certain minimal requirements. DOE will choose locations for new facilities on sites after it issues WM PEIS Records of Decision and completes any additional sitewide or project-level NEPA reviews that could be required. The INEL Land Use Plan will be considered in any project-level reviews. Until final selection of alternatives and the subsequent identification of proposed specific locations on sites, consideration of adjacent land use is not possible. DOE is committed to working with local governments to clarify planning expectations and evaluate future uses of sites and contiguous areas.

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The waste management land-use requirements would be generally small in relation to total available land. As a result, the final analysis does not necessarily discriminate between alternatives, since sufficient land area would exist under any of the alternatives. However, the analysis does conclude that sufficient land exists at most sites to allow DOE to avoid environmentally or culturally sensitive areas.

Cumulative impacts of land-use requirements at the sites are presented in Chapter 11 in Volume I. This includes cumulative impacts of current activities and reasonably foreseeable future activities.

Section 12.5 describes the potential irreversible and irretrievable commitment of land at DOE sites. Only land used for disposal would be irretrievably committed.

Comment (2895)
Volume I, Section 4.3.8 states that "pertinent" State and local land-use plans are acknowledged as an important factor in determining the impact of siting the disposal facilities. However, site-specific evaluations are identified as the appropriate vehicle for determining siting constraints. This is contradictory to the purpose of the WM PEIS. In the case of BNL, special surrounding land-use decisions have already been made that are inconsistent with the disposal of hazardous and/or radioactive wastes, and BNL officials have suggested that BNL's mission is not incompatible with such planning decisions. Therefore, it seems that at least one site, BNL, has made it easier for DOE to address land-use issues prior to a site-specific study. Accordingly, Section 4.3.8 should be modified to address the particular case of BNL, and use this issue as an obvious reason for dismissing BNL as a candidate for the disposal of wastes, even under the Decentralized Alternatives. In addition, Section 5.4.8, contains a generic discussion of the land-use analysis that is too simplistic, especially when considering site-specific issues relating to BNL. There are many land-use issues concerning BNL that must be addressed.

Response
The WM PEIS does not attempt to identify or select the actual locations of the proposed waste management facilities on sites. The land-use analysis evaluates the potential land-area requirements for the proposed treatment, storage, and disposal facilities against the potentially available land at each site. For purposes of analysis, newly constructed facilities were assumed to be located near existing facilities or at the center of the site. Therefore the WM PEIS land-use analysis does not attempt to determine the acceptability of the available land for use by waste management facilities. Rather, the PEIS assumes that sufficient land will be available in comparison to waste management requirements to allow DOE to avoid environmentally or culturally sensitive areas. Waste management land-use requirements would be generally very small in relation to total available land area.

While useful at a programmatic level, the WM PEIS land-use analysis will be supplemented by detailed analyses in sitewide or project-level NEPA reviews if waste management facilities are actually to be located at BNL. These analyses would consider local and regional land-use plans in more detail. Until final selection of alternatives and the subsequent identification of proposed specific locations on sites, consideration of adjacent land use is not possible. DOE is committed to working with local governments to clarify planning expectations and evaluate future uses of sites and contiguous areas.

Comment (3067)
It appears that land requirements below 5.4 square miles at Hanford are not "displayed in the waste-type chapters" (as suggested in Section 5.4). This disregards a substantial portion of land.

Response
The 1% criterion for land use applies to 1% of either the land area available for development at the site, or of land specifically designated for waste management activities at the site, not to the total site acreage. The designated waste management land area used in the Final WM PEIS for Hanford is 6,000 acres (approximately 9.4 square miles), substantially less than the approximately 540-square-mile total size of the site. The 1% criterion for Hanford, then, applies to all waste management activities requiring 60 or more acres (less than 0.1 square mile).

Considering the size of the site and the extensive area designated for waste management activities, this is not a substantial portion of land. As noted in Chapter 5, the 1% screening criterion for land-use impact is established to increase the clarity of the document and focus attention on the sites and alternatives where the land requirement is more likely to result in significant land-use impacts. Requirements below the 1% criterion, although not expected to result in significant impacts, are not disregarded, but are presented in the Site Data Tables contained in Volume II of the WM PEIS. These tables present detailed acreage requirements for each site under each waste management alternative.

Comment (3071)
Section 5.4.8 establishes a concept for land-use impact evaluation and a threshold screening criterion that, when applied in the analysis, does not discriminate between alternatives.

Response
The PEIS does not identify or select the actual locations of the proposed waste management facilities on sites. Neither does it determine the acceptability or suitability of available land beyond certain minimal requirements. The PEIS land-use analysis simply compares the potential land-area requirements for the proposed treatment, storage, and disposal facilities to the land potentially available at each site. The actual siting of new facilities would be done after completion of the sitewide of project-level NEPA analyses.

The waste management land-use requirements would be generally small in relation to total available land at each site. As a result, the final analysis does not necessarily discriminate between alternatives, since sufficient land area would exist under any of the alternatives. However, the analysis does conclude that sufficient land exists at most sites to allow DOE to avoid environmentally or culturally sensitive areas.

Comment (3085)
Volume I, Section 8.7.2, of the Draft WM PEIS stated that the Centralized Alternative for transuranic waste would require 0.17% of Hanford's available land for a treatment facility. It is unclear whether the 0.17% acreage required for transuranic waste facilities at Hanford under the Centralized Alternative is based on the 14,496 available acres referenced elsewhere in the Draft WM PEIS (Table 4-8). The available acreage should be based on the 6,000 acres recommended by the Hanford Future Site Uses Working Group.

Response
DOE revised the WM PEIS to use the 6,000 acres of the Central Plateau that was set aside in Hanford's site development plan for waste management. This is the same area recommended for use by the Hanford Future Site Uses Working Group. In the transuranic waste land-use analysis, 24.7 acres was estimated to be required to construct new facilities at Hanford under Regionalized

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Alternatives 2 and 3. In Volume II, Table II-5.3-11, that acreage translates to 0.41% of the 6,000 available acres. DOE revised Volume I, Section 8.7.2, to indicate that the acreage required for transuranic waste facilities under Regionalized Alternatives 2 and 3 would be 0.41% of the available acres.

Comment (3242)
Economic impacts and land-use impacts should include the lost value of the land set aside for use by DOE for waste disposal operations. The value of land should be based on contingent valuation based on the greater of Tribal or agricultural value amortized forever.

Response
Section 12.4 in Volume I of the WM PEIS does consider the potential impacts of land set aside for waste disposal operations. However, land valuation is a strongly site-specific consideration. Because the precise location of future waste management facilities at individual sites is not yet known, a more detailed assessment of the value of any land commitments, either in market terms or as the value of any other social or economic use that might be forgone, is not considered useful to this programmatic analysis. Moreover, because of the potential for variation from site to site and over time, it would be difficult to develop, at the programmatic level, a consistent and uniform methodology that could be applied to all sites. Therefore, the WM PEIS land-use analysis is limited to a comparison of the land available to land required. No attempt was made to determine the acceptability or suitability of land or the potential value of other uses of the land beyond certain minimal requirements.

DOE is committed to the process of developing Site-Specific Advisory Board sponsored plans for future land use as another approach to incorporating community values and encouraging local community input into the land-use evaluation process. This is especially useful in determining the importance of particular land areas or uses to stakeholder groups and incorporating a concern for future generations into current land-use studies. This information would be used during sitewide or project-level NEPA reviews.

Comment (3299)
Given the potential for irreversible and irretrievable land use, DOE site managers should work closely with local government officials to clarify planning expectations and avoid conflicts with anticipated future uses of the site or contiguous areas. In general, every effort should be made to use already contaminated sites for waste management operations.

Response
No attempt was made in the WM PEIS to identify or select the actual locations of the proposed waste management facilities on sites. The implementation of waste management alternatives will require additional studies. DOE is committed to working with stakeholders to clarify planning expectations and evaluate future uses of sites and contiguous areas.

Although there are some advantages to using contaminated sites that are already for waste management activities, there are some disadvantages. These include interference with remediation activities, exposure of waste management workers to existing contamination, and interference of existing contamination with future monitoring.

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Comment (3554)
The comparison of alternatives summaries in the waste-type chapters should consider land use a factor, because waste management actions will destroy important habitat at some of the sites (e.g., at Hanford, mature shrub steppe ecosystems), especially in arid climates where restoration/mitigation is difficult due to low amounts of precipitation.

Response
The PEIS does not identify or select the actual locations of the proposed waste management facilities on sites, and no attempt was made to determine the acceptability or suitability of available land beyond certain minimal requirements. If site development plans identified areas set aside for waste management, then these areas were used.

The waste management land-use requirements would be generally small in relation to total available land. As a result, the final analysis does not necessarily discriminate between alternatives, since sufficient land area would exist under any of the alternatives. However, the analysis does conclude that sufficient land exists at most sites to allow DOE to avoid environmentally sensitive areas.

Comment (3724)
The WM PEIS fails to place any value on land and other resources at the Hanford Site. It ignores the Hanford Future Site Uses Working Group Report and Native American Treaty Rights to use Hanford lands after they are cleaned up.

Response
DOE is concerned about the future use of land at and surrounding DOE sites and facilities. Recommendations for future use of the Hanford Site are being developed by the Hanford Future Site Uses Working Group, which includes representatives of Federal, Tribal, State, and local entities. These recommendations will be considered during the sitewide and project-level NEPA reviews that may follow the WM PEIS programmatic decisions.

The WM PEIS land-use analysis evaluates the potential land area requirements for the proposed treatment, storage, and disposal facilities against the land potentially available at each site. If site development plans identified areas set aside for waste management, then these areas were used. The PEIS does not identify or select the actual locations of the proposed waste management facilities on sites, and no attempt was made to determine the acceptability or suitability of available land beyond certain minimal requirements.

The waste management land-use requirements would be generally small in relation to total available land. The analysis indicates that sufficient land exists at most sites to allow DOE to avoid environmentally or culturally sensitive areas.

Comment (4061)
The PEIS does not adequately address land-use planning in the selection of nuclear waste or treatment sites (e.g., although Site 300 is proposed as a low-level waste site, it is not permitted as such).

Response
At the programmatic level of analysis, consideration of land-use issues is, by definition, very general in scope. No attempt was made in the WM PEIS to identify or select the actual locations of the proposed

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waste management facilities on sites. DOE will select actual locations on sites for new facilities after completion of any necessary sitewide or project-level NEPA analyses. Therefore, the PEIS land-use analysis does not attempt to determine the acceptability of the land available for waste management facilities. However, the PEIS analysis indicates that sufficient land will be available for waste management facilities to allow DOE to avoid environmentally or culturally sensitive areas. DOE is committed to working with local governments to clarify planning expectations and evaluate future uses of sites and contiguous areas. Sitewide or project-level NEPA analyses will also address local and regional planning issues.

5.8 Infrastructure

Comment (219)
In the Site Data Tables for BNL low-level mixed waste, the predicted power requirement for the Decentralized Alternative is 0.2 megawatts at 24% of existing capacity, while for the No Action Alternative the requirement is 0.23 megawatts at 49% of existing capacity. It seems illogical that a treatment/removal process could use less power than a storage/removal process. DOE's answer was that storage uses more power. One possibility is that combustible waste products would be used to lower energy costs at the site. If this were the case, then airborne waste might stay airborne beyond the boundaries of the site, and that would help explain the projected health effects listed in Volume II, Table II-3.1-2. These figures show a greater health risk for offsite individuals than for BNL lab workers. Is this true?

Response
Table II-3.1-14 in Volume II of the WM PEIS shows infrastructure impacts for low-level mixed waste treatment and disposal at BNL, including requirements for electrical power.

Electrical power requirements for the Decentralized and No Action Alternatives are similar. However, this similarity is coincidental. The Decentralized and No Action Alternatives are different management alternatives with an emphasis on different activities. For the low-level mixed waste No Action Alternative, the emphasis is on storage of BNL waste onsite, while for the low-level mixed waste Decentralized Alternative, the emphasis is on treatment and disposal of BNL waste onsite.

Waste at BNL is mainly combustible and requires primarily incineration and grouting. For BNL's waste, both of these treatment activities would have relatively small power requirements. Because this treatment would result in a large reduction in the volume of waste to be disposed of, the power required for disposal would be much lower than for indefinite storage. Another site with a different waste profile could have very different power requirements. DOE added a footnote to Table II-3.1-14 to explain the varying power requirements for BNL under the two alternatives.

Estimated health risks can be greater for offsite residents than for onsite workers. Onsite workers are assumed to be exposed to contaminants for 8 hours per day, 5 days per week, over the 10-year operational period of the waste management facility. Offsite residents are assumed to be exposed for 24 hours per day, every day for the 10-year operational period of the facility. Another reason is that the BNL waste profile contains a high proportion of organic liquids and sludges.

Comment (2877)
Under some alternatives, power consumption at INEL would increase to a level that would require new generating plants. The impacts and costs of these new facilities should have been estimated and included in the appropriate sections and with the cumulative impacts in the WM PEIS.

Response
The WM PEIS analyzed the combined impacts for each waste type of placing multiple facilities at each site. The minimum and maximum impacts for individual sites were then considered together with the impacts of other past, present, and reasonably foreseeable actions at and in the region of each of the 17 major sites. Volume I, Table 11.7-2, shows the cumulative impacts for INEL. DOE revised Section 11.7 to reflect that the maximum cumulative power consumption rate would be approximately 100% of current use. More detailed site-specific information is contained in the SNF/INEL PEIS, specifically in Sections 4.13 and 5.13.

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Comment (3044)
DOE should consider infrastructure age as well as capacity in Section 4.3.9 when calculating impacts of proposed additional loads.

Response
DOE assumed that any excess infrastructure capacity would be available for use by waste management activities. The infrastructure analysis does not account for, nor should it account for, replacement costs for systems nearing the end of their useful lifetimes. Although waste management activities could overload an already stressed site infrastructure, the waste management activities by themselves would not be the reason for replacing an aging infrastructure.

Comment (3238)
Volume I, Section 6.12, does not include infrastructure impacts for associated basalt, rock, or other materials needed for capping any disposal cells. The Environmental Restoration Program is already having difficulties in this area, as all of the basalt outcroppings on or near the Hanford Site are religious sites for the Tribes. As such, they may not be considered for use. Also, use of gravel and other materials could result in additional damage to the environment. This needs to be accounted for and mitigated.

Response
The WM PEIS site infrastructure impacts analysis focused on the effects of the waste management alternatives on water supplies, wastewater treatment, and electrical power systems. The consumption of resource materials such as basalt, rock, or other required materials (e.g. wood, concrete, sand, gravel, plastics, metals, and other materials used in construction) is addressed in Volume I, Section 12.5.

Since the WM PEIS is a national-level analysis, individual or spot shortages at specific sites are not considered. Sitewide or project-level NEPA analyses will consider any significant effects on consumption or potential shortages of construction materials, as well as potential mitigation measures.

With the exception of materials that can be recovered or recycled with present technology, the WM PEIS analysis assumes that these construction resources would be irretrievably lost. However, none of the identified construction materials is in critically short supply nationally, and most are generally available in the regions of sites that are being considered.

Comment (3301)
Although the WM PEIS addresses potential transportation infrastructure improvements associated with an increase in the number of commuters, it does not address potential impacts associated with up to 257,000 shipments of low-level waste over 20 years.

Response
Although 257,000 low-level waste shipments over 20 years is a large number of shipments, this works out to approximately 50 shipments per day, or 6 shipments per hour. Six trips per hour should not significantly impact traffic in the site regions of influence. In addition, waste shipments would tend to be spread across the workday, while worker trips tend to occur during the morning and evening rush hours. Therefore, the impacts to traffic would tend to be less for waste shipments, even when there are more waste shipments per day than worker trips.

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Sections 12.1 and 12.2 in Volume I describe measures that could be used to mitigate impacts from transportation. These include using a mix of truck and rail transport to minimize potential impacts from truck transport alone, and working with local and regional planners to prepare for additional road traffic.

Comment (3302)
Commuter numbers for NTS are based on the assumption that the relative distribution of NTS workers will be the same as the current distribution. However, the town of Pahrump, Nevada, has doubled in size since the 1990 Census, and is one of the fastest growing communities in the Nation. Travel on Highway 160, a two-lane route to NTS, should be analyzed based on higher commuter projections.

Response
DOE recognizes the potential for sudden and rapid changes in the socioeconomic conditions of local communities. However, because the WM PEIS is a broad, programmatic document intended to support a relative comparison of the alternatives, DOE did not attempt to analyze the potential effects of population growth on individual elements of offsite transportation infrastructure. That type of detailed analysis would be conducted, where warranted, in sitewide or project-level NEPA reviews. In the PEIS, DOE used an estimate of percentage increase in population as an index of the potential for effects on regional infrastructure.

Comment (3947)
DOE's assumption that there will be little impact to infrastructure elements such as drinking water supplies, sewage treatment, and roads is erroneous. DOE is only considering the immediate consequences, not the direct and indirect impacts of the proposed action for the next 20 years, as mandated by NEPA.

Response
DOE did not assume that there would be little impact to infrastructure elements. DOE understands the potential for impacts that its proposed actions could have on the infrastructure resources of the surrounding communities and regions as a whole. Section 5.4.9.2 in Volume I states that new resource requirement demands on offsite infrastructure for each alternative were based on population increases from 1990 regional population data. Evaluation of the transportation effects on infrastructure resources was based on forecasted increased traffic from employees directly or indirectly associated with the alternatives, based on estimated population changes. New offsite demands of less than 5% of current demand were assumed to be negligible or to result in minor impacts. Increases in demand of 5% or more were assumed to have the potential to cause moderate impacts, and increases of 15% or more were assumed to have potentially major impacts. The results are discussed in each waste-type chapter.

It is possible that the proposed action could attract other commercial development projects compatible with radioactive waste treatment and disposal. However, the introduction of these new projects in regions is a function of other factors (such as local taxes, facilities, regional preferences, etc.), as well as the proposed DOE action. As such, the proposed number, size, and location of these projects cannot be reasonably foreseen and their potential cumulative impacts when combined with the WM PEIS actions cannot be estimated.

5.9 Cultural Resources

Comment (96)
Commentors are concerned about impacts to Native American cultural resources from waste treatment, storage, and disposal activities at the LLNL.

Response
Volume I, Section 4.4.6, summarizes known cultural resources at LLNL. DOE could not evaluate site-specific cultural resources impacts in the WM PEIS because it has not proposed specific locations for waste management facilities on the sites. However, DOE did determine in the PEIS that the land required for such facilities would be a small fraction of the land available or designated for waste management. Therefore, DOE believes it probably will have sufficient flexibility to avoid or mitigate potential impacts to cultural resources. Sitewide or project-level NEPA reviews would consider cultural resources in detail. (See Volume I, Section 5.4.10.)

Volume I, Section 5.4.10, of the Final WM PEIS discusses the unique nature of Native American Cultural and religious resources. Five Federal laws prompt consultation between Federal agencies and Native American tribes: the National Environmental Policy Act, the National Historic Preservation Act, as amended, the American Indian Religious Freedom Act, the Archaeological Resources Protection Act, and the Native American Graves Protection and Repatriation Act. In accordance with these Acts, and in consideration of DOE's American Indian Policy, DOE would consult with Native American stakeholders before implementing waste management alternatives.

Comment (511)
The PEIS identifies Tribal members as minorities for the analysis. Although clearly mandated by Presidential Memoranda, Executive Orders, and DOE policy, the WM PEIS fails to recognize the sovereignty of the Native American Tribes and their unique government-to-government relationship with the United States government. The Tribes were not consulted early in the WM PEIS development process to identify issues critical to the survival of the Tribes and their cultures. The Federal Government must take affirmative steps to protect Tribal lands, resources, treaty rights, and ways of life. This includes the gathering of wild foods, fishing, and the use of several sites for religious activities. Without such steps, the treaty rights and obligations and Federal Trust responsibilities that have already been negatively impacted by DOE actions will be further adversely impacted. To ensure consideration of these issues, DOE should keep the Tribes informed on a timely and direct basis, and should clearly identify the plans for and timing of future Tribal consultations prior to making waste management decisions.

Response
The WM PEIS classifies Native Americans as minority populations in a numerical context only to describe the demographic characteristics of the regions surrounding the DOE sites. This information is used in the environmental justice analysis. This designation is not intended to contradict the discussion of the unique government-to-government relationships between the United States Government and Tribes, nor the Federal Trust responsibility. DOE policy recognizes the sovereignty of Native American Tribal Governments and their unique government-to-government relationship with the Federal Government as defined by history, treaties, statutes, court decisions, and the U.S. Constitution. DOE recognizes that it must consider the treaty rights of Native American Tribal Governments and the Federal Government's trust responsibility toward them when making decisions.

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DOE policy requires the agency to consult with Tribal Governments to ensure that Tribal rights and interests are considered; that the potential impacts of proposed DOE actions on cultural or religious resources are disclosed; and that any unnecessary interference with traditional religious practices is avoided. DOE is committed to incorporating this policy into its ongoing and long-term planning and management processes, including the NEPA process, and has worked through its site representatives to notify the Tribes of the WM PEIS scope and the availability of the document for comment. The Final WM PEIS was revised to include a general discussion of the consultation obligations and activities, as well as DOE's treaty obligations in Section 1.4.5. Section 5.4.10 in Volume I was revised to discuss the unique nature of Native American cultural and religious resources.

The WM PEIS analysis focuses on alternatives to support a national waste management strategy. The programmatic nature of the WM PEIS analyses is not conducive to considering the individual character of Native American cultures near DOE sites, and the specialized nature of each Tribe's concerns related to site activities. Sitewide and project-level NEPA reviews will more fully explore specific concerns related to Native American issues, such as the protection of sacred lands, cultural properties, and religious practices. During these reviews, local DOE officials will continue to work with Tribal representatives to exchange information about the need for and location of any necessary facilities and related activities, such as transportation requirements, and to consider specific Tribal values, potential environmental impacts, and appropriate mitigative measures. Several DOE Operations Offices have cooperative agreements with Tribal Governments about a range of environmental issues, and the sites' Tribal contacts will assist in the consultation process for site-specific and transportation issues related to the WM PEIS.

Comment (532)
DOE needs to understand the values of the Tribes in the State of Idaho and how their view of cultural resources diverges from the scientific community's. The Tribes believe air, land, and water are cultural resources and that an intrusion into "mother earth" is an effect on cultural resources.

Response
DOE recognizes that, for many Tribes, cultural resources include the natural environment and the natural landscape, and air, plant, water or animal resources that might have special significance. To facilitate communication between DOE and the Tribes, each local DOE office has a point of contact for Tribal issues and an ongoing cultural resource program to discuss such issues.

Section 1.4.5 was added to the Final WM PEIS to recognize DOE's obligation to consult with Tribal Governments about actions that could affect Tribal cultural resources. Section 5.4.10 discusses the unique nature of Native American cultural and religious resources, including regional locations, natural features, and biological and geological resources.

Comment (1561)
A Pueblo Native American site at LANL is being threatened by the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility. DOE needs to ensure traditional and cultural resources will be protected and their integrity maintained.

Response
DOE is committed to consultation. As described in Volume I, Section 1.4.5, of the Final WM PEIS, DOE's American Indian Policy, as implemented by DOE Order 1230.2, emphasizes the importance of

5.9 Cultural Resources

establishing a proactive approach to solicit input from Tribal governments on Departmental policies and issues. It also encourages Tribal governments and their members to participate fully in national and regional dialogues concerning Departmental programs. Consultation with Federally recognized Tribes is also an integral part of compliance with a number of cultural resource statutes and their implementing regulations discussed in Volume I, Section 1.4.1, of the WM PEIS

DOE complies with all laws protecting cultural resources, including the National Historic Preservation Act, the Archaeological Resources Protection Act, the Native American Graves Protection and Repatriation Act, the American Indian Religious Freedom Act, and Executive Order 13007 regarding sacred sites.

Potential impacts associated with DARHT are presented in the DARHT Final EIS.

Comment (3083)
The WM PEIS states that impacts to cultural resources from construction of facilities cannot be effectively analyzed at the programmatic level because there have been no decisions about where to locate facilities on sites. This is an admission of insufficient basis for effective analysis.

Response
DOE prepared the WM PEIS to support its strategy for broad, programmatic decisions about Department-wide waste management. NEPA permits the "tiering" of environmental analyses; that is, the agency may prepare levels of NEPA documentation beginning with an upper tier, broad analysis, and proceeding to lower tier, more detailed analyses as specific project and location decisions are developed. The detailed analysis of potential cultural resources impacts depends very much on the location of facilities on sites. In addition, at this time DOE cannot presume to know the results of cultural resources surveys until those surveys are conducted. DOE believes that the WM PEIS provides a sufficient basis for making programmatic decisions about its Waste Management Program.

Comment (3087)
Volume I, Section 8.10, states that "none of the alternatives appear to be superior in terms of limiting potential effects on cultural resources because the acreage requirements at the TRUW sites do not vary markedly across alternatives." This assumes that cultural resources are equally distributed throughout all DOE sites being considered, which is not true.

Response
DOE recognizes that the distribution of cultural resources is not uniform across the sites. Construction and operation of transuranic waste facilities could adversely affect cultural resources depending on final siting decisions. The WM PEIS analysis determined that land requirements for transuranic waste facilities, when measured against the total available land at potential sites, were sufficiently small that DOE would have sufficient flexibility in siting facilities so that, under all alternatives, DOE probably could avoid or mitigate potential impacts to cultural resources.

The No Action Alternative would result in no effects on cultural resources. Acreage requirements at each site under the other alternatives do not vary significantly, with the single exception of WIPP under the Centralized Alternative. Because these acreages are small relative to the site sizes in all cases, there is no basis for discrimination among alternatives in terms of the potential for cultural resources impacts. DOE revised Section 8.13 in Volume I to clarify these points.

Comment (3089)
Table 9.13-2 on acreage disturbance by site for construction of high-level waste facilities is based on the simplistic assumption of uniform distribution, and is followed by a footnote worth noting: Hanford's land requirements for high-level waste will increase by 8 acres if the high-level waste repository isn't taking wastes by 2015.

Response
Table 9.13-2 has been removed because DOE was concerned that this table could be misinterpreted as estimates of impacts, which they were not. Note that the acreage requirements at all sites under all alternatives are only a small fraction of the areas available for waste operations so DOE should be able to avoid impacts to any known cultural resources and any identified during pre-construction site surveys. If not, measures would be taken to mitigate negative effects on these resources.

The acreage for construction of the high-level waste interim storage facilities was determined by correlation of the available literature for similar facilities. Further information on the methodology for estimation of the land area required is given in Appendix A of the High-Level Waste Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The footnote referred to in the comment addresses the second Centralized Alternative, which considers the delay of the opening of the national geologic repository for high-level waste disposal beyond the year 2015. In this case, an interim high-level waste storage facility would be required for the Hanford glass canisters produced after 2015, which would occupy a land area of 8 acres. For the other high-level waste alternatives in the PEIS, DOE assumed that the national geologic repository would be available for receipt of high-level waste in 2015, and that any canisters produced after 2015 could be shipped directly to the repository without construction of an interim storage facility.

The WM PEIS does not provide a detailed analysis of the potential for cultural resources impacts because the specific locations of facilities on sites are not yet known. After DOE announces its programmatic decisions, it will conduct detailed cultural resources studies as part of sitewide or project-level NEPA analyses before implementing any waste management alternative.

Comment (3114)
If cultural resources impacts are not evaluated in the WM PEIS, how will such information be used in subsequent decisions.

Response
After DOE announces its waste management programmatic decisions, it will conduct more detailed sitewide or project-level analyses before making final decisions about the locations of waste management facilities on sites selected. Environmental analyses based on actual conditions and site resource surveys will be conducted to determine the nature and extent of any potential impacts to cultural resources. However, based on the WM PEIS land-use analysis, DOE believes that it will have sufficient flexibility in locating new facilities to avoid or mitigate any potential impacts to cultural resources.

5.9 Cultural Resources

Comment (3118)
Section C.4.10.3 states that, at the programmatic level, both the specific area of potential effects and the presence or absence of National Register eligible historic properties are at present unknown. How will such unknowns affect the decisions to be made?

Response
DOE does not expect the absence of detailed information on the specific area of potential effects or the location of historic properties to have a substantial effect on the WM PEIS decisionmaking process. There is sufficient information on the land-use requirements for proposed waste management facilities, existing cultural resources at sites, and the extent to which each site has been surveyed for cultural resources for DOE to make programmatic decisions. Based on the WM PEIS land-use analysis, DOE believes that it will have sufficient flexibility in locating waste management facilities to be able to avoid or mitigate cultural resources impacts.

Sitewide and project-level environmental analyses will determine the potential for impacts to cultural resources when specific locations for proposed waste management facilities have been identified. Cultural resources surveys will be conducted where appropriate to determine the extent and degree of any such potential impacts. DOE will evaluate the potential for cultural resources impacts in coordination with State Historic Preservation Offices, Tribal Governments, and site advisory boards, and will develop plans to avoid or mitigate impacts to cultural resources.

Comment (3119)
The statement in Section C.4.10.2 that adverse effects on historic properties include the introduction of visual, audible, or atmospheric elements that are "out of character" with the property or alter its setting would seem to preclude any uses.

Response
It is DOE policy to locate proposed facilities in a manner that avoids or minimizes impacts to cultural resources to the greatest extent possible. In addition to the other considerations noted in Section C.4.10.2, the potential to introduce visual, audible, or atmospheric conditions that are out of character with the property would be an important factor in determining the level of anticipated impact and the ability to avoid or mitigate those impacts. DOE believes that it will have sufficient flexibility to locate its facilities without seriously affecting the nature and character of existing cultural resources. More detailed sitewide or project-level NEPA analyses will explore these elements at specific sites.

Comment (3226)
Section 4.4.4. In addition to the Tribal lands identified in Figure I-4b, all of the Hanford lands are subject to Tribal Treaty Obligations. Many locations on the Hanford site are of religious significance to the Tribes. Native remains have also been found at many locations on the site.

Response
The presence of Native American cultural and religious properties of significance to local tribes at the Hanford Site is addressed in Volume I, Table 4.3-8 and Section 5.4.10, and in the WM PEIS Environmental and Socioeconomic Technical Report. The description of the affected environment for Hanford notes the presence of Native American settlements, and numerous recorded archaeological and traditional cultural properties. To date, archaeological surveys covering 21,358 acres of the site have

been completed. Section 1.4.5 in Volume I discusses DOE's Tribal treaty obligations and consultations with Tribes.

DOE recognizes that it must consider the interests of Native American groups and, as applicable, Federal and Sate regulations with regard to Native American and cultural resources, as well as any treaty obligations in the siting of any new facilities at the Hanford Site. The analysis of cultural resources and other land uses at the Hanford site indicates that there would be sufficient land area available for this purpose and that facilities could be located without disturbance to traditional, historic, or cultural properties. DOE will consult with Tribal Governments to assure that Tribal rights, including treaty rights, are considered prior to taking any actions. DOE will honor all applicable obligations under Tribal treaties.

Comment (3230)
The WM PEIS does not appear to assess the potential impacts on Tribal members exercising their rights under the Treaties. Tribal members often have diets significantly different from the general population. A Tribal risk scenario should be included similar to the resident farmer scenario.

Response
Section D.2.2.1 in Volume III of the WM PEIS states that DOE has not evaluated the human health risk to subpopulations that derive a portion of their food supply from native plants and animals that live near the DOE sites. The risk to human health from ingesting native plants and animals cannot be fully analyzed with confidence until the locations of facilities on the sites are known, the routes of exposure are explicitly defined, and the dietary habits of affected subpopulations are quantified. Therefore, analysis of health effects from subsistence consumption of fish, wildlife, and native plant species is not included in the WM PEIS, but would be considered in sitewide or project-level NEPA reviews.

Section C.4.7.2.4 in Volume III does contain a discussion of the vulnerability of minority and low-income populations to adverse health affects due to subsistence food consumption.

Comment (3984)
In agency consideration of Native American Resources (Chapter 5) access to sacred sites *preserved in their natural setting* is crucial to the mandates of American Indian Religious Freedom Act of 1978. Indigenous peoples cannot and do not separate the surroundings, including graves, from the sacred quality of the site itself. To allow waste disposal and treatment in the natural surroundings of these sites is to desecrate the site. Tribal peoples view the earth, their relationship to the natural world, and to their creator as a connected entity that cannot be dissected or disrupted without violating their religious beliefs.

Response
DOE recognizes that Native American cultural resources include a wide range of historic and traditional properties as well as regional locations, natural features, and sacred or traditional areas that are associated with the cultural practices or beliefs of a living community. The Native American Resources impacts discussion in Section 5.4.10 in Volume I of the Final WM PEIS has been revised in response to this comment. Section 5.4.10 now identifies impacts to Native American Resources to include reduced access to sacred sites preserved in their natural setting.

5.9 Cultural Resources

In general, cultural resource issues must be addressed at the site level due to the individual nature of the Tribes, the local cultural resources, and the ongoing and planned DOE activities. Sitewide or project-level NEPA analyses will more fully explore these concerns as they relate to specific sites. During these analyses, local DOE offices will continue to work with other agency and Tribal representatives, as well as other members of the public. It is during this next level of planning and project-level implementation that specific values and environmental considerations will be examined and appropriate mitigative measures developed. To facilitate communication between DOE and the Tribes, each local DOE office has a point of contact for Tribal issues and an ongoing cultural resources program to discuss such issues.

Comment (3985)
Agencies should attempt to identify sacred sites and burial sites in consultation with authorities recognized by the potentially impacted culture, rather than authorities with no knowledge of the specific impacts on that unique culture.

Response
DOE is aware of the sensitivity of these resources, especially Tribal traditional and religious properties, and is committed to minimizing any potential impacts wherever possible. In addition to close coordination with State Historic Preservation Offices and the Advisory Council on Historic Preservation, DOE's policy includes consultation with Native American Tribal Governments to inform these groups on current and potential activities at the sites. DOE has and will continue to provide every opportunity for participation in the NEPA process to Native American Tribes. Consistent with Federal cultural resource laws, the American Indian Religious Freedom Act, and Executive Order 13007 (Sacred Sites). Each DOE field office or site with areas of cultural or religious concern to Native Americans will consult with them about potential impacts of proposed actions on those resources and will avoid unnecessary interference with traditional religious practices.

Comment (4014)
The WM PEIS analysis of the impacts of waste management activities on cultural resources is inadequate because it fails to consider the consequences of restricted access to American Indian cultural resources. The analysis fails to consider that in addition to the physical disruption of land, the DOE facilities will require that access be restricted to a much larger amount of land surrounding the facilities. In general, most Tribes prefer that the remains of their ancestors be left undisturbed by archaeologists or construction activities, and appreciate the WM PEIS assurances that DOE will be able to avoid impacts to any known cultural resources or any identified during preconstruction site surveys. However, access is also important to the cultural vitality of the Indian people. The WM PEIS needs to consider the issue of restricted access to cultural resources at the programmatic level; at the site-specific level, there will be little or no opportunity to change the access policies.

Response
DOE is aware of the potential for impacts to cultural resources, including Native American religious and traditional properties, that the actions proposed by WM PEIS alternatives might have. As indicated in Volume I, Section 5.4.10 of the PEIS, the concern for impacts to these areas includes both direct physical impacts, such as destruction or reduced access to sacred sites preserved in their natural setting, and indirect social and economic effects, such as intrusion on religious beliefs or cultural practices that might be connected to the earth and its resources. It is DOE's policy to manage its operations to avoid or minimize such impacts. Moreover, DOE must comply with all treaties, laws, and regulations

protecting Native American cultural properties. The description of cultural resources presented in Chapter 4 for each of the 17 major sites considered in the PEIS includes an identification of Native American resources at the sites, qualified by the extent to which site land area has been surveyed.

Because the WM PEIS document does not propose specific locations for waste management facilities on sites, DOE has not evaluated cultural resources impacts in detail at this programmatic level. However, the PEIS land-use analysis indicates that the amount of land required for such facilities would be only a small fraction of the land available or designated for waste management facilities at the sites. As a result, DOE would have sufficient flexibility in siting these facilities to avoid impacts to cultural resources. Sitewide and project-level NEPA analyses will include an examination of both direct (damage, destruction, loss of access) and indirect (institutional control, disruption of religious or traditional practices) impacts to cultural resources.

In general, cultural resources impacts must be addressed at the site level due to the individual nature of the resource itself, unique or specialized local Tribal interests, and the ongoing and planned DOE activity at each site. To enable discussion between DOE and Native American Tribal groups, each local DOE office has a point of contact for Tribal issues, as well as an ongoing cultural resources program to address such issues as they arise.

5.10 Geology, Soils, Seismicity

Comment (20)
Commentors are concerned about earthquake impacts, including above-design-basis earthquakes, at LLNL. The proposal to establish a radioactive disposal site in a "hot bed" of seismic activity makes no sense. The PEIS neglected earthquakes, and decontamination of the waste treatment facility was not addressed in the WM PEIS. The Final WM PEIS should address the possible splay of the Las Placitis fault, and possible cracking and shaking at both sites. The PEIS should also address secondary effects like the number of farms and livestock in the area around Site 300.

Response
The WM PEIS is a national and programmatic study to help DOE formulate and implement a strategy to manage its radioactive and hazardous wastes. DOE identified 16 candidate low-level waste disposal sites for evaluation based on a screening it performed in coordination with the States under the Federal Facility Compliance Act. The screening applied three exclusionary criteria, one of which was that the waste disposal facility could not be within 200 feet of a seismic fault. Section 4.4.6 in Volume I does mention major earthquake faults in the LLNL area. A supporting document, the WM PEIS Affected Environment Technical Report, contains more detailed information on seismic activity near LLNL. This report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Appendix E in Volume IV of the PEIS describes the accident scenarios caused by seismic events (earthquakes) at the sites during which exposure to chemical or radiological constituents of the waste could occur. Facility accident results are presented in Sections 6.4.3 (low-level mixed waste), 7.4.3 (low-level waste), and 8.4.3 (transuranic waste). These analyses assume generic design and do not incorporate earthquake criteria in design (which would be required to ensure public safety).

Sections 6.4.3 and 7.4.3 in Volume I present the health risks from a treatment facility accident at LLNL that is induced by an earthquake. For low-level mixed waste, the probability of a maximum offsite maximally exposed individual radiation-induced cancer fatality from the earthquake-induced accident is 2E-06, and the probability of a chemical-related cancer incidence is 3E-08. (More recent data on waste volumes at LLNL for tritium indicates these estimates could increase by a factor of 3.) For low-level waste under the same accident scenario, the probability of a maximum offsite maximally exposed individual radiation-induced cancer fatality is 4E-04 (chemical related cancer incidence is not applicable for low-level waste). (More recent data on low-level waste volumes suggest these risk estimates could decrease by 4 orders of magnitude.)

Storage facility accidents were estimated to result in a radiation-induced incremental cancer fatality risk to the maximally exposed individual of about 5E-06 to 2E-03. The accident frequencies ranged from greater than 1E-02 per year for the low-consequence accidents to less than 1E-06 per year for the high-consequence accidents. Additional information on accident scenarios and health risks from accidents initiated by earthquakes is provided in Appendix F (Volume IV) and Appendix D (Volume III), respectively. Thus, DOE decisionmakers have information in the PEIS to account for seismic activity in the vicinity of LLNL when selecting the final integrated waste management configuration.

Sitewide or project-level NEPA reviews would consider specific design basis and exact location of the waste management facility, would be as well as potential earthquake impacts. DOE would design,

construct, operate, and maintain waste management facilities in accordance with appropriate local seismic standards.

Secondary effects on farms and livestock are site-specific concerns that are best evaluated in sitewide or project-level NEPA documents. These reviews can provide a level of precision that is not attainable in a programmatic document such as the WM PEIS.

As described in Section 5.3.3, the program life-cycle cost estimates for the various WM PEIS alternatives include decontamination and decommissioning (D&D) costs. D&D costs include demolition of facilities, environmental closure, postclosure, and monitoring activities. Environmental impacts of D&D of waste management facilities were not included in the WM PEIS. These impacts would occur well in the future and D&D of waste management facilities would be subject to all applicable environmental requirements at that time. D&D impacts are not expected to exceed the impacts of construction and operation.

5.11 Cumulative Impacts

Comment (122)
Commentors are concerned about the impacts of treatment and disposal activities on the environments of areas that are already contaminated. More specifically, a number of commentors are concerned about the impacts to public health and safety if new wastes are added to the current pollution at Superfund sites.

Response
DOE analyzed the potential impacts of waste management activities at the 17 WM PEIS candidate sites. The baseline conditions for each site, against which the potential waste management impacts were measured, identified existing environmental contamination. Summaries of existing conditions at the sites are in Volume I, Chapter 4, of the PEIS. More detailed descriptions are contained in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS.

DOE has estimated the impacts of waste treatment, storage, and disposal activities added to other past, present, and reasonably foreseeable future actions (see Volume I, Chapter 11). To the extent that the impacts from environmental restoration sites, including Superfund sites, are known, they are identified in Chapter 11. DOE would undertake mitigation measures where necessary to meet regulatory requirements at sites where DOE would otherwise exceed the applicable standards.

The WM PEIS does not evaluate site-specific cumulative impacts in detail because DOE has not selected specific locations for waste management facilities on the candidate sites. Sitewide or project-level NEPA reviews would examine site-specific cumulative impacts in greater detail.

Comment (315)
The WM PEIS should include an analysis of the cumulative environmental impacts of the waste management facilities required across the country, including the transcontinental transportation of waste.

Response
Chapter 11 in Volume I of the WM PEIS describes the cumulative impacts that could result from the various alternatives under consideration. Section 11.20 discusses the cumulative impacts of transporting wastes. Appendix E in Volume IV of the PEIS discusses the transportation analysis.

Comment (1134)
The WM PEIS does not adequately address the potential cumulative impacts. It does not include the waste volumes generated as a result of environmental restoration activities, stockpile stewardship, fissile materials management, Naval and foreign research reactor fuels, and commercial high-level waste storage and disposal. In addition, the data in the Draft PEIS regarding many of the individual sites and their current environmental problems and future activities are wholly inadequate. Moreover, possible waste management technologies, including treatment and vitrification of high-level waste that could cause extensive exposures to workers and the public, are not adequately addressed. Consequently, potential cumulative impacts regarding waste management at individual sites or within the DOE complex as a whole are not adequately analyzed. Review and discuss the impacts that high-level waste reprocessing, plutonium and highly enriched uranium disposition, spent fuel, and other related treatment issues presented in different environmental impact statements will have on DOE waste treatment decisions.

Response
Section 1.8.1 in Volume I in the WM PEIS summarizes other DOE NEPA documents that address the activities identified in the comment. Section 1.8.1 also discusses the relationship between these NEPA documents and decisions to be made based on the WM PEIS analysis.

Cumulative impacts are evaluated in Chapter 11 (Volume I) of the WM PEIS. The WM PEIS considers the cumulative impacts of the proposed waste management actions, existing site conditions, and impacts of other reasonably foreseeable future actions to the extent possible. Consideration of cumulative impacts was necessarily limited in some respects because of the lack of data. The Draft WM PEIS did consider the cumulative impacts of spent fuel management, tritium supply and recycling, high-level waste treatment, and transuranic waste disposal. Plans for disposal of commercial spent nuclear fuel are not sufficiently developed to allow inclusion in the analysis. Additional information on stockpile stewardship and management, storage and disposition of weapons usable fissile materials, and disposition of excess highly enriched uranium that has become available since the Draft WM PEIS was prepared, is included in Chapter 11 of the Final WM PEIS.

The effects on the comparison among waste management alternatives of environmental restoration wastes for which responsibility would be transferred to the waste management system are qualitatively evaluated in the WM PEIS. The results of this analysis appear in Appendix B in Volume III and in Sections 6.15, 7.15, and 8.15 in Volume I.

Environmental restoration activities at most DOE sites cannot be meaningfully included in a cumulative impacts assessment at this time because information on environmental impacts of these activities at most sites is not available. For sites that do have adequate evaluations of environmental restoration actions, information on potential impacts is included in the cumulative impacts analysis presented in Chapter 11 in Volume I of the WM PEIS.

Comment (1360)
Cumulative impacts did not include surface-water quality, groundwater quality, or ecological/wildlife resources. DOE should have provided cumulative impacts on these three factors or detailed reasoning for their omission from the WM PEIS.

Response
DOE has revised the WM PEIS cumulative impacts analysis (Chapter 11 in Volume I) to identify the alternatives that could result in groundwater quality exceedances. Section 11.1 explains that DOE does not consider impacts to surface water and ecological resources because they depend on the specific location of facilities on sites and mitigation measures developed during design and regulatory review. DOE can better evaluate impacts to these resources in sitewide or project-level NEPA reviews.

Comment (1361)
The assessment of cumulative impacts for groundwater assumed that contaminants from each disposal site are separate and do not merge or commingle. However, it would be likely that within a single disposal site, if more than one of the waste types contaminates groundwater, the wastes will merge and commingle within the aquifer. Thus, DOE should have completed a cumulative impacts analysis of potential groundwater impacts at each disposal site.

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Response
At some sites, certain WM PEIS alternatives would require the construction of multiple disposal units (see Sections 6.4.1.9 and 7.4.1.8 in Volume I). DOE has revised Sections 5.4.1.2.2 and 11.1 in Volume I to clarify the following assumption. Concentrations of groundwater contaminants are assumed to be higher at 300 meters (984 feet) from the center of the disposal unit than at greater distances due to dispersion of contaminants. DOE assumes that contaminant plumes from multiple units will not commingle at the 300-meter wells, but that the likelihood of commingling increases with distance from the unit. However, at distances greater than 300 meters, the concentrations of groundwater contaminants in any given plume should be lower than those estimated at 300 meters as a result of dispersion and dilution. Sitewide and project-level NEPA reviews, and the performance assessment process required for the design and siting of disposal facilities (DOE Order 5820.2A), will consider site-specific conditions in more detail to ensure that groundwater resources are protected. Both the siting of the disposal facilities and the spacing of individual units can be selected by the designer to limit commingling of contaminant plumes that might increase pollutant concentrations beyond safe levels.

Comment (1520)
The WM PEIS fails to characterize the existing risk. DOE will not admit that current operations pose a risk to public health. DOE should address the existing public health problems from environmental restoration actions.

Response
Cumulative impacts are evaluated in Chapter 11 (Volume I) of the WM PEIS.

The WM PEIS has considered cumulative impacts from past, present, and reasonably foreseeable future actions to the extent possible. Factors that limited the consideration of cumulative impacts in some areas include lack of available data and schedule conflicts. DOE revised Chapter 11 to include a more comprehensive evaluation of other DOE actions that might affect the sites. Impacts of current activities are incorporated into the cumulative impacts analysis, since they contribute to the baseline (existing) conditions at each site.

The impacts of environmental restoration activities are generally not considered in the WM PEIS. However, the WM PEIS evaluates how environmental restoration wastes that might enter the waste management system could affect the comparison of waste management alternatives evaluated in the WM PEIS. The results of this analysis appear in Volume III in Appendix B, and in Volume I in Sections 6.15, 7.15, and 8.15. To the extent that the impacts from Superfund sites contribute to current estimates of dose and health risk, or were considered in sitewide EISs, these impacts are considered in the cumulative impacts chapter. Sitewide or project-level NEPA reviews will examine cumulative impacts in greater detail.

Comment (1737)
Risk factors and estimates should make it clear if any additional risks arising from the private sector have been considered. Some commercial facilities treat DOE wastes, are expanding their facilities, and are generating wastes as process by-products. ORR has several major commercial facilities supporting DOE waste management facilities.

Response
The WM PEIS evaluates the potential risks to members of the offsite population and to DOE site workers resulting from potential releases of radionuclides and hazardous chemicals from generic waste management facilities located on DOE sites. The health risk analysis does not consider impacts from the use of offsite commercial facilities because information about their locations and operations (e.g., process efficiency, number of workers, process release factor, etc.) would be required. Given the variety of potential commercial facilities available, such analyses are not feasible for this programmatic analysis. The Final WM PEIS includes a discussion of these and other privatization issues. See Section 1.7.4 in Volume I.

Comment (1751)
The WM PEIS assumptions do not obviously include all necessary parameters and are not conservative parameter levels for assessment studies (RADTRAN vs. ALOHA). For the general public to actively participate in the NEPA process, clear statements and uniformity in assumptions should be made for the levels of concern and the order of priority for the various parameters. For any technical document to lend itself to comparison and constructive criticism, the presentation of data must be explicit.

Referring to Volume I, Table 11-18, the commentor stated that the ORR health risk estimates dealing with the reduction and recycling PEIS for tritium in different waste types are much lower than the WM PEIS risk assessment figures. PEIS documents and EIS documents should include the impacts of earlier proposals as part of their analyses. Exclusion of such data tends to downplay the risk factors and is misleading to the public.

Response
Section 11.11 in Volume I of the WM PEIS contains a discussion of the impacts of combined waste management actions at ORR. This section also discusses cumulative impacts that could occur as a result of implementing waste management actions at the site in conjunction with other proposed or existing site actions. Table 11.11-1 presents the impacts from the combined management of low-level mixed waste, low-level waste, transuranic waste, and hazardous waste at ORR. A summary of this information is presented in Table 11.11-2, which addresses the cumulative impacts of the proposed combined waste management actions in conjunction with existing conditions at ORR and other proposed future actions. Note that the December 5, 1995, Record of Decision for the Tritium Supply and Recycling PEIS did not select ORR for these activities. Therefore, impacts would not occur at ORR from tritium supply and recycling activities. DOE removed the tritium supply and recycling impacts from the Final WM PEIS cumulative impacts analysis for ORR. The Final WM PEIS includes a more comprehensive analysis of other reasonably foreseeable future actions at the site, including management, storage and disposition of weapons-usable fissile materials.

It is not possible to estimate impacts from multiple EISs in the cumulative impacts analysis with a single methodology based on a single set of assumptions. Moreover, the analysis of cumulative impacts in the WM PEIS is, to some extent, limited by data availability.

Section 11.20 presents the combined and cumulative impacts analyses for transportation. The WM PEIS used different models to estimate potential health risks from routine transportation and transportation accidents. Section E.5.1 in Volume IV, describes the RADTRAN 4 and RISKIND models used to estimate collective population and maximally exposed individual risks from the transportation of radioactive waste. Section E.15.1.2.1 describes the ALOHA model used to estimate

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risks from the transport of hazardous waste and the chemical constituents of low-level mixed waste and transuranic waste. This section also describes some of the differences in the model assumptions. Uncertainty in the transportation risk assessments is discussed in Sections E.8 and E.18.

Comment (1811)
State officials believe that DOE must address the radiological exposure and health effects of all waste management activities planned in Nevada, in combination with past weapons testing at NTS, past low-level radiological waste disposal at Beatty, past and current hazardous waste disposal at Beatty, and current and prospective low-level waste disposal at NTS. The radiological health impacts of concern include the release of carbon-14 into the atmosphere and potential long-term leaching of other long-lived radionuclides into the regional groundwater system. DOE must address, in a single NEPA document, the potential cumulative groundwater contamination in the region of NTS, Yucca Mountain, and the Beatty low-level waste disposal site.

Response
The WM PEIS cumulative impacts analysis considers the potential impacts of the combined waste management actions for each of the five waste types evaluated in the context of both the existing site conditions and the potential impacts of other reasonably foreseeable site actions. DOE has revised Volume I, Section 11.10, to incorporate information for a number of these future actions at NTS, including the impacts of spent nuclear fuel management as described in the SNF/INEL PEIS, the Foreign Research Reactor Spent Nuclear Fuel EIS, the Stockpile Stewardship and Management PEIS, and the Fissile Materials PEIS. Impacts from the proposed Yucca Mountain high-level waste repository are not included because much of the required information is not available. Other NEPA documents, such as the Yucca Mountain Repository EIS and greater-than-Class-C and special-case wastes NEPA documents, to be published after the WM PEIS, will also address the potential cumulative impacts of the proposed future actions involving these waste types. The NTS Sitewide EIS contains more detailed information on impacts at NTS, including cumulative impacts.

The proposed waste management actions addressed in the WM PEIS are not expected to release significant amounts of carbon-14 into the atmosphere. The WM PEIS anticipates few impacts to groundwater quality and human health from the proposed waste disposal actions at NTS. Under the conservative assumptions in the low-level mixed waste impacts analysis, the hazardous solvents in some low-level mixed waste would end up in the disposal facility. Some of the low-level mixed waste contains these solvents in concentrations great enough to exceed standards when the wastes are disposed. In practice, however, DOE would meet EPA standards for low-level mixed waste treatment and disposal and, therefore, should not produce major impacts to groundwater quality.

Since DOE does not expect that the disposal of wastes at NTS would release significant concentrations of radionuclides into the regional groundwater system, and the proposed actions are separated by significant distance from other non-DOE waste management facilities (Beatty), those activities are not expected to significantly contribute to cumulative impacts at the site. The potential for leaching of contaminants into groundwater at NTS is extremely limited. All evaluations of the potential disposal sites at NTS have shown that, due to the very high rates of evaporation and transpiration by plants, combined with the low rainfall, water movement in the first 200 feet of the soil is upward, toward the land surface, not downward, toward the aquifers. A qualitative analysis of the vulnerability of offsite populations to risk from disposal units leading into groundwater, described in Volume I in Chapters 5, 6, and 7 of the WM PEIS, indicates that NTS poses one of the lowest risk situations of any of the

potential disposal sites. Factors included in the analysis were depth to groundwater, annual groundwater recharge, and estimated time of travel of water from the surface to a downgradient well. Based on this information and analysis findings, contamination of the aquifers from waste disposal at NTS at any level of significant concern is not expected to occur. Recent DOE guidance requires that performance assessments for low-level waste disposal facilities conducted under DOE Order 5820.2A be supplemented with a composite analysis. The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from active or planned low-level waste disposal facilities and other sources of radioactive material in the ground that might interact with the low-level waste disposal facilities.

Comment (1874)
The WM PEIS indicates that ORR currently produces the highest population dose among the 54 DOE sites around the Nation. We believe that a large-scale low-level mixed waste and low-level waste disposal facility at ORR would add additional risk to an already unacceptable situation.

Response
Although implementation of a low-level waste or low-level mixed waste disposal facility would add some risk to that already resulting from existing facilities, and to risk potentially resulting from other proposed site actions, DOE will comply with all applicable regulations and DOE Orders intended to protect human health and environmental quality from multimedia exposure to radionuclide and chemical contaminants. DOE acknowledges that implementation of waste management actions at a given site might be limited because of potentially unacceptable cumulative impact risks. However, sitewide or project-level NEPA reviews can better address this issue, since the waste management risks reported in the WM PEIS are conservative estimates based on the use of conceptual facilities and do not account for potential mitigation.

Comment (2082)
While the effort to estimate cumulative effects is very valuable, it is somewhat incomplete. It does not include, apparently, the impacts of locating at SRS the de-enriching operations associated with disposal of highly enriched uranium. These impacts might not be great. However, as noted in the text, SRS is approaching the 10-millirem limit for air emissions of radionuclides without this additional effect. Some added discussion in the text of how impacts at SRS and at other highly impacted facilities could be mitigated would be a valuable addition to the document.

Response
To the extent possible, the Draft WM PEIS considered cumulative impacts from existing conditions, the proposed waste management actions, and other reasonably foreseeable future DOE waste management actions. However, in some areas the lack of available data and schedule conflicts limited the consideration of cumulative impacts. For instance, the Draft PEIS did not consider the impacts of high-level waste disposal at Yucca Mountain because that information is not available. The Draft PEIS considered the potential cumulative impacts at SRS of continued management of spent nuclear fuels; tritium supply and recycling; the transfer of nuclear weapons complex nonnuclear functions to SRS; the processing of F-Canyon plutonium solutions to plutonium metal; the interim management of nuclear materials; the operation of the Defense Waste Processing Facility; other site projects for the management of waste; and environmental restoration activities (see Section 11.17 in Volume I). The Final PEIS cumulative impacts analysis includes information that has become available since the publication of the Draft. Chapter 11 now contains information from the EISs on stockpile stewardship

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and management, fissile materials management, foreign research reactor spent nuclear fuel, and storage and disposition of excess highly enriched uranium. Based on the WM PEIS analyses presented in Chapter 11, LANL and WIPP are the only sites where the 10 millirem standard for air emissions of radionuclides is estimated to be exceeded. Sitewide or project-level NEPA reviews would examine site-specific cumulative impacts in greater detail. Chapter 12 in Volume I includes a discussion of general mitigation measures that could be used to mitigate impacts of managing wastes. If the cumulative impacts would approach or exceed standards, DOE added a discussion of mitigation measures to Chapter 11, Volume I.

Comment (2091)
A cumulative assessment of disposal of radioactive and hazardous wastes should be done, including other types of impacts in the BNL region (as this, for example, was a major driver for the Pine Barrens Protection Act).

Response
The WM PEIS evaluated the potential disposal of low-level mixed waste and low-level waste at BNL. The potential groundwater quality impacts from the combined disposal of low-level mixed waste and low-level waste at BNL are discussed in Volume I, Section 11.4.1. Section 11.4.2 addresses the potential cumulative impacts on groundwater quality from the proposed waste disposal actions and existing groundwater contamination at BNL.

The WM PEIS disposal analysis is a screening-level assessment. The objective of the assessment is to provide a relative comparison of the potential suitability of sites for disposal of low-level mixed waste and low-level waste as waste management alternatives are varied. The siting of a disposal facility at a specific location at BNL or any other DOE site would be subject to additional sitewide or project-level NEPA review, including a more detailed cumulative impacts analysis. Also, in the actual siting and design of a disposal facility, more detailed, site-specific analyses would be conducted in accordance with the requirements for a performance assessment specified in DOE Order 5820.2A. Recent DOE guidance requires that the performance assessment process be supplemented with a composite analysis. The composite analysis would estimate the potential cumulative impacts to a hypothetical future member of the public from active or planned disposal facilities and other sources of radioactive material in the ground that might interact with the disposal facility.

Comment (2194)
The WM PEIS does not effectively address the cumulative impacts of all the nuclear activities within the Portsmouth/Paducah area.

Response
The existing environmental conditions at PGDP and the Portsmouth Plant resulting from ongoing activities are described in Sections 4.4.10 and 4.4.12, respectively, in Volume I of the WM PEIS. The cumulative impacts are evaluated in Sections 11.12 and 11.14, respectively. The cumulative impacts analysis in Chapter 11 of the WM PEIS for each of the 17 major DOE sites incorporates the impacts of existing operations, combined waste management impacts, and the impacts of reasonably foreseeable future actions as identified in recent draft and final EISs. These impacts are placed in the context of the environmental conditions within the region (e.g., the air quality impacts analysis considers current air quality conditions). Where appropriate, the projected impacts of non-DOE activities that contribute to radiological dose within the region are also considered and included within the analysis. Chapter 11

was revised extensively pursuant to public comments. Sitewide or project-level NEPA reviews would examine site-specific cumulative impacts in greater detail.

Comment (2296)
Transportation accident rates are not covered in any cumulative way, and that needs to be rectified.

Response
The WM PEIS transportation risk analysis used accident rate statistics based on information from the U.S. Department of Transportation, as discussed in Section E.6.4 in Volume IV. These accident rates are State averages based on historical commercial carrier performance with all types of cargo under all weather conditions. Actual accident rates are expected to be slightly lower because commercial carriers of hazardous and radioactive waste have a higher awareness of transportation risk than the general public, and prepare their shipments accordingly. Cumulative accident risks are provided for each waste type for each alternative in Volume IV, Section E.7.

Comment (2391)
The WM PEIS provides only a portion of the information needed to evaluate cumulative impacts. The summary provided in Section 11.15 is cryptic and not comprehensive. The technical meaning of the summation and the data sources are obscure. DOE needs to make a better attempt to effectively integrate the projected impacts of DOE planned environmental restoration activities and Defense Programs-related future production work at SRS.

Response
DOE has extensively revised Chapter 11 of the WM PEIS to make the text both more readable and more comprehensive. Many additional draft and final EISs have been incorporated into the Chapter 11 discussion to ensure meaningful inclusion of reasonably foreseeable future actions at each of the 17 major waste management sites. Section 11.17.2 describes the activities considered as other reasonably foreseeable future actions at SRS. These include impacts related to defense waste processing, tritium supply and recycle, spent nuclear fuel management, foreign research reactor spent nuclear fuel management, interim management of nuclear materials, storage and disposition of weapons-usable fissile materials, stockpile stewardship and management, and disposition of highly enriched uranium. Environmental restoration activities for sites with adequate evaluations available were also incorporated in the WM PEIS cumulative impacts analysis.

Comment (2477)
The socioeconomic analysis is complicated by the possible consequences of other pending DOE actions at INEL. Until DOE indicates its preferred alternatives for each waste type, all that we really know is that the maximum increase in jobs at INEL could be as high as 4,925. Should any substantive proportion of the additional 4,384 jobs from pending actions be realized, INEL would experience an upsurge in jobs never before experienced in the area. To date, no one in the Idaho Department of Employment is projecting job growth of this magnitude at INEL.

It is very likely that there will be an overlap in the construction phases for the spent nuclear fuel and waste management projects at INEL. The overlap would temporarily inflate employment at INEL and in its region of influence (ROI); but once the overlap period ended, employment would rapidly decrease, subjecting employment at INEL and within its ROI to a yo-yo effect. Given the possibility of

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a construction overlap with other pending DOE projects, employment levels of this magnitude might be difficult to accommodate in the ROI.

The Draft WM PEIS Summary document states, "Both Council on Environmental Quality and DOE regulations for implementing NEPA require the assessment of cumulative impacts because significant impacts can result from several smaller actions that, individually, may not have significant impacts." The WM PEIS analysis of the cumulative effects of pending DOE actions is totally inadequate. It does not provide the State or the INEL ROI the information necessary to implement mitigation measures to reduce the disruptive effects of major changes in employment at INEL and within its ROI.

Response
The WM PEIS was prepared to help DOE develop a Department-wide strategy to treat, store, and dispose of DOE wastes in a safe and efficient manner, that minimizes impacts to the local environments around sites that might be associated with waste management. The PEIS has considered cumulative impacts for past, present, and reasonably foreseeable actions to the extent possible (see Volume I, Chapter 11). The analysis of cumulative impacts in the PEIS is, however, limited by certain factors such as data availability and schedule priorities and conflicts.

The cumulative impacts analysis presents a reliable basis for the comparison of alternatives for each waste type and includes consideration of other proposed activities at the individual site level. Although the analysis attempts to be sensitive to the unique character and local concerns of each individual ROI, it must be recognized that at the programmatic level, the information available will be very general. As a broad, Department-wide analysis, the PEIS, while sufficient for comparison of the effects of each of the waste type alternatives, might not provide enough information for local government and planning agencies at the regional and State levels to ascertain specific impacts or implement mitigation measures. Sitewide and project-level NEPA reviews will examine site-specific cumulative impacts, including socioeconomic impacts, in greater detail.

DOE recognizes the potential for project overlaps to cause rapid or temporary fluctuations in employment and spending in the ROIs and is especially concerned with the effect of "yo-yo" or "boom-bust" phenomena. The WM PEIS socioeconomic impact analysis was specifically designed as a conservative approach to highlight the potential for such phenomena at the programmatic level. Site-specific NEPA documentation would add a more detailed understanding and provide potential strategies for mitigating impacts. It is expected that a more definitive projection of the total number of jobs to be realized for all planned and reasonably foreseeable site activities would be incorporated into site-specific analyses. Any potential conflict with current or planned future growth at the local or State level will become evident during this process.

DOE revised Section 5.4.6.1 in Volume I and Section C.4.6.1.2 in Volume III of the WM PEIS to indicate DOE's recognition of the potential for a sudden increase in population migration from the potential overlapping of waste management activities and other DOE projects. These sections also state that because the actual timing of peak employment is not yet available, only a general discussion was possible in the WM PEIS. As noted in Section 11.2, the WM PEIS cumulative impacts analysis includes site employment impacts.

DOE has revised Chapter 11 to include a more comprehensive analysis of cumulative impacts from a number of future actions, including the impacts of spent nuclear fuel management, foreign research

reactor spent fuel management, and storage and disposition of weapons-usable fissile materials, and information from the Navy's evaluation of container systems for the management of naval spent nuclear fuel.

Comment (2547)
Volume I, Section 11.18. The 80% figure needs referencing. It seems high.

Response
Note that Section 11.18 in the Draft WM PEIS was changed to Section 11.20 in the Final WM PEIS. The WM PEIS states that within this cumulative total number of potential fatalities, the general transport of radioactive material accounts for approximately 80% of radiation-related latent cancer fatalities. DOE derived the 80% figure from calculations based on the data in Table 11.20-4, as clarified in the accompanying text. Footnote "a" for Table 11.20-4 provides the source for the data, which is the SNF/INEL EIS.

Comment (2594)
For cumulative impacts, the WM PEIS considered impacts that are additive and did not include groundwater risks and contamination from disposal. This was based on the assumption that contaminants from each disposal site are separate and do not merge or commingle. Why is no mixing of groundwater plumes assumed? Why is existing disposal inventory and existing groundwater contamination not included? Depending on the geology, aquifer characteristics, disposal site location, and constituents, the impacts could be cumulative. Groundwater impacts should be analyzed on a cumulative basis.

Response
Section 4.4 in Volume I provides summaries of the affected environment at each major site, including levels of groundwater contaminants.

The WM PEIS screening-level analyses conducted to assess disposal risks required the use of several simplifying assumptions. As described in Section 5.4.1.2.2 in Volume I, the analyses assume that each disposal unit is a discrete structure and that no mixing of groundwater plumes from multiple units occurs. In addition, the analyses consider only new disposal units and do not account for existing disposal inventory or existing groundwater contamination. These assumptions were necessary because of the screening-level nature of the analyses used for this programmatic evaluation. No attempt was made to identify locations of disposal units on a site, and only limited site-specific data were used in the analyses of the 16 sites.

Sections 5.4.1.2.2, 6.4.1.8, and 7.4.1.7 in Volume I were revised to explain that disposal risks were analyzed for the hypothetical maximally exposed individual, who would be exposed through a drinking well located 300 meters (984 feet) from the center of a single disposal unit. At greater distances from the disposal units, where overlap of plumes is more likely, the concentrations in any given plume should be lower than those estimated at the 300-meter well as a result of dispersion and dilution.

DOE added groundwater impacts to the cumulative impacts analysis in Chapter 11 of the Final WM PEIS. However, DOE did not consider the combined and cumulative health risks resulting from the disposal of low-level mixed waste and low-level waste because the potential contaminants were assumed to neither merge nor commingle within 300 meters of a single unit.

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Site-specific studies, including the performance assessment analysis required by DOE Order 5820.2A, will better address issues such as commingling of groundwater plumes from multiple units and existing groundwater contamination. These studies will attempt to design and site new disposal units, so they will investigate these issues more rigorously than can be attempted in a programmatic document.

Although not part of the WM PEIS, the DOE Workgroup that is responding to Defense Nuclear Facilities Safety Board Recommendation 94-2 is moving forward with plans to revise DOE performance assessments for radioactive waste disposal sites to include existing contamination, and ongoing activities that contribute to groundwater contamination.

Comment (2595)
In the cumulative impacts analysis, why does the WM PEIS assume that contaminant plumes from each disposal site are separated and do not merge or commingle? Groundwater should be included in the cumulative impacts analysis.

Response
The WM PEIS hypothetical farm family scenario assumes that individual receptors are exposed through drinking water from a well 300 meters (984 feet) downgradient from the center of a single disposal unit. Concentrations of groundwater contaminants at the well are assumed to be higher than those that could be expected at greater distances from the unit due to dispersion and dilution. DOE expects that multiple units will need to be constructed at certain sites to process projected waste volumes. However, DOE believes it is reasonable to assume that each of the individuals located 300 meters from a disposal unit will be affected primarily by the contaminant plume from the unit closest to them.

DOE recognizes that the likelihood of commingling of contaminant plumes from multiple disposal units increases as the downgradient distance from the units increases, but anticipates that, at 300 meters, the highest concentration of contaminants is likely to come from the single closest plume. At greater distances from the disposal units, where significant plume overlap is more likely, dispersion, dilution, and decay should cause the concentrations in the overlapping plumes to be lower than those estimated at the 300-meter well for a single plume.

DOE revised the PEIS to clarify this point. See Volume I, Section 5.4.1.2.2. In addition, the cumulative impacts analyses in Chapter 11 (Volume I) now includes the potential for exceedances of drinking water standards in groundwater.

Comment (2624)
In Volume I, Section 11.5 and Table 11-10, why are the health impacts (other than cancer) associated with exposure to the hazardous chemical components in low-level mixed waste not included?

Response
The WM PEIS combined and cumulative impacts analyses presented in Chapter 11 of the WM PEIS did not use noncancer health effects from chemical exposure as an evaluation factor. Effects of other health effects were not used because these effects on the public would not be expected as a result of the treatment of low-level mixed waste, transuranic waste, and hazardous waste. Most mechanisms of noncancer toxic effects have thresholds below which no toxic effects are observed. For the alternatives evaluated for each waste type, the estimated exposure concentrations of noncarcinogenic chemicals were several orders of magnitude below the threshold concentrations presumed to be protective of

human health. Therefore, the combined effects would also be below the threshold values. Noncancer effects in waste management workers are of potential concern only as a result of hazardous waste treatment. Risks to individual waste management workers were not considered part of the combined analysis because each worker was assumed to work with a single waste type at a time.

Comment (2820)
The WM PEIS assumption for cumulative impacts is that they will be, at worst, additive. It is not certain that many land-use planners, ecological specialists, or contamination experts would agree that this is necessarily so. The possibility of synergistic effects should be addressed, especially in any discussion regarding environments already under some stress. It should be noted that BNL has the largest population in any region of influence under discussion, and that the mere presence of such a large population brings certain effects. In addition, BNL has already caused a great deal of environmental contamination, from past (and possibly from continuing) practices. The combination of these factors could indicate that BNL is unsuitable for further environmental insults, or that the effects from any further environmental stresses might not be merely additive.

Response
The WM PEIS uses generally accepted methods to estimate cumulative impacts. The PEIS analyzes the impacts of the general program alternatives using very conservative generic analyses of impacts. DOE does not believe it is appropriate to apply a synergistic effects analysis to this type of data. DOE did not evaluate potential synergistic and antagonistic effects resulting from exposure to mixtures of contaminants. As noted in Section D.2.5.1 in Volume III, risks from enhanced (synergistic) or diminished (antagonistic) toxicity from interactions among components of contaminant mixtures were not evaluated because not enough information exists on these effects. If synergism or antagonism is occurring, these effects should be operative at all sites under all alternatives. Therefore, although the WM PEIS health risk estimates might actually underestimate or overestimate potential risks, the uncertainty added by the inability to address synergistic or antagonistic effects is systematically inherent throughout the analysis. However, the relative differences in risk estimates among waste management alternatives should not be affected by errors associated with these systematic uncertainties.

DOE believes that it is unlikely that cumulative impacts would exceed the sum of the individual impacts of the actions considered in the cumulative impacts section because (1) individual impact estimates are generally conservative; (2) most impacts would occur at different locations; (3) most impacts would not overlap or would only partially overlap in time; and (4) most impacts would affect different endpoints. For example, each action might affect a different maximally exposed individual.

DOE revised Chapter 11 in Volume I of the WM PEIS to include a more comprehensive analysis of cumulative impacts. Where impacts from other programs have been documented, they are identified in the PEIS. Cumulative impacts for BNL are evaluated in Section 11.4. Sitewide or project-level NEPA reviews would contain more detailed cumulative impacts analyses.

Comment (2829)
The entire cumulative impacts analysis for BNL is tremendously flawed. For example, a footnote in Section 11.2 indicates that although it was known to be otherwise, outdated data stating that BNL produced no LLW was used in the analysis of LLW impacts. Yet, in spite of the fact that more recent data showed that LLW was being produced, the new data were ignored. Furthermore, as noted in previous sections, the analyses for BNL indicate that hazardous waste is produced at this site, yet this

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information was excluded. Accordingly, this entire section should be reconsidered in light of updated information.

Response
DOE has revised Chapter 11 to incorporate recent and comprehensive information. Estimates of waste generation at the sites are revised every year. The data used in the Draft PEIS represented the best available data at the time of the analysis. Since the Draft PEIS was issued, new information from updated databases has become available, including new integrated data base data for 1995. Appendix I in Volume IV of the Final PEIS presents new waste-volume data and discusses how these data might effect any of the impacts described in the PEIS.

Appendix I compares the updated estimates of low-level waste, low-level mixed waste, and transuranic waste generation to the estimates used in the Draft PEIS. Where these estimates vary significantly in volume, treatment category, or radiological profile, the new waste volumes were used to estimate potential impacts for those sites in the Final WM PEIS.

The 1992 Integrated Data Base, the source of LLW data for the Draft WM PEIS, did not provide LLW data for BNL. Thus, the evaluation in the Draft PEIS for BNL did not include impacts from management of LLW. However, Tables 1.6-2 and 7.1-1 in Volume I of the Final PEIS show that the projected LLW volume at BNL is approximately 5,600 cubic meters. The updated data were obtained from the 1995 version of the Integrated Data Base. Consideration of updated LLW estimates for BNL are included in Appendix I in Volume IV of the Final PEIS. Appendix I addresses the issue of how updated waste projections affect analyses in the PEIS.

Hazardous waste is generated, or is projected to be generated, at about 45 DOE sites. Based on RCRA uniform hazardous waste shipping manifests, facility reports, and hazardous waste generation and disposal information dating back to 1984, DOE estimates that more than 90% of the total hazardous waste (wastewater and nonwastewater) in a given year is generated by 11 or fewer of the 45 DOE sites, although not always the same sites every year. In general, only nonwastewater hazardous waste from these eleven larger sites was analyzed in this PEIS. Table 10.1-1 in Volume I of the PEIS provides the quantities of hazardous waste at the 11 largest DOE hazardous waste generators used for the evaluation of the PEIS alternatives. Because BNL is not one of the 11 largest generator sites, the PEIS does not specifically analyze hazardous waste at BNL, but the PEIS analysis is representative of DOE sites in general.

Comment (2879)
The separate evaluations, conducted by various groups within DOE, might not adequately account for the cumulative impacts of all the potential decisions that could affect INEL. The most serious example is the lack of a quantitative analysis of the impact of environmental restoration activities, even though estimates of the wastes to be produced by these activities are available.

Response
As stated in Volume I, Section 1.7.1, of the WM PEIS, DOE has concluded that remediation decisions, including the level of site remediation, must reflect site-specific conditions. While the WM PEIS does not analyze environmental restoration activities, it does contain information on the anticipated waste volumes generated as a result of environmental restoration activities and a qualitative discussion of the

extent to which those waste volumes could affect the comparison of waste management alternatives in the WM PEIS.

Although estimates of environmental restoration waste volumes are available, adequate characterization data are generally not available to allow meaningful assessments of environmental impact assessment as explained in Volume I, Section 1.7.1, of the PEIS. Therefore, for many sites, DOE was not able to include impacts from environmental restoration activities in the cumulative impacts analysis.

Comment (3093)
The Hanford Site cumulative impacts section should clarify the statement that combined alternatives would affect between 47 and 179 acres of land at the site, while other actions could affect another 70 acres. Are the 70 acres related to waste management? The PEIS should describe what other actions could affect another 70 acres.

Response
The Final WM PEIS cumulative impacts chapter (Chapter 11) contains a more comprehensive evaluation of the impacts of other reasonably foreseeable actions that might affect the sites. As described in Section 11.6.2 and Table 11.6-2, for the Hanford Site these actions include spent nuclear fuel management, the Hanford tank waste remediation system, disposal of decommissioned naval nuclear plants, safe interim storage of Hanford tank wastes, storage and disposition of weapons usable fissile material, and plutonium finishing plant stabilization. These actions could involve 1,949 acres more than the estimated 7 to 178 acres required for the waste management actions proposed at the Hanford Site.

Comment (3143)
The WM PEIS does not adequately address potential cumulative impacts because it uses out-of-date Integrated Data Base data, even though a more up-to-date Integrated Data Base was published months before the Draft WM PEIS was issued.

Response
DOE used the 1995 Integrated Data Base to obtain waste-volume data for the Final WM PEIS. The transuranic waste volume estimates reported in Section 8.1 in Volume I are not directly comparable to the values presented in the Integrated Data Base because the latter contains information about buried transuranic waste, which will be handled under the Environmental Restoration Program.

As part of the Final WM PEIS, DOE has performed an analysis to address how more recent data on low-level waste, low-level mixed waste, and transuranic waste might affect the analyses of alternatives in the PEIS (see Appendix I in Volume IV). For transuranic waste, for example, the analysis finds that, although transuranic waste inventory and projected generation volumes at each site vary to some extent, similar health risks would be expected at all sites except SRS. At SRS, radiological impacts would be lower. Any changes to health risk estimates or other impact parameters were incorporated into the combined and cumulative impacts analysis presented in Chapter 11 in Volume I.

Comment (3154)
The impacts of low-level waste and low-level mixed waste disposal at the Pantex Plant are dramatically underestimated because routine and accidental emissions from Pantex are not well documented.

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Response
Under some of the alternatives discussed in the PEIS, DOE would treat or dispose of low-level and low-level mixed wastes at Pantex. Under other alternatives, DOE would ship such wastes off the site for treatment and disposal. If DOE decided to locate waste management facilities at Pantex, it would prepare sitewide or project-level NEPA reviews, which would provide more detailed information on projected routine and accidental releases of radioactivity.

The PEIS human health and ecological risk assessments under both routine operations and accident conditions examined potential Waste Management Program effects on humans and the environment near the proposed waste management site at Pantex. DOE found that public health and environmental risks from waste management activities would be low under all alternatives, especially after implementation of radionuclide- or chemical-specific limits for disposal.

As identified in Chapter 11 (Volume I), Table 11.13-2, the maximum annual radioactive releases from the combined waste management alternatives of all waste types managed at Pantex (including transportation) would result in a slight increase in the dose to the offsite population from the Pantex Plant. However, maximum cumulative radioactive releases, which include releases from existing operations at Pantex, would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Comment (3155)
Before the cumulative impacts of the disposal options at the Pantex Plant can be adequately considered, DOE must consider the proposed Pantex role as a major storage site for plutonium pits from dismantled warheads.

Response
DOE has revised Section 11.13 in Volume I of the WM PEIS, which discusses cumulative impacts for the Pantex Plant, to include impacts resulting from DOE's Stockpile Stewardship and Management PEIS and Fissile Materials Management PEIS. In addition, the impacts of actions analyzed in the draft *Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapons Components Environmental Impact Statement*, including the role of the Pantex Plant as a storage location for plutonium pits, are now included in the Final WM PEIS cumulative impacts analysis.

If DOE decided to locate waste management facilities at the Pantex Plant, sitewide or project-level NEPA reviews would provide more detailed information on projected routine and accidental releases of radioactivity. The cumulative impacts section of such a site-specific document would incorporate more detailed information about any DOE plans for the proposed storage of plutonium pits at the Pantex Plant.

Comment (3167)
The State of Washington and U.S. EPA should not allow DOE or the U.S. Department of Defense to transfer to the Hanford Site any hazardous and radioactive waste unless the following criterion is met: Cumulative impacts (e.g., of other waste types) must be analyzed and considered in decisions concerning the movement and treatment of DOE wastes. DOE must fully disclose all projected waste types and quantities that might be shipped to Hanford prior to any consideration by the State of Washington of treatment, storage, or disposal permits for wastes generated at other facilities. This information must be part of the WM PEIS and Draft Site Treatment Plan public comment/public

participation process, and of an inter-regional and inter-site advisory board dialogue, prior to development of final Site Treatment Plans and any agreement by the State of Washington to accept offsite wastes.

Response
Section 11.6 in Volume I of the WM PEIS presents the combined and cumulative impact analyses for the Hanford Site. The combined impact analysis addresses the total potential impacts of the proposed alternatives of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste at the site. The cumulative impact analysis considers the combined waste management actions and other proposed actions at Hanford, in addition to existing site conditions.

The Hanford Site has an existing agreement that exempts it from the FFCAct Site Treatment Plan requirement. At the Hanford Site, DOE, EPA Region X, and the State of Washington entered into the Hanford Federal Facility Agreement and Consent Order, commonly known as the Tri-Party Agreement, on May 17, 1989. The current document has been formally amended four times with the latest amendment issued in January 1995. The Tri-Party Agreement contains provisions pertaining to mixed waste treatment, including treatment conducted under the RCRA land disposal restrictions. Under the agreement, the Hanford Site submits annually an updated Land Disposal Restriction Plan for Mixed Wastes, with the most recent update issued in April 1995. Because the Hanford Site has a Federal Facility Agreement and Consent Order and the Land Disposal Restriction Plan is a part of these agreements, EPA and the Washington Department of Ecology have formally concurred that a Site Treatment Plant is not required.

Although the Hanford Site is exempt from the Site Treatment Plan requirement, it has actively participated in DOE's FFCAct compliance activities during the reporting period. These activities have included providing site representation on DOE's nationwide Policy Coordination Group and on a variety of working groups associated with DOE's FFCAct Task Force. Contributions were made within the Policy Coordination Group, Mixed Waste Inventory Data Group, Technical Support Teams, and the Disposal Workgroup.

The Hanford Site also performed the following tasks in support of DOE's FFCAct compliance efforts during fiscal year 1995:

- Hanford reviewed several proposed Site Treatment Plan submittals from both approved offsite mixed waste generators and other DOE sites.

- The Hanford Site assisted in the identification of "Likely Preferred Options" for DOE's complex-wide treatment analysis.

- Hanford participated in Public Hearings on the FFCAct in the local area and in Bremerton, Washington.

DOE's treatment option analysis resulted in an emerging nationwide treatment configuration for mixed wastes. Under this configuration the Hanford Site is considered an option to provide storage, treatment, and possible disposal for mixed wastes from other DOE sites. Therefore, the Hanford Site will participate in discussions with the State of Washington, other states, and other DOE sites concerning the acceptance of offsite wastes.

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Comment (3173)
NEPA requires the Federal Government to thoroughly consider the cumulative impacts of its proposed actions. At Hanford, cleanup and handling of wastes are being addressed in a series of EISs. Each of these could leave large quantities of waste in place. The contamination plumes from migration of these wastes will have impacts for tens of thousands of years across most of the Hanford Site. The risks from each of these EISs is cumulative and overlapping. These impacts and risks must also be included in the WM PEIS. The PEIS should comprehensively examine the cumulative impacts of all existing, planned, or considered Federal actions at each site.

Volume I, Section 2.2.3, neglects the immense quantities of plutonium discharged to the ground at many sites, including Hanford. DOE reports 1.521 metric tons of plutonium either in buried or stored solid waste, or liquid tank waste that was directly disposed of in the ground. Much of this material is in burial at Hanford in the 200 West area adjacent to the proposed location for the national low-level and mixed waste repository. The WM PEIS also should disclose impacts from DOE's proposals to ship weapons plutonium to Hanford for use in reactors, to create reactor fuel, or to vitrify it for disposal. The risks from these are cumulative along with the other proposed or potential site actions.

Response
The WM PEIS does not address weapons grade nuclear material such as "weapons plutonium" because it is not classified as waste and is not part of the Waste Management Program responsibility. Section 1.8.1 in Volume I of the WM PEIS identifies other DOE EISs and their relationship to the WM PEIS. Impacts from other programs and actions analyzed in other EISs are considered in the WM PEIS cumulative impacts analysis (Chapter 11 in Volume I). Other EISs are listed in Table 11.2-1.

DOE has revised the cumulative impacts analysis presented in Chapter 11. The Storage and Disposition of Weapons-Usable Fissile Materials EIS, which addresses plutonium disposition, has been added to the list of documents evaluated for information on impacts from other reasonably foreseeable actions at Hanford, as described in Section 11.6.2 in Volume I of the PEIS. Other actions considered include spent nuclear fuel management, management of K-Basin spent nuclear fuel, disposal of decommissioned Naval nuclear plants, safe interim storage of Hanford tank waste, and Plutonium Finishing Plant stabilization. The Hanford Remedial Action EIS addresses additional information about potential cumulative impacts at Hanford, including those from proposed environmental restoration actions.

Comment (3337)
The PEIS conveys assurances where there is no basis for them. DOE is "in the dark" about levels of contamination all over the country, so its "predictive speculations" are not convincing.

Response
The WM PEIS addresses the potential impacts of proposed waste management actions using best available data at the time of the analysis and state-of-the-art models. Conservative assumptions were used to develop estimates that would overestimate rather than underestimate impacts. Existing levels of contamination are discussed in Chapter 4. This information is also used in the cumulative impacts analysis presented in Chapter 11 to characterize existing site conditions.

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Comment (3343)
Before the Final WM PEIS is issued, each impact parameter should be analyzed on a case-by-case, site-specific basis, including past, present, and projected future activities. Some sites are "notoriously contaminated and out of control" (e.g., the danger of spontaneous combustion of sludge pools at Hanford; plutonium and tritium migration down the canyons and aquifer/Rio Grande at LANL; unknown levels of contamination at SRS, INEL, and NTS).

Response
Chapter 11 in Volume I of the WM PEIS discusses the combined impacts that could result from locating waste management facilities at each of the 17 major waste management sites, the cumulative impacts that could result at each of the 17 major sites and in their surrounding regions, and the cumulative impacts of transporting waste. Cumulative impacts are the impacts that result from the incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions. Both CEQ and the DOE regulations for implementing NEPA require the assessment of cumulative impacts because significant impacts could result from several smaller actions that, by themselves, might not have significant impacts. To conduct the WM PEIS cumulative impacts analysis, DOE first examined the combined impacts of waste management alternatives for the five types of wastes analyzed in the WM PEIS at each of the 17 major sites. To these combined impacts, DOE added the impacts of other past, present, and reasonably foreseeable future actions external to the WM PEIS analysis. To the extent possible, where data on environmental remediation of contamination at the sites, such as that described by the commentor, the impacts of remediation are included in the future actions evaluated in Chapter 11. Information pertaining to Hanford, INEL, LANL, NTS, and SRS can be found in Sections 11.6, 11.7, 11.9, 11.10, and 11.17, respectively, in Volume I of the WM PEIS. Sitewide or project-level NEPA reviews can better evaluate site-specific cumulative impacts.

Comment (3353)
The WM PEIS cumulative impacts analysis is "grossly deficient." Each section on the impacts of various waste types states that each site is assumed to build and operate facilities with capacities sufficient to handle only a particular type of waste. This avoids linking results of one waste type to decisions not yet made in another and results in conservative estimates of risk, cost, and impacts. It appears that DOE based the cumulative impacts analysis on segmented impacts analyses.

Response
The major effect of adding together impacts that were estimated for one waste type without consideration of the other waste types, is that impacts are overestimated. Chapter 11 (Volume I) of the WM PEIS discusses the combined impacts that could result from locating more than one waste management facility at each of the 17 major sites for the applicable waste management alternatives. In addition, Chapter 11 identifies the cumulative impacts that could result at each of the 17 major sites and in their surrounding regions as a result of the proposed waste management actions, existing site operations, and the impacts of other reasonably foreseeable actions at the sites.

The DOE Waste Management Program is distinct from other programs, and DOE believes that it is appropriate to analyze it in this separate programmatic NEPA document. The WM PEIS is complex and covers five major types of radioactive and hazardous waste. It does not include some wastes that DOE believes are not ready for the decisionmaking process. The WM PEIS also does not include some other materials (e.g., spent nuclear fuel) because they are not wastes, nor does the WM PEIS include

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other DOE programs; however, the impacts of managing these materials and those other programs have been included in Chapter 11, wherever possible.

Comment (3354)
DOE analyzes the so-called cumulative impacts on each individual "major site," rather than discussing the cumulative effects of all of the applicable actions across the country.

Response
Most of these impacts affect only the region of influence of each site. The focus of the cumulative impacts analysis is on site-specific impacts, because it is at this level that cumulative impacts of the Waste Management Program and other programs are most relevant and could be relatively more severe. An example of impacts at a nationwide or global level would reveal a much less significant contribution to cumulative impacts from waste management because the dilution of impacts across a much larger area. Transportation impacts were analyzed on a national rather than site-specific basis. As shown in Volume I, Section 11.20 of the WM PEIS, shipping waste by truck would result in a combined total of between 12 and 69 potential fatalities from shipping low-level mixed waste, low-level waste, transuranic waste, and hazardous waste over the next 20 years, and for shipping high-level waste over the next 40 years, as shown in Volume IV, Appendix E, and Section 11.20. Shipping low-level mixed waste, low-level waste, transuranic waste, and high-level waste by rail, and hazardous waste by truck would result in a combined total of between 2 and 6 potential fatalities over the same periods.

The results of the transportation analyses conducted in Appendix E show that impacts relating to the transport of waste analyzed in the WM PEIS, which include fatalities from radiation exposure, diesel exhaust emissions, and physical trauma from accidents, are low when compared to nationwide vehicle transportation yearly impacts. Comparatively, from 1971 to 1993, over one million persons were killed by physical trauma in vehicular accidents in the U.S.

Comment (3355)
NEPA requires that the incremental impacts of the proposed action added to other past, present, and reasonably foreseeable future actions be assessed. In spite of this, DOE admits that the combined human health risks resulting from the disposal of low-level waste and low-level mixed waste were not considered. In addition, the cumulative impacts analysis does not include the impacts of the No Action Alternatives for low-level mixed waste, transuranic waste, and high-level waste because they do not comply with existing law.

Response
For purposes of the screening-level assessments conducted for the WM PEIS, several simplifying assumptions were made with respect to the potential for low-level mixed waste and low-level waste disposal to contaminate groundwater. At some sites, the construction of multiple disposal units would be required under certain alternatives (see Volume I, Sections 6.4.1.9 and 7.4.1.8). One of the simplifying assumptions made to aid in the analyses was that groundwater plumes from multiple units do not mix at the well 300 meters (984 feet) from the center of the disposal unit. DOE revised Section 5.4.1.2.2 and Section 11.1 in Volume I of the WM PEIS to clarify this assumption. Related to this assumption, existing disposal inventory and/or existing groundwater contamination at a site were not considered in the human health risk analysis because the locations of the future waste management disposal facilities are not known. These assumptions are not believed to compromise the comparison of

the programmatic alternatives. In addition, the PEIS addresses groundwater quality using the disposal modeling results to estimate where exceedances of contaminant-specific standards might occur in the future.

Additional analyses that will incorporate site-specific conditions in place of these assumptions will be conducted as part of sitewide or project-level NEPA reviews and the performance assessment process required for the operation of disposal facilities under DOE Order 5820.2A. Recent DOE guidance requires that performance assessments be supplemented with a composite analysis. The composite analysis will develop reasonably conservative estimates of the cumulative impacts from active and planned low-level waste disposal facilities and all other sources of radioactive contamination that could interact with the disposal facility to affect the dose to future members of the public.

DOE revised Chapter 11 (cumulative impacts) of the PEIS to include the No Action Alternatives and to include cumulative impacts of contamination on groundwater quality.

Comment (3356)
The PEIS states that the human health risks to the offsite population and the maximally exposed individual are reported as annual exposures and annual risk, rather then for the entire period of operation. The cumulative effects of some of the radionuclides and chemical contaminants would last far beyond the expected life of the facility. These contaminants do not disappear from the body in 1 year, and the effects from such exposure do not go away in 1 year. They bioaccumulate and biomagnify, with ever-increasing effects as time goes on. If synergistic effects are possible they need to be disclosed. If DOE is not capable of disclosing these effects, they must disclose them as scientific uncertainty, and disclose this to the public in the PEIS.

Response
DOE revised the WM PEIS cumulative impacts analysis (Chapter 11 in Volume I) to include collective doses for the offsite public and site workers for the 10-year waste management processing period combined with exposure from existing site activities and other reasonably foreseeable future actions. This analysis includes collective doses attributable to the entire operating period assumed for the proposed facilities.

DOE did not evaluate potential synergistic and antagonistic effects resulting from exposure to mixtures of contaminants. As noted in Section D.2.5.1 in Volume III, risks from enhanced (synergistic) or diminished (antagonistic) toxicity from interactions among components of contaminant mixtures were not evaluated because not enough information exists on these effects. If synergism or antagonism occur, these effects should be operative at all sites under all alternatives. Therefore, although the WM PEIS health risk estimates might actually underestimate or overestimate potential risks, the uncertainty regarding the inability to address synergistic or antagonistic effects is systematically inherent throughout the analysis. However, the relative differences in risk estimates among waste management alternatives should not be affected by errors associated with these systematic uncertainties.

Comment (3376)
Under land use, DOE forgets to mention the abandoned Kentucky Ordnance Plant adjacent to PGDP. This plant is severely contaminated and is either proposed or listed as a Superfund site. There could be significant cumulative impacts from this plant and any future actions associated with it. Also, within the PGDP region of influence and fairly close to the site is a commercial hazardous waste incinerator

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located at Calvert City, where there are also several other major chemical plants, all discharging millions of pounds of toxics and carcinogens annually. There is a cement kiln burning hazardous waste in Cape Girardeau, Missouri. There are numerous other chemical plants in the region of influence. There is also a major paper mill, Westvaco, in Wickliffe, Kentucky, not far from PGDP. In addition, there are several significant coal fired plants in the region of influence, two of the largest of which are right across the river from PGDP. All of these facilities are significant to the affected environment and could have cumulative impacts.

Response
Impacts of existing facilities (such as those identified in the comment) in the PGDP region of influence are reflected in the air monitoring data from the site. These monitoring data are summarized in Section 4.4.10 in Volume I of the WM PEIS and described in detail in the WM PEIS Affected Environment Technical Report. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. These monitoring data form the basis for the existing conditions information in Chapter 11 (Volume I) and are used in assessing waste-type specific and cumulative air quality impacts in the PEIS. Sitewide or project-level NEPA reviews would examine cumulative impacts in more detail, including the effects of nearby facilities.

Comment (3411)
The WM PEIS fails to disclose the cumulative impacts of importing vast quantities of waste including waste from other weapons plants and high-level nuclear waste from foreign and naval reactors on (1) the public along transportation routes; (2) Hanford's ability to cleanup its own wastes; (3) using the vast land area of valuable habitat to bury wastes at Hanford. The law requires that we get to see the cumulative impacts now.

The Hanford Site cumulative impacts section fails to mention impacts from the environmental restoration disposal facility (165 acres, potentially up to 1,024 acres); the safe interim storage EIS (74 acres); the 240 access road (18 acres); the solid waste retrieval complex (46 acres); and the tank waste remediation system EIS (148 acres); which, taken together with waste management impacted land, might affect 1,489 acres or 25% of the 6,000 acres designated by the Hanford Future Uses Working Group. Most of the habitat has been designated as Priority Habitat by the Washington Department of Fish and Wildlife. Further, Chapter 11 does not address the cumulative impacts of high-level waste leaks at the Hanford Site.

Hanford plans now call for 1,791 football fields worth of nuclear national sacrifice zone for disposal. If environmental restoration wastes and waste management wastes follow Hanford's own wastes, where is the room, what are the land-use impacts, what are the human health impacts, what are the long-term impacts on treaty rights, and what are the impacts on Future Site Use Working Group report values that call for release of that land for public use?

Response
DOE has revised the cumulative impacts analysis presented in Chapter 11 in Volume I of the WM PEIS to include new information available on other DOE actions at Hanford. The Hanford Tank Waste Remediation System EIS, the Hanford Remedial Action EIS, and the CERCLA documentation for the Environmental Restoration Disposal Facility were added to the list of documents evaluated for information on impacts from other reasonably foreseeable actions at the site, as described in Volume I, Section 11.6.2. Other EISs considered in Section 11.6.2 include spent nuclear fuel management,

management of K-Basin spent nuclear fuel, disposal of decommissioned Naval nuclear plants, safe interim storage of Hanford tank wastes, storage and disposition of weapons-usable fissile materials, and plutonium finishing plant stabilization. These actions might involve 1,949 acres more than the estimated 7 to 178 acres required for the combined waste management actions proposed for the Hanford Site. Assuming a footfall field of approximately 1.25 acres, the anticipated actions at Hanford would require acreage on the order of the 1,791 noted by the commentor. So far as the "nuclear national sacrifice zone for disposal" at the Hanford Site, the commentor is likely referring to land irreversibly committed to environmental remediation waste disposal. The Draft Hanford Remedial Action EIS and Comprehensive Land Use Plan indicates that under the Restricted (R2) and Exclusive Future Land-Use Alternative, the capped areas of the Reactors on the River, Central Plateau, and All Other Areas geographic areas would be irreversibly and irretrievably committed. The caps in several waste sites would irreversibly commit environmental resources (geologic and groundwater) in the Reactors on the River (137 hectare [339 acres]), Central Plateau (1,138 hectare [2,812 acres]), and All Other Areas (73 hectare [180 acres]) geographic areas for long-term disposal of environmental remediation wastes.

The area required on the Central Plateau for environmental wastes commits less than half the acreage. More than 3,000 acres would remain to support other activities on the Central Plateau, including the proposed waste management activities. The Hanford Future Site Use Working Group Report and its values are not threatened by any alternative in the WM PEIS. No alternative in the WM PEIS will require additional land use for waste management facilities outside the 200 Area at Hanford.

The State of Washington has designated large and small blocks of shrub-steppe as priority habitat because it possesses unique or significant value to many species. The State made this determination based on the quality of the following attributes: comparatively high fish and wildlife density, comparatively high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, important fish and wildlife movement corridors, limited availability, high vulnerability to habitat alteration, and unique or dependent species.

Almost the entire Hanford Site is classified as shrub-steppe and is, therefore, priority habitat. However, much of the site's habitat, including the habitat of the Central Plateau, the site of nearly all of Hanford's waste management operations, is previously disturbed. The site is criss-crossed with dirt roads; old concrete water tanks are scattered throughout the site; an abandoned gravel pit is centrally located on the site; and an old laydown yard (used during construction of the REDOX plant) is on the western end of the site.

Unlike the U.S. Fish and Wildlife Service's designations of critical habitat, Washington State's priority habitat designations have no associated legal requirements for habitat protection. However, DOE Order 430.1, Life-Cycle Asset Management, requires that DOE consider ecosystem management and preservation values during all phases of Hanford Site operations. DOE intends to limit disturbances to priority habitats through the designation of future Hanford Site land uses. The Draft Hanford Remedial Action EIS and Comprehensive Land Use Plan (DOE/EIS-0222D), which is currently undergoing public review and comment, takes into account the preservation of valuable natural resources when developing broad classes of future land uses. When the Record of Decision for this EIS is issued and land uses are designated, a Hanford Biological Resources Management Plan will be finalized (it is currently in draft form) to provide direction regarding the protection and enhancement of the natural environment.

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The Foreign Research Reactor Spent Nuclear Fuel EIS evaluates alternatives for the management of reactor fuel irradiated in foreign reactors, including the risks associated with its transportation. In addition, the SNF/INEL EIS evaluates DOE spent nuclear fuel management at the programmatic level, just as this PEIS evaluates the DOE Waste Management Program. As documented in the SNF/INEL EIS Record of Decision, DOE decided to regionalize spent nuclear fuel management by fuel type at three sites--the Hanford Site, INEL, and SRS. Hanford production reactor fuel will remain at the Hanford Site. In addition, the Record of Decision for the Foreign Research Reactor Spent Nuclear Fuel EIS. indicates that neither Tacoma, nor Seattle, Washington, would be used to receive foreign research reactor spent nuclear fuel. DOE believes that these extensive documents cover their subjects, including transportation, thoroughly and completely. In addition, Section 11.20, Volume I, of the WM PEIS contains the cumulative impacts analysis for transportation.

Comment (3548)
The first paragraph of Section 5.4.13 in Volume I of the WM PEIS only mentions cumulative impacts from the Waste Management Program, while excluding cumulative impacts from other actions (e.g., environmental restoration).

Response
Section 11.2 in Volume I of the WM PEIS describes the cumulative impacts analysis. The analysis considers the potential impacts of the proposed waste management actions in the context of existing site conditions and the impacts of other reasonably foreseeable future actions at each site. Environmental restoration activities at most DOE sites cannot be meaningfully evaluated in terms of cumulative impacts at this time, since environmental restoration actions are too uncertain for most sites. However, several sites currently have adequate evaluations available for environmental restoration activities. Environmental restoration impacts for these sites have been incorporated into the cumulative impacts analysis presented in Chapter 11 of the WM PEIS. The PEIS does consider the effects of environmental restoration waste volumes on the comparison among waste management alternatives (see Chapters 6, 7, and 8 in Volume I and Appendix B in Volume III). In general, the PEIS does not consider impacts of environmental restoration activities, which DOE believes are specific to each affected location. Sitewide or project-level NEPA reviews would analyze cumulative impacts in greater detail.

Comment (3571)
DOE's course of evaluation through the WM PEIS process must entail consultation with each Native Nation - government to government - in order to understand the big picture effects and needs of Native Peoples. The stated reliance in the WM PEIS on site-specific analysis for cultural impacts will not address the cumulative impacts on Native Peoples as Nations or as a minority group. DOE facilities have already greatly impacted Native Peoples. Overall, of any "ethnic" group, Native Peoples have suffered the most under the nuclear complex. To ignore this history and the current and future cumulative impacts on Native Nations from DOE management of nuclear and hazardous materials is to contribute to "genocide and crimes against humanity."

Response
DOE policy recognizes the sovereignty of Native American Tribal Governments and the unique government-to-government relationship with the Federal Government as defined by history, treaties, statutes, court decisions, and the U.S. Constitution. DOE recognizes that it must fulfill its obligations

under Treaties with Native American Tribal Governments, and must fulfill the Federal Government's trust responsibility toward Tribes when making decisions.

DOE's policy is to consult with Tribal Governments to ensure that Tribal rights and interests are considered; that the potential impacts of proposed DOE actions on cultural or religious resources are disclosed; and that any unnecessary interference with traditional religious practices is avoided. DOE is committed to incorporating this policy into its ongoing and long-term planning and management processes, including the NEPA process, and has worked through its site representatives to notify the Tribes of the WM PEIS scope and availability for comment. Section 1.4.5 in Volume I of the Final WM PEIS addresses DOE's consultation obligations and activities and acknowledges the Tribal/Federal Government-to-Government relationship and U.S. trust and treaty obligations. Section 5.4.10 discusses the unique nature of Native American cultural and religious resources.

The WM PEIS classifies Native Americans as minority populations in a numerical context to describe the demographic characteristics of the regions surrounding the DOE sites. This designation is not intended to contradict the discussion of the unique government-to-government relationship between the U.S. and Tribes nor the Federal Government trust responsibility.

The WM PEIS analysis focuses mainly on alternatives addressing national-level strategic issues. The individual character of Native American cultures at DOE's sites, and the specialized nature of each Tribe's concerns in site activities, while considered in the WM PEIS at the programmatic level, is more productive as part of a site-level analysis. Sitewide or project-level NEPA reviews would more fully explore specific concerns related to Native American issues such as the protection of sacred lands, cultural properties, and Tribal and religious practices. During these reviews, local DOE officials will continue to work with Tribal representatives to listen to their concerns regarding need for and location of any necessary facilities and related activities, such as transportation requirements, and to consider specific Tribal values, potential environmental impacts, and appropriate mitigative measures. Some DOE Operations Offices have cooperative agreements in place with Tribal Governments about a range of environmental issues, and the sites' Tribal contacts will assist in the consultation process for site-specific and transportation issues for the WM PEIS.

The WM PEIS considers cumulative impacts from past, present, and reasonably foreseeable future actions to the extent possible (see Chapter 11 in Volume I). At individual sites, DOE believes it will have sufficient flexibility to avoid or minimize any human health or environmental impacts found to be potentially significant, including those that could have the potential to pose disproportionately high and adverse impacts to Native American Tribes, minorities, or low-income populations, through selection of a different waste management technology or facility location.

Comment (3573)
The Clinton memorandum (and Executive Orders) are attached for your review to help guide you in re-configuring your process for re-analyzing the impacts on Native Nations. The potential number of Native Nations that could be impacted is over 60, dependent upon transportation routes taken. Minus transportation, approximately 18 to 20 Native Nations are already impacted directly by just DOE's weapons production, etc., and could be further impacted by future "management" schemes of nuclear and hazardous materials by the DOE.

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Response
DOE believes that the analytic process used for the WM PEIS is correct and that impacts to Tribal Nations do not need to be reevaluated. The WM PEIS has considered cumulative impacts from past, present, and reasonably foreseeable future actions to the extent possible. Factors that have limited the consideration of cumulative impacts in some areas include lack of available data and schedule conflicts. Additional information that became available after the Draft WM PEIS was prepared, has been included in Chapter 11 in Volume I of the Final WM PEIS. The WM PEIS analysis based on this available information shows that the impacts on human health and the environment from facility or transportation accidents associated with the management of waste types would be low under any alternative. Where cumulative impacts approach or exceed standards, a brief discussion of mitigation measures is provided.

Comment (3575)
To fully address the radiological and chemical health risks, it will be necessary to analyze the global pathways for ingestion, inhalation, direct radiation, and indirect radiation on all populations. Hopefully, at some point DOE will realize there is a limit to the total amount of radiation (from all added human sources to naturally occurring radiation) in the environment, where the cellular structures of life will be altered to the permanent and unrecoverable detriment of human and many other life-forms. The assumption that the continuation of production of radiation, radiological materials, and weapons is propitious, is no longer acceptable.

Response
The WM PEIS did analyze health risks from all relevant pathways. DOE determined that the airborne pathway was dominant and that consideration of other pathways would not affect the relative comparison of the alternatives. Other pathways will be considered in sitewide or project-level studies prior to implementing any waste management decisions. The cumulative impacts of waste management activities and other past, present, and reasonably foreseeable future actions at particular DOE sites are discussed in Chapter 11 in Volume I of the WM PEIS.

Comment (3691)
The CEQ regulations at 40 CFR 1508.7 and 1508.8 state that impacts on the environment include direct effects, which are caused by the action and occur at the same time and place; indirect effects, which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable; and cumulative impacts, which result from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions. The CEQ regulations at 1508.7 define cumulative impact as the impact on the environment that results from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The CEQ regulations at 1508.25(a)1) state that to determine the scope of EISs, among other things, agencies shall consider three types of actions as "connected." Actions are connected if they automatically trigger other actions that might require environmental impact statements; cannot or will not proceed unless other actions are taken previously or simultaneously; are interdependent parts of a larger action and depend on the larger action for their justification. For high-level waste, we feel DOE has not complied with the above NEPA regulations.

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Review and discuss the impacts that high-level waste reprocessing, plutonium and highly enriched uranium disposition, spent fuel, and other related treatment issues presented in different environmental impact statements will have on DOE waste treatment decisions.

Response
Chapter 9 describes the impacts of the management of high-level waste. The PEIS analyzes only the impacts of stored vitrified high-level waste. DOE assumed vitrification of high-level waste as a prerequisite to the WM PEIS analysis of high-level waste storage. Section 9.1.1 describes DOE's decision to vitrify high-level waste.

The WM PEIS considers cumulative impacts of existing conditions, proposed waste management actions, and reasonably foreseeable future actions to the extent possible. Factors that have limited the consideration of cumulative impacts in some areas include lack of data and schedule conflicts. For instance, impacts of high-level waste disposal at Yucca Mountain were not considered in the WM PEIS because this information is not yet available. The Draft WM PEIS considers the cumulative impacts of spent nuclear fuel management, tritium supply and recycling, high-level waste treatment, and transuranic waste disposal. Additional information on stockpile stewardship and management, fissile materials management, and storage and disposition of excess highly enriched uranium that has become available since the Draft WM PEIS was prepared is now included in Chapter 11 of the Final WM PEIS.

Comment (3736)
The WM PEIS fails to consider the cumulative impacts of transporting the vast quantities of LLW from weapons plants to the Hanford Site, along with mixed, high-level, Class C, hazardous, and transuranic wastes.

Response
Cumulative impacts are presented in Chapter 11 in Volume I of the WM PEIS. For the Final WM PEIS, DOE revised Chapter 11, which now contains a more comprehensive evaluation of other DOE actions that might affect the sites. Section 11.20 contains the cumulative impacts analysis for transportation, which considers all sites and waste types examined in this document. Section 11.6.2 contains the cumulative impacts analysis for the Hanford Site, including cumulative transportation impacts. For the waste types considered in the WM PEIS, a maximum of approximately 100 shipments per day would occur at Hanford. The transportation infrastructure in the Hanford area can easily handle such a load. Annual radiological doses to a maximally exposed individual are projected to be within regulatory limits.

The WM PEIS combined and cumulative impacts analyses analyze the management of low-level mixed waste, low-level waste, transuranic waste, high-level waste and other materials such as spent nuclear fuel and nuclear materials, as appropriate for each site. Class C waste refers to the NRC classification of commercial radioactive waste, which is not DOE's responsibility. DOE is responsible for managing "greater-than-Class-C" waste. However, as discussed in Section 1.5.6 in Volume I DOE has not performed the detailed analysis required to develop options for this waste stream.

Comment (3986)
How can DOE make final determinations of preferred alternatives for waste treatment and management without considering the cumulative impacts of the proposed actions at these major sites?

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How can DOE reasonably select sites as suitable for treatment and disposal alternatives without addressing cumulative impacts? How can a site be determined suitable without addressing past and present impacts? Existing site conditions would appear to have great importance in determining appropriate agency actions at that site.

Response
Chapter 11 in Volume I includes an analysis of the cumulative impacts of all alternatives analyzed in the WM PEIS. The combined impacts of the proposed waste management actions, the impacts of existing site conditions, and the impacts of reasonably foreseeable future actions are addressed in Chapter 11. DOE has revised Chapter 11 to include additional ongoing and reasonably foreseeable actions that were not included in the Draft PEIS.

Comment (3999)
With an anticipated aqueous treatment facility being listed in the WM PEIS for the Portsmouth Plant, but discussed in a separate document; with no agency consideration in change of operations that the DOE can reasonably be expected to foresee (downblending of highly enriched uranium and spent nuclear fuel); with remedial actions by other agencies; and with recent considerable upgrades to the onsite sewage treatment system at the Portsmouth Plant combined with changes in Ohio EPA antidegradation regulations for industrial wastewater discharge in process; DOE has considerable impacts to consider that are both cumulative and combined.

How is the agency addressing combined impacts in its decisionmaking process? DOE must consider actions by other agencies and private corporations in the context of current site conditions at the Portsmouth Plant in its decisionmaking. DOE is apparently considering only DOE actions at Portsmouth rather than operations currently occurring onsite under USEC.

Response
The impacts of waste management actions at Portsmouth Plant combined with past, present and reasonably foreseeable future actions are described in Section 11.14 in Volume I of the WM PEIS. This section was revised for the Final WM PEIS to include additional present and reasonably foreseeable actions. Section 4.4.12 in Volume I describes existing environmental conditions at the Portsmouth Plant. Those existing conditions are the result of, among other activities, the uranium enrichment process and USEC activities. The current resource use and effluent discharges at the Portsmouth Plant are described in Section 4.4.12 and the WM PEIS Affected Environment Technical Report. The existing conditions, including resource use and effluent discharges, form the baseline against which potential waste management impacts are compared. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I.

As stated in Section 11.14, DOE has no other actions planned at the Portsmouth Plant, except environmental restoration activities. No other actions are planned in the Portsmouth region that would contribute to the impact of waste management alternatives. The impacts of existing operations at the Portsmouth Plant, including USEC activities, within the context of cumulative impacts, is presented in Table 11.14-2 in Volume I.

Impacts from environmental restoration activities at the Portsmouth Plant are not sufficiently known to allow full incorporation into the cumulative impacts analysis. Such information will be incorporated in sitewide or project-level NEPA reviews.

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The planned facility for aqueous waste treatment at the Portsmouth Plant will be covered by a separate sitewide or project-level NEPA review; however impacts have been modeled in the WM PEIS using conceptual treatment facilities, if insufficient capacity was available onsite.

Comment (4021)
In the cumulative impacts analysis, the WM PEIS provides collective occupational and collective general population dose information based on historical transportation (see Table 11-39), but Appendix E does not explain how population dose from historical transportation is calculated or measured.

Response
DOE has revised the cumulative impacts analysis for transportation presented in Section 11.20 in Volume I. As stated in footnote "a," the data presented in Table 11.20-4 were taken from Section I-10.1 in Volume 1 of the SNF/INEL PEIS. The methodology for calculating these doses can be found in that PEIS as well. DOE obtained collective doses from historical shipments of spent nuclear fuel to Hanford, SRS, INEL, ORR, and NTS from a number of sources. For example, shipment data were linearly extrapolated for years for which such information was unavailable; population densities were based on census data for 1990; and transportation routes were based on the 1993 configuration of the U.S. highway and rail system.

Comment (4070)
DOE should be truthful and produce a thorough inventory of all traces of contamination in its facilities, waste sites, adjoining waters, and drainages. DOE should employ simple analytical methods rather than coverup tricks (e.g., mathematic subtraction of a presumed background.)

Response
Information on existing contamination is discussed in Chapter 4 in Volume I. In addition, this information is included in the cumulative impacts analysis to characterize existing site conditions. No attempt was made to factor out background concentrations.

Cumulative impacts are evaluated in Chapter 11 (Volume I) of the WM PEIS. The WM PEIS considers the cumulative impacts of the proposed waste management actions, existing site conditions, and impacts of other reasonably foreseeable future actions to the extent possible. Factors that have limited the consideration of cumulative impacts in some areas include lack of available data and schedule conflicts. For instance, impacts of proposed high-level waste disposal at Yucca Mountain were not considered in the Draft WM PEIS because this information is not yet available. The Draft WM PEIS did consider the cumulative impacts of spent fuel management; tritium supply and recycling, high-level waste treatment, and transuranic waste disposal. Additional information on stockpile stewardship and management, fissile materials management, and storage and disposition of excess highly enriched uranium that has become available since the Draft WM PEIS was prepared is included in Chapter 11 of the Final WM PEIS.

Impacts from environmental restoration actions at most DOE sites cannot be meaningfully evaluated in a cumulative impacts assessment at this time because they are too uncertain. For those sites that do have adequate evaluations of environmental restoration actions, information on potential impacts has been included in the cumulative impacts analysis presented in Chapter 11.

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Comment (4133)
The WM PEIS should fully disclose the quantities of and cumulative impacts from all mixed wastes, including wastes from environmental restoration and decontamination and decommissioning of the nuclear weapons complex, that might be imported into Washington State for treatment or disposal, including at privately owned facilities built to serve Hanford. The public has a right to know what wastes will be managed locally and the resulting potential exposures and risks.

Response
DOE has revised the cumulative impacts analysis presented in Chapter 11 in Volume I of the WM PEIS. To the extent that information on the impacts from environmental restoration exists, it has been included for each site. Decontamination and decommissioning of the nuclear weapons complex is incorporated in the WM PEIS in cases where it is also incorporated in other EISs. The Hanford Tank Waste Remediation System and Hanford Remedial Action EISs, and the CERCLA documentation for the Environmental Restoration Disposal Facility were added to the list of documents evaluated for information on impacts from other reasonably foreseeable actions at the site, as described in Section 11.6.2 in Volume I of the WM PEIS. Other actions considered in Section 11.6.2 include spent nuclear fuel management, management of K-Basin spent nuclear fuel, disposal of decommissioned Naval nuclear plants, safe interim storage of Hanford tank waste, storage and disposition of weapons-usable fissile materials, and Plutonium Finishing Plant stabilization.

For the purposes of this document a distinction is made between private facilities and commercial facilities. Private facilities are those DOE operations/facilities privatized on DOE sites. The impacts of using a privatized facility on a DOE site would be the same as those using a DOE facility at the same site. Commercial facilities are facilities operated off DOE sites. None of the alternatives proposed for waste management in the WM PEIS analyze treatment of waste at commercial facilities. However, shipment of wastes to commercial facilities is not prohibited and may be considered at the site level. DOE revised the WM PEIS to include a discussion of privatization issues (see Section 1.7.4 in Volume I).

Comment (4375)
DOE failed to integrate and disclose related actions and cumulative impacts for transportation such as the spent nuclear-fuel program, under which DOE wants to import high-level nuclear waste from throughout the world through the ports of Tacoma, Seattle, or Portland. We know that in the Northwest there will be fatal cancers if DOE imports the total number of shipments proposed. But DOE shoves that aside so it can conveniently only look at this little piece--so you can say, not many impacts.

DOE should rule out shipping high-level nuclear waste on commercial freighters through public ports in the Puget Sound. This is a military problem that should be dealt with through a military port.

Response
DOE addressed related actions to the extent possible in Volume I, Chapter 11, of the Final WM PEIS. Table 11-2 in Volume I identifies other EISs whose impacts were included in the WM PEIS cumulative impacts analysis and the sites where these impacts would apply. Table 11-2 indicates that the SNF/INEL PEIS impacts would apply to the Hanford Site, INEL, and SRS. The Foreign Research Reactor Spent Nuclear Fuel EIS impacts would apply to INEL and SRS. The impacts associated with

the preferred alternatives in these and other DOE EISs and EAs were included in the WM PEIS cumulative impacts analysis.

The Foreign Research Reactor Spent Nuclear Fuel EIS evaluates alternatives for the management of reactor fuel irradiated in foreign reactors, including the risks associated with its transportation. In addition, the SNF/INEL PEIS evaluates DOE spent nuclear fuel management at the programmatic level, just as the WM PEIS evaluates waste management at the programmatic level. Based on the SNF/INEL PEIS, DOE decided to regionalize spent nuclear fuel management by fuel types at three sites: the Hanford Site, INEL, and SRS. Hanford production reactor fuel will remain at the Hanford Site. In addition, the Record of Decision for the Foreign Research Reactor Spent Nuclear Fuel EIS indicates that Portland, Tacoma, and Seattle would not be used to receive foreign research reactor spent nuclear fuel.

Comment (4400)
The entire WM PEIS document fails to adequately assess or consider all past, present, and future impacts including cumulative, connected, direct, indirect, and synergistic effects of DOE's waste management activities of nuclear and hazardous wastes as required under CEQ Section 1508 *et seq.*

Response
Cumulative impacts are those that result from the incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions. Both CEQ and DOE regulations for implementing NEPA require assessment of cumulative impacts because significant impacts can result from a combination of actions that, by themselves, might not have significant impacts.

Chapter 11 in Volume I of the WM PEIS discusses the combined impacts that could result from locating waste management facilities at each of the 17 major waste management sites, the cumulative impacts that could result from waste management and other actions at each of the 17 major sites and in their surrounding regions, and the cumulative impacts of transporting waste.

Connected actions (CEQ regulations at 40 CFR 1508.25) are those closely related actions proposed by an agency that should be discussed in the same impact statement because (1) they automatically trigger other actions which may require an EIS, (2) they cannot proceed unless other actions are taken previously or simultaneously, or (3) they are interdependent parts of a larger action and depend on the larger action for justification. For example, shipment of large volumes of untreated waste would not occur unless a number of new waste management facilities are constructed at receiver sites. DOE has captured all of the connected actions of its overall Waste Management Program in the impacts analyses under each waste type, including construction of new facilities at various sites, shipment of wastes between sites, treatment of wastes, and storage and disposal of wastes where they are within the scope of the particular waste-type program. Impacts of actions such as treatment of high-level waste, which may be argued to be connected actions, but which are addressed in other NEPA analyses, are evaluated in the cumulative impacts chapter.

Factors that limited the consideration of cumulative impacts in some areas include lack of available data and schedule conflicts. For instance, impacts of proposed high-level waste disposal at Yucca Mountain were not considered in the WM PEIS because this information is not yet available. The Draft WM PEIS did consider the cumulative impact of spent fuel management, tritium supply and recycling, high-level waste treatment, and transuranic waste disposal. Additional information on stockpile

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stewardship and management, fissile materials management, and storage and disposition of excess highly enriched uranium that has become available since the Draft WM PEIS was prepared is included in Chapter 11 of the Final WM PEIS. Impacts from environmental restoration actions at most DOE sites cannot be meaningfully evaluated in a cumulative impacts assessment at this time because they are too uncertain. For those sites that do have adequate evaluations of environmental restoration actions, information on potential impacts is included in the cumulative impacts analysis presented in Chapter 11. Sitewide or project-level NEPA reviews would include more detailed cumulative impacts analyses.

Synergistic effects are those exaggerated effects that cannot be predicted based solely on adding the separate effects of the separate actions that may combine to cause them.

In general, synergistic effects of waste management actions were not evaluated because environmental impacts are not expected to be greater than additive. In particular potential synergistic and antagonistic effects resulting from exposure to mixtures of contaminants were not evaluated. As noted in Section D.2.5.1 in Volume III, risks from enhanced (synergistic) or diminished (antagonistic) toxicity from interactions among components of contaminant mixtures were not evaluated because not enough information exists on these effects. If synergism or antagonism is occurring these effects should be operative at all sites under all alternatives. Therefore, although the WM PEIS health risk estimates may actually underestimate or overestimate potential risks, the uncertainty added by the inability to address synergistic or antagonistic effects is systematically inherent throughout the analysis. However, the relative differences in risk estimates among waste management alternatives should not be affected by errors associated with these systematic uncertainties. The risks there will be accordingly under- or overestimated.

Comment (4415)
The Draft WM PEIS provides an ambiguous summary of cumulative health impacts with insufficient detail to make waste management siting decisions. It fails to show the cumulative impacts of all combinations of alternatives, giving only a range for each site and for transportation; fails to show the cumulative impacts of transportation combined with stationary sources and trade-offs between risks; fails to cover most of the cumulative exposure from all significant routes of exposure for many existing sites; calculates fatalities from existing sites as if people were only in the vicinity of the sites for 1 year (and does not clearly indicate this fact); and fails to include the impacts of changes in site impacts from DOE actions not considered in the WM PEIS (defense reconfiguration, spent nuclear fuel, stockpile maintenance, high-level waste treatment, etc.).

Response
Analysis of all combinations of alternatives would involve calculating 11,760 different estimates of health risk and other environmental effects at the 17 major sites. DOE considered this to be unreasonable in terms of the time and resources required to do such analyses and in terms of the infeasibility of presenting the results of such a large number of analyses in an appropriate, understandable way that would aid in decisionmaking.

DOE has revised the WM PEIS cumulative impacts analysis (see Chapter 11 in Volume I), which includes the information on existing site conditions presented in Chapter 4 in Volume I and summarizes the impacts of the combined management of each waste type presented in Chapters 6 through 10. In addition, DOE has expanded the discussion of other reasonably foreseeable future actions at the sites to include information from its EISs on stockpile stewardship, fissile materials management, storage and

disposition of excess highly enriched uranium and others, and on environmental restoration actions (for sites for which information is available).

DOE has not combined transportation and stationary source risks because the receptors for the two sources are different; that is, the maximally exposed individuals for transportation occur along the transportation routes and those for stationary sources occur in the offsite populations of individual DOE facilities.

The PEIS does analyze health risks from all relevant pathways. The analysis determined that the airborne pathway was dominant and that consideration of other pathways would not affect the relative comparison of the alternatives. Sitewide or project-level NEPA reviews would consider other pathways.

The revised cumulative impacts analysis includes collective doses for members of the offsite public and workers from waste management activities, combined with exposures from existing site activities and other reasonably foreseeable future actions. This analysis includes collective doses attributable to the entire assumed operating period for the proposed waste management facilities, not just one year.

Comment (4471)
The Draft WM PEIS does not evaluate cumulative impacts because it does not add in the impacts of other reasonably foreseeable future actions such as defense programs reconfiguration, environmental restoration, high-level waste treatment, spent nuclear fuel, etc., along with transportation risks.

Response
Cumulative impacts are evaluated in Chapter 11 (Volume I) of the WM PEIS. To the extent possible, the WM PEIS considers the cumulative impacts of proposed waste management actions, existing site conditions, and impacts of other reasonably foreseeable future actions. Factors that limited the consideration of cumulative impacts in some areas include lack of available data and schedule conflicts. For instance, the PEIS did not consider impacts of proposed high-level waste disposal at Yucca Mountain because this information is not yet available. The Draft WM PEIS did consider the cumulative impacts of spent fuel management, tritium supply and recycling, high-level waste treatment, and transuranic waste disposal. Chapter 11 now includes information on stockpile stewardship and management, fissile materials management, and storage and disposition of excess highly enriched uranium that became available after the preparation of the Draft PEIS.

DOE cannot meaningfully evaluate impacts from environmental restoration actions at most of its sites in a cumulative impacts assessment at this time because such impacts are too uncertain. For sites that do have adequate evaluations of environmental restoration actions, information on potential impacts is included in the cumulative impacts analysis in Chapter 11.

Comment (4553)
Previous modeling of the impact of treating high-level waste (HLW) indicates disproportionate impacts from treatment of HLW at WVDP compared to other sites.

If there is better information in the EISs cited than in the modeling for HLW treatment, that information should be tabulated and included in the cumulative impacts section of the WM PEIS. The results of modeling for HLW treatment should also be provided. An explanation of why the

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information from many site-specific EISs is better than that provided for the environmental restoration and WM PEIS should also be provided and should consider differences in the conservatism of the modeling and associated assumptions in the different EISs for HLW treatment at the various sites and associated uncertainties.

The cumulative impacts section of the Draft WM PEIS asserts that vitrification is assumed to result in the same levels of human health risks, air quality, resource commitments, and employment as included under existing conditions. However, no convincing justification for this assertion was provided. In addition, this assertion does not cover the pretreatment of the waste, which could cause significant adverse impacts on human health if emissions of radionuclides are not adequately controlled.

Previous modeling of HLW treatment at WVDP predicted that the pretreatment and vitrification of waste at WVDP could be a serious threat to the health of the general public.

According to modeling of WVDP, HLW treatment and vitrification would cause seven fatalities from cancer (not the 0.0000012 reported as the site impact in the Draft WM PEIS) and a cancer risk to the maximally exposed individual (MEI) of the general public of 0.0003 (not the 0.00000000015 risk reported in the Draft WM PEIS).

A quick review of the HLW treatment EIS for WVDP also revealed high impacts. For other sites modeled, total fatalities predicted were about 0.014 and highest risk of cancer was $3x10^{-7}$ to the MEI in the general public.

The modeling for other sites was based on the assumption that the HLW treatment at the other sites would have much better pollution control, designed to reduce risks to less than one in one million for the MEI in the general public. The only air pollution control assumed for WVDP HLW treatment was reported to be high-efficiency particulate air filters (which fail to collect volatile emissions at the operating temperatures assumed).

The best available information from all sources, including documentation provided to NRC should be used to quantify the expected impact of HLW pretreatment and vitrification at WVDP (and at other sites). These results should be included in the WM PEIS, as cumulative impacts and as part of the alternatives involving the treatment of HLW, along with mitigating measures.

The Draft WM PEIS reports the annual radiation dose to the MEI as 2.9E-4 mrem; and the 1992 WVDP Site Environmental Report reports an annual dose to the MEI of 4.6E-2 mrem from eating 42 pounds of fish (an exposure 159 times higher than the exposure from air emissions reported in the Draft WM PEIS).

The dose to the population near WVDP from liquid effluents (and associated fish contamination) was estimated in the Site Environmental Report to be 0.0092 mrem. This should be added to the 0.0024 mrem air exposure to give a total dose of approximately 0.011 mrem.

Response
The commentor is referring to preliminary, unreviewed, and unpublished analyses that were developed during the scoping period for the WM PEIS. Since site-level analyses were planned or completed for the treatment of HLW at the Hanford Site, SRS, and WVDP, HLW treatment was removed from the

initial scope of the WM PEIS. Site-level analyses are better able to estimate the potential impacts of HLW treatment at these sites than this programmatic document. Anticipated impacts related to HLW treatment are included in the cumulative impacts analysis for the Hanford Site, INEL, SRS, and WVDP presented in Chapter 11 in Volume I of the PEIS.

The HLW vitrification facility at WVDP began operation in July 1996. Offgases from the vitrification process are routed through a series of treatment steps to remove radioactivity and nitrogen oxides. The pollution control system for the main stack includes multiple banks of HEPA filters. The goal of the offgas treatment system design is to key emissions to the lowest reasonable level.

Emissions from the main stack have been continuously monitored since HLW vitrification began at WVDP. Actual emission data and weather data are input into computer models used to estimate the highest possible dose to an offsite individual from HLW treatment emissions. Projections based on data collected in the first few months following startup estimate potential maximum exposure to an offsite individual at 0.025 mrem, far below the 10 mrem limit.

The radiological airborne releases from the vitrification facility are expected to be primarily cesium-137, strontium-90, and their short-lived daughters, barium-137_m and yttrium-90.

The consumption of contaminated wildlife and other multimedia exposure scenarios will be addressed as parts of site-specific analyses. These pathways would be relevant only for certain specialized populations (e.g., subsistence hunters and fishermen), and would require additional information or assumptions about their dietary habits. In contrast, the WM PEIS estimated risks to offsite populations through pathways that are more relevant for the general population (i.e., airborne releases from facilities leading to inhalation exposure, and deposition of contaminants to soil followed by uptake in crops and livestock and ingestion by receptors). The MEI exposure and risk estimates for these pathways are more applicable to most members of the general public.

Comment (4554)
A commentor provided a table showing the predicted number of radiation fatalities among the general public for the sites analyzed in the Draft WM PEIS:

NUMBER OF RADIATION FATALITIES AMONG THE GENERAL PUBLIC

	For a Lifetime of Exposure from All Onsite Waste Treatment		From 1992 Site Environmental Reports		
Site	Max	Min	Lifetime	1-Yr exp	1992 From WM PEIS (1-Yr)
Argonne	0.0013	1.0E-5	0.53	0.0076	0.0085
Brookhaven	1.2E-5	5.2E-8	0.18	0.12	0.0014
Fernald	0.23	1.4E-7	0.046	6.5E-4	6.5E-4
			But radon-255 higher, implying		
VERY ROUGH ESTIMATE----------→			12	0.16	
Hanford	0.11	0.0014	0.028	0.0040	3.0E-4
Idaho	0.042	0.0000058	0.0011	7.0E-4	1.5E-5
Lawrence Livermore	0.55	4.3E-6	0.0098	1.4E-4	8.5E-4
Los Alamos	0.65	2.8E-4	0.039	0.0055	7.0E-4
Nevada Test Site	1.5E-10	1.1E-10	0.0015	2.1E-5	1.5E-5
Oak Ridge	0.094	1.3E-5	1.5	0.022	0.022
Paducah	1.2E-4	8.3E-7	6.0E-5	8.5E-7	8.5E-6
Pantex	3.5E-5	2.4E-6	1.8E-6	2.5E-8	2.5E-8
Portsmouth	0.019	1.8E-8	0.11	0.00015	0.0015
Rocky Flats	0.11	1.6E-5	0.0035	5.0E-5	7.0E-5
Sandia	0.0014	1.7E-6	70E-4	1.0E-5	1.0E-5
Savannah River	2.6	6.4E-5	0.61	0.0088	0.0032
			+ game, which would be for MEI hunter		
			0.0017	2.5E-5	--
WIPP	0.61	0			
WVDP	2.5E-7	1.7E-7	3.9E-4	5.5E-5	1.2E-6

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NUMBER OF RADIATION FATALITIES AMONG THE GENERAL PUBLIC
(Cont'd)

Site	For a Lifetime of Exposure from All Onsite Waste Treatment		From 1992 Site Environmental Reports		1992 From WM PEIS (1-Yr)
	Max	Min	Lifetime	1-Yr exp	
Trucks					
Radiation	14	3.7	Not Available		Not
Accident	42	5.2	Not Available		Avail.
Trains					
Radiation	1.9	0.56	Not Available		Not
Accident	0.55	0.055	Not Available		Avail.

The Draft WM PEIS shows only the range of transportation fatalities from radiation and from mundane accidents for trucks. No information is provided on how the cumulative transportation impacts vary for the various combinations of alternatives shown for the maximum and the minimum impacts at sites.

Estimates in the Draft WM PEIS of the impacts of the alternatives at sites may not be realistic. There were no indications in the Draft WM PEIS that any additional emissions above those associated with normal process operations (assuming everything runs perfectly) and a few severe accidents were included in the estimates of the impacts of the alternatives.

DOE environmental studies do not adequately account for common deviations from assumed normal operating conditions, and the actual impacts of facility operation were severe due to common process upsets, inadequate maintenance of pollution control equipment, problems with the design and operation of process equipment, etc. These excess emissions caused severe environmental impacts around the Solvent Refined Coal site in Washington State, while the associated DOE environmental impact studies indicated no significant impacts.

Similar problems have occurred at DOE nuclear sites, including FEMP, where an estimated 3.5 million tons of uranium were emitted into the air due to improper design, operation, and maintenance of baghouse facilities; similar releases were reported at other sites in the December 21, 1995, Issue #473, of *RACHEL'S Environment & Health Weekly*. (Commentor provided information attributed to the article cited.)

No information on the population dose from radon was provided in the 1992 FEMP Site Environmental Report. As a result, the 12 fatalities for FEMP were estimated, including radon, by scaling up the predicted number of fatalities from non-radon exposure (based on exposures reported in the 1992 FEMP Site Environmental Report), by multiplying this number by the ratio of the impact on the MEI including radon divided by the exposure to the MEI, not including radon. Although the degree of accuracy of the estimate is unknown, it suggests that the radon emissions reported in 1992 could have significant impacts. More accurate estimates of the number of fatalities from the radon at FEMP might be available from the Dose Reconstruction project, which took place in the Spring of 1996.

Impacts of the reduced radon emissions should be evaluated in the revised Draft WM PEIS, along with the impact of radon emissions at ANL-E before and after whatever programs might exist to reduce them are implemented. This is very important for the affected environment and the cumulative impacts section of the WM PEIS.

The number of fatalities for the general public provided in the table are associated with site conditions as reported in Chapter 11 of the Draft WM PEIS. These figures are for one year of exposure to site conditions as they were in 1992.

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These estimates of the number of fatalities associated with DOE sites would be valid only if no members of the general public were anywhere within 50 miles of the sites at any time, except during the year 1992. However, the impacts of the alternatives at sites were computed for exposures well into the 21st century, for the entire population within 50 miles of the sites during the entire duration of the alternatives considered in the WM PEIS. Under the circumstances, it would be more appropriate to calculate fatalities from existing sites using a 70-year lifetime exposure and 1992 demographics and annual exposure. It would be best to do modeling and adjust the population figures based on the best estimates of existing and future cumulative populations and their distribution around the sites.

The site risks presented in the WM PEIS are highly misleading, especially when presented in the context of the impacts of the alternatives. The commentor has no confidence in the accuracy or representativeness of the predicted impacts of the alternatives in the WM PEIS (except that trains should be used to haul DOE's radioactive waste instead of trucks, to reduce environmental impacts significantly).

Because site risks presented in the Draft WM PEIS are misleading, especially when presented in the context of the impacts of the alternatives, the accuracy or representativeness of the predicted impacts of the alternatives in the WM PEIS is suspect.

A detailed, independent, well-funded analysis of the assumptions and models used for predicting the impacts of the alternatives would be needed for the modeling to be credible. Furthermore, the amount of time necessary for such a venture would require a considerable extension to the deadline for comments on the Draft WM PEIS (1 year, at least). The technical support documentation in the Draft WM PEIS does not appear adequate for such an analysis, but perhaps it is buried in the library of technical support documents cited.

Response
The combined waste management impacts and cumulative impacts analyses presented in Volume I, Chapter 11, of the WM PEIS have been revised. Health risk estimates are presented both as annual radiation doses and risks for the hypothetical offsite maximally exposed individual and as collective radiation doses and risks received by the offsite public over the entire 10- to 20-year period of waste management operations.

Section 11.20 of the Final WM PEIS, which addresses transportation combined and cumulative impacts, has also been revised. This section discusses the range of combined and cumulative impacts that occur regionally and nationally from the transportation of waste, including the estimated combined impacts of the routine transportation of waste by truck and rail for the waste management alternatives.

The WM PEIS cumulative impacts analysis, consistent with practice in other major EISs, does not consider facility accidents. A range of potential conceptual facility accidents were evaluated (see Appendices D and F). Potential health risk estimates from representative risk dominant accidents are presented in Sections 6.4.3, 7.4.3, 8.4.3, 9.4.3, and 10.4.3 in Volume I. Quantitative estimates are presented for both the consequences (if the accidents were to occur) and the estimated probabilities of occurrence of the accidents. Facility accident impacts for each waste type are not summed across waste types in Chapter 11. Note that it is not possible to predict accident occurrences.

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The commentor's "estimate" of 3.5 million tons of airborne releases of uranium at FEMP is clearly in error. Recent estimates of total airborne releases of uranium from all sources at FEMP while it functioned as the Feed Materials Production Center are from 400,000 to 70,000 pounds (Addendum (Special-UC-702) to *History of FMPC Radionuclide Discharges* (FMPC-2082, 1987); C. Miller and J. Smith, "Why Should We Do Environmental Dose Reconstructions?", *Health Physics*, 71(4), 10/96)

Radon accounts for about 200 mrem of the estimated 300 mrem average annual background radiation dose received in the United States. These exposures are not associated with site activities. At some DOE sites, the storage of wastes containing uranium, thorium, and radium might constitute an additional, source of radon exposure because radon forms when these radionuclides decay. The WM PEIS Affected Environment Technical Report supporting the WM PEIS (META/Berger-SR-01) contains estimates of this type of radionuclide exposure, which, for example, totaled 51 mrem at the fenceline at FEMP in 1992 and 0.3 mrem at ANL-E in 1993. The main radon emission at FEMP came from radium-bearing materials stored in the K-65 silos. Radon releases from Building 200 at ANL-E were due primarily to radioactive contamination from the "proof-of-breeding" program. These contaminated areas are undergoing remedial actions, which should reduce or eliminate these releases.

DOE revised Table 4.2-2 in the Final PEIS to note radon doses related to actions at FEMP and ANL-E and noted these estimates in the cumulative impacts tables in Chapter 11 in Volume I for these sites.

Model uncertainty results from the general limitations of mathematical models' ability to simulate an infinitely complex process using a finite number of variables. Model uncertainty also results from the inappropriate application of a model to a particular scenario. Maximum consequence assumptions can be made where model uncertainty is high.

These modeling issues, or uncertainties, were determined during a September 1993 risk assessment model review at ORNL to provide additional information on models such as MEPAS. Peer reviewers from across the country reviewed the models and provided comments and criticisms. This review included discussion of the consistency of the models used in the WM PEIS with each other and uncertainties associated with each model. The peer reviewers' comments and recommendations about these uncertainties were presented at a national workshop held in December 1993 in Washington, D.C.

Appendix D, in Volume III of the WM PEIS and Appendices E and F in Volume IV discuss in detail the health risk assessment assumptions and models used to estimate risks at the sites and in waste transportation. These appendices are supported by the technical reports listed in Section 15.2 in Volume I. These technical reports are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the WM PEIS. The WM PEIS risk analysis used currently accepted state-of-the-art models and conservative assumptions to produce risk estimates that tend to overestimate rather than underestimate risks. The health risk methods were subjected to peer review before being used in the WM PEIS.

Comment (4557)
The analysis of cumulative impacts should be more detailed than that presented in the Draft WM PEIS, which provides only extremes as separate numbers for unspecified combinations at individual sites, for transportation in general, and for existing site impacts. This information should be displayed in one table to make it more understandable. All reasonable combinations of alternatives should be included. If deaths are predicted, the predicted numbers of deaths should be added, after accounting for

differences in the conservatism of the models used to compute these cumulative impacts. While thousands of combinations of alternatives are possible, the results could be easily displayed graphically.

(The commentor provided a design for a graph and offered suggestions, as follows, on how to use the graph format to depict cumulative impacts.)

Combinations of alternatives could be organized to show the pattern for given indicators of environmental impacts and the relationships among them. Uncertainties and the differences among models shown to be factored into the process, and other methods of compiling, displaying, and analyzing the results of this analysis should also be used.

Cumulative impact graphs could also show the impacts of the combinations of alternatives in the WM PEIS. The existing site impacts and impacts of alternatives not in the WM PEIS could also be displayed (on the same axis as the combinations of alternatives, as if they represented combinations of alternatives). Such graphs could facilitate an understanding of how the cumulative impacts of the alternatives in the WM PEIS compare to current site impacts and non-WM PEIS impacts at the site.

Uncertainties in the predicted numerical indicators of risk should be quantitatively analyzed so that the adequacy of available information for decisionmakers and the value of the numbers predicted can be understood; an exhaustive probabilistic risk assessment would be desirable. Insights on the magnitude of uncertainties in the key impact indicators could be gained from appropriate sensitivity analysis.

Without such information, the numbers in the WM PEIS lack not only scientific credibility, but also general credibility, because no one has sufficient information to understand how seriously the numbers should be taken.

Informed decisionmaking on where to place waste treatment, storage, and disposal facilities can involve trade-offs among different impact indicators, such as risks to workers versus the public, costs versus impacts, risks to the maximally exposed individual versus total fatalities (a not uncommon trade-off), etc.

The probability that the more expensive combinations of alternatives would cause lower impacts than the less expensive should be factored into the evaluation of such trade-offs.

Response
Chapter 11 does not include summary tables or graphs that enable comparisons among sites or alternatives, but it does contain summary tables for impact categories at individual sites. DOE chose this presentation method because it enables the public to understand more fully the impacts anticipated at each DOE facility. This approach also includes the expected impacts. Thus, if the alternative with the maximum impact would result in acceptable exposure levels, all other alternatives would be acceptable.

DOE revised Chapter 11 to provide additional information about other proposed actions at DOE sites. The impacts of the combined waste management actions are considered in the context of existing site conditions, as well as the potential impacts of other reasonably foreseeable actions at the sites.

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Because of the programmatic nature of the document, and the fact that waste management facility locations have not been selected, DOE did not conduct a detailed analysis of uncertainties and their potential effects on impacts estimates for the WM PEIS. DOE also did not attempt to factor estimates of uncertainty into the analysis to establish ranges of effects. DOE did conduct a qualitative analysis of uncertainties for the human health risk assessment (see Volume III, Sections D.2.15 and D.4). More importantly however, DOE structured the PEIS analyses of human health risks and environmental impacts to ensure both that the effects would not be underestimated and that they would be estimated consistently from alternative to alternative.

Consistency and conservatism in the human health risk assessment were ensured by:

- Using the best, most recent data available on toxicity, accident frequencies, contaminant-specific environmental characteristics, and other important parameters;
- Using environmental-setting data on site meteorology and geohydrology developed by Pacific Northwest Laboratories specifically for risk assessment purposes;
- Using conservatively structured risk exposure scenarios to estimate maximally exposed individual and population doses.

Uncertainty for different types of risk estimates is also qualitatively discussed in Section 5.4.1.1 in Volume I.

DOE decisions on where to place waste management facilities will likely involve consideration of just the kinds of trade-offs the commentor suggests. A discussion of the criteria DOE is considering in waste management program decisionmaking is provided in Section 1.7.3 in Volume I of the WM PEIS.

Comment (4558)
Cumulative impacts calculated in the Draft WM PEIS seem to involve adding risks from one year of exposure to a site's misrepresented 1992 impacts to risks from a lifetime of exposure to the alternatives.

Concerning the absolute and the relative number of fatalities associated with the alternatives in the WM PEIS, perhaps another indication of the uncertainties in the magnitude of the risks would be appropriate, once this magnitude of uncertainties is known. Without this information, how would the estimated fatalities and other important indicators of impacts in the WM PEIS be used to make informed decisions?

Even if the uncertainties were known and biases accounted for, information concerning cumulative impacts of transportation and stationary source risks for enough combinations of alternatives to make informed siting decisions is not provided in the WM PEIS.

Response
To the extent possible, Chapter 11 in Volume I of the WM PEIS considers the cumulative impacts of waste management actions combined with existing site conditions and other reasonably foreseeable future actions. DOE has revised the cumulative impacts analysis to include collective doses for members of the offsite public and workers attributable to the entire assumed operating period for the proposed waste management facilities.

5.11 Cumulative Impacts

Because of the programmatic nature of the document, and the fact that waste management facility locations have not been selected, DOE did not conduct a detailed analysis of uncertainties and their potential effects on impacts estimates for the WM PEIS. DOE also did not attempt to factor estimates of uncertainty into the analysis to establish ranges of effects. DOE did conduct a qualitative analysis of uncertainties for the human health risk assessment (see Volume III, Sections D.2.15 and D.4). More importantly however, DOE structured the PEIS analyses of human health risks and environmental impacts to ensure both that the effects would not be underestimated and that they would be estimated consistently from alternative to alternative.

Consistency and conservatism in the human health risk assessment were ensured by:

- Using the best, most recent data available on toxicity, accident frequencies, contaminant-specific environmental characteristics, and other important parameters;
- Using environmental-setting data on site meteorology and geohydrology developed by Pacific Northwest Laboratories specifically for risk assessment purposes;
- Using conservatively structured risk exposure scenarios to estimate maximally exposed individual and population doses.

Uncertainty for different types of risk estimates is also qualitatively discussed in Section 5.4.1.1 in Volume I.

The WM PEIS used different types of models to estimate potential risks from stationary sources, such as waste management facilities, versus those from wastes transported under the Regionalized and Centralized Alternatives. The risk analyses for waste management workers considered the effects of shielding on limiting exposures to direct radiation from stationary sources. However, the transportation assessment could not use shielding as a factor in reducing exposures because of uncertainties about potential locations of the receptors (e.g., the offsite population) in relation to the shipments. As a result, the transportation radiological risk estimates are conservative (i.e., they are higher than would be likely to occur on the implementation of the alternatives). This difference in conservatism does not complicate the risk management decisionmaking process because transportation radiological risk estimates are routinely lower than transportation physical trauma risks. Therefore, the risk manager must balance potential risks to offsite populations associated with exposure to radionuclides released from waste management facilities under the various alternatives against potential transportation risks associated mainly with physical trauma from accidents.

Transportation and stationary source risks are not combined because the receptors differ between the two sources. The maximally exposed individuals for transportation occur along the transportation route, whereas, the maximally exposed individuals for stationary sources occur in the offsite populations of individual DOE facilities. Combined and cumulative impacts for stationary sources are presented on a site-specific basis in Chapter 11 in Volume I. Section 11.20 contains the combined and cumulative impacts discussions for transportation risks. Combined impacts for transportation are presented in an alternative rather than a site-specific basis.

5.12 Environmental Justice

Comment (689)
Protect Native Americans from waste facility emissions and effluents at LLNL.

Response
The Final WM PEIS analyzes potential human health risks to minority and low-income populations in a revised environmental justice analysis. For the purposes of this analysis, Native Americans were included as minority populations. Sections 6.10, 7.10, 8.10, 9.10, and 10.10 in Volume I describe any potential disproportionate impacts to these populations identified by the analysis. The analysis indicated that in no instance would any minority or low-income population in the region surrounding LLNL potentially experience high and adverse health effects from waste management for any waste type managed at the site.

Comment (1504)
The WM PEIS is not accurate regarding environmental justice. DOE has inaccurately estimated the percentages of the minority populations around the sites discussed in the PEIS.

Response
DOE has revised the WM PEIS environmental justice analysis to provide a more in-depth analysis of the potential impacts of the waste management alternatives on low income and minority populations. The methodology for the analysis is summarized in Section 5.4.7 (Volume I) and detailed in Section C.4.7 (Volume III). The percentages presented in Section 4.3.7 in Volume I reflect the overall proportions of minority and low-income individuals within a 50-mile radius of the center of smaller DOE sites and 50-mile radius of existing waste management facilities at larger DOE sites. The analysis of health effects, however, addressed potential health effects at the census tract level, not at the regional level. Census tracts within 50 miles of each site center were categorized as minority or low-income if their proportions exceeded the national averages for those groups even though the regional population overall might not. The maps in Section C.4.7 illustrate all minority and low-income census tracts at the 17 sites that exceed the national average criteria. Results of the analysis are presented by waste type in Sections 6.10, 7.10, 8.10, 9.10, and 10.10 in Volume I. Site-specific NEPA reviews would evaluate environmental justice issues in greater detail.

Comment (1506)
The PEIS Summary document should describe what DOE will do to mitigate environmental justice impacts at LANL.

Response
DOE revised the WM PEIS environmental justice analysis, as described in Section 5.4.7 in Volume I of the Final PEIS (see Section C.4.7 in Volume III). The results of the analysis, discussed in Sections 6.10, 7.10, 8.10, 9.10, and 10.10 in Volume I, identify any locations where minority populations could potentially experience disproportionately high and adverse health risks or environmental impacts. The analysis indicated that in no instance would minority or low-income populations in the region surrounding LANL potentially experience high and adverse health effects from waste management actions for any of the waste types managed at LANL. Site-specific NEPA reviews would evaluate proposed waste management facility locations at LANL and related environmental justice impacts, and would also discuss appropriate mitigation. Examples of mitigation include selecting treatment and disposal facility locations within the fenceline, changing treatment and disposal technologies or modifying engineering designs in order to minimize risk.

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Comment (1508)
A commentor does not believe that DOE is concerned about environmental justice. DOE needs to assure the public that Native American and Hispanic workers shoveling waste alongside white scientists on the sites in New Mexico will be treated equally with regard to health and safety.

Response
Executive Order 12898 directs Federal agencies, including DOE, to incorporate environmental justice as part of their missions. The Executive Order specifically directs agencies to identify and address, as appropriate, potential disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the agencies' programs, policies, and activities.

In addition, DOE is working with the public, including minority and low-income populations, through Site-Specific Advisory Boards and other forums. These groups provide excellent opportunities to discuss operational issues that might be beyond the scope of this PEIS, but are still extremely important.

It is DOE policy that all employees be treated equally and that DOE and it's contractors comply with all applicable worker health and safety requirements. Instances of known or suspected noncompliance should be reported through the appropriate channels at each site.

Comment (1528)
DOE has not paid enough attention to environmental justice in the WM PEIS.

Response
DOE is committed to the principles of environmental justice, as defined in Executive Order 12898. The WM PEIS presents a broad evaluation of environmental justice, which is suitable for a programmatic review. The PEIS analyzes human health and environmental impacts associated with the alternatives for the five waste types. This analysis focuses on risks to the hypothetical maximally exposed individuals in offsite populations around the sites, and on environmental impacts, such as those to air quality, that could have direct impacts on offsite populations. The WM PEIS then compares the locations of minority and low-income populations to the predicted locations of impacts to the maximally exposed individuals and environmental impacts. Environmental justice concerns occur if the analysis indicates that the maximally exposed individual resides in an area that meets the criteria established in Executive Order 12898.

To address potential environmental justice impacts, DOE mapped the minority, low-income, and where applicable, Native American populations within an 80-kilometer (50-mile) radius of an existing waste management facility or the geographic center for each of the 17 sites evaluated for waste management activities. The maps in Volume III, Section C.4.7, are based on analyses of 1990 U.S. Census Bureau Tiger Line files, which contain political boundaries and geographical features, and Summary Tape Files 3A from the U.S. Census Bureau, which contain demographic data. The evaluation resolved data to the census-tract level. Section C.4.7 contains more information on mapping procedures and minority population identification.

No potential disproportionately high and adverse impacts were predicted for the general population under routine waste treatment operations at any DOE facilities. However, the potential for

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disproportionate impacts to minority and low-income populations is discussed in Sections 6.10, 7.10, 8.10, 9.10 and 10.10 in Volume I. Sitewide or project-level NEPA reviews will include in-depth assessments of environmental justice and other factors pertinent to individual sites.

Comment (1714)
According to 1990 census data, minorities comprise 8.35% of the population around ORR, and 10.6% of the population is below poverty level. Volume I, Table 4-7, in the Draft PEIS provides no statistics by age group or employment level within the subgroups to allow meaningful interpretations of environmental justice. The proposed waste management sites should have been presented as a part of the justice factor to ensure such sites are not principally concentrated among low-income or minority groups (e.g., Scarboro community in Oak Ridge, Tennessee).

Response
DOE is committed to the principles of environmental justice, as defined in Executive Order 12898. Accordingly, the WM PEIS provides an evaluation of environmental justice suitable for a programmatic review.

The analysis of environmental justice impacts in the PEIS uses census tract statistics for minorities or low-income populations, although county-level summary statistics were provided in Volume I, Section 4.3.7, of the Draft PEIS. Other population subgroups, such as children, the elderly, and the unemployed are not called out in Executive Order 12898, and were not explicitly included in the PEIS analysis of environmental justice impacts. However, these subpopulations were implicitly addressed in the human health risk and economic impacts analyses.

To address environmental justice impacts, DOE mapped the minority, low-income, and Native American Tribal lands within an 80-kilometer (50-mile) radius of the site center for each of the 17 sites evaluated for waste management activities. The revised maps in Volume III, Section C.4.7, are based on analyses of 1990 U.S. Bureau of the Census Tiger Line files, which contain political boundaries and geographical features, and Summary Tape Files 3A from the U.S. Census Bureau, which contain demographic data. The evaluation of health risks resolved data to the census-tract level. Section C.4.7 contains more information on mapping procedures, minority population identification methods, and analysis of health risks used for the PEIS environmental justice analysis. Using methods identified in Appendix C, Section C.4.7, health risks were distributed spatially to identify potential disproportionately high and adverse effects. Results of the environmental justice analysis are presented by waste type in Volume I, Sections 6.10, 7.10, 8.10, 9.10, and 10.10. The analysis indicated that in no instance would minority or low-income populations in the region surrounding ORR potentially experience high and adverse health effects from waste management actions for any of the waste types managed at ORR.

Sitewide or project-level NEPA reviews would include more detailed assessments of the potential for environmental justice impacts, including disproportionate health risks and environmental and socioeconomic impacts pertinent to a specific onsite waste management facility location.

Comment (2087)
According to recent census data, there are a number of minority populations in the BNL area; this might create environmental justice issues.

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Response
The PEIS assessment of potential environmental justice impacts from waste management activities is detailed by waste type in Section 6.10, 7.10, 8.10, 9.10 and 10.10 in Volume I. The analysis indicated that in no instance would any minority or low-income population in the region surrounding BNL experience potential disproportionately high and adverse health effects because of waste management activities for any waste type managed at BNL. Sitewide or project-level NEPA reviews would analyze environmental justice and other socioeconomics concerns in detail.

Comment (2144)
The study considers housing statistics and minority populations, although income or race should not have anything to do with the siting of a disposal site.

Response
Executive Order 12898 directs Federal agencies, including DOE, to incorporate environmental justice as part of their missions. The Executive Order specifically directs agencies to identify and address, as appropriate, potential disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the agencies' programs, policies, and activities.

Comment (2236)
The PEIS does not adequately analyze ecological impacts, especially in terms of Native American uses of land at Hanford for a food source. Doses to offsite populations do not consider the doses and pathways for the Tribes.

Response
DOE did not specifically evaluate the human health risk to populations near the sites that may derive a portion of their food supply from native plants and animals that exist near DOE sites, or that obtain water from nearby contaminated surface water bodies. This is a complex analysis which cannot be performed with confidence until locations of the facilities on the sites, as well as additional information about the specific dietary habits involved, are known. These types of analyses would be included in sitewide or project-level NEPA reviews. DOE did evaluate the relative potential for subsistence lifestyle exposures to lead to increased human health risk at each of the 17 major sites and found that Hanford and other sites with Native American groups present would have a higher possibility of experiencing increased risks through subsistence consumption. This information was added to Section 5.4.7.2 (Volume I) of the Final PEIS and Section C.4.7.2.4 (Volume III), along with a discussion of the risk analyses for the maximally exposed individual.

Comment (2384)
Discuss the meaning of the data presented on environmental justice; as now presented, the inclusion of numerous demographic maps of minority populations without explanation only serves to confuse the public.

Response
Executive Order 12898 directs Federal agencies, including DOE, to incorporate environmental justice as part of their missions. The Executive Order specifically directs agencies to identify and address, as appropriate, potential disproportionately high and adverse human health or environmental effects on

minority and low-income populations that could result from the agencies' programs, policies, and activities.

In the Final WM PEIS, DOE has attempted to make the discussion on environmental justice more meaningful. The expanded discussion now describes the methods used to evaluate the distribution of low-income, minority, and Native American populations, as shown in the maps in Section C.4.7 in Volume III, in relation to the results of the health and air quality impact analyses. These maps present more relevant demographic profiles. Minority population in the Final WM PEIS refers to any census tract (within the region of influence) with a minority population greater than the national average of 24.4%. The revised summary of the environmental justice methodology is presented in Section 5.4.7 in Volume I. Section C.4.7 was revised to present a more detailed description of the environmental justice impact methodology.

Comment (2544)
Volume I, Section 9.10.1.3: For the first two definitions (and throughout), please define the word "significantly."

Response
The environmental justice discussion contained in Section 9.10.1.3 in Volume I and elsewhere in the WM PEIS has been substantially revised. The words "significant" and "significantly" are not used in the revised discussions because their meanings would be unclear within the context of the environmental justice analysis.

Comment (3138)
The Appendix I analysis of the distribution of minority and low-income populations should address ecological impacts (e.g., habitat destruction, degradation). Sites with arid climates will be affected much more than sites that receive adequate precipitation.

Response
As discussed in Volume I, Sections 6.7, 7.7, 8.7, 9.7, and 10.7, the WM PEIS ecological impacts analysis determined that no significant habitat impacts are likely to occur as a result of waste management activities because of the limited land required for waste management facilities and the flexibility DOE has in locating facilities on sites. Sitewide or project-level NEPA reviews would evaluate ecological impacts, including those that could affect minority and low-income populations, in greater detail.

Note that the maps showing the distribution of minority and low-income populations around DOE sites are included in Volume III, Section C.4.7, of the Final WM PEIS.

Comment (3295)
The distribution of low-income populations at NTS, as represented in Figure I-25, is misleading. The map identifies census tracts within 50 miles of the site center with median income of $12,674 or less. This does not capture the fact that 25.6% of persons in Armagosa Valley, one of the communities closest to NTS operations, are below poverty level. The WM PEIS environmental justice analysis, therefore, might be inadequate.

Further, the minority and low-income zone of impact maps (Figures I-8 and I-25) appear to inaccurately illustrate the location of county boundaries, showing NTS in Nye, Lincoln, and Clark Counties. NTS is completely located in Nye County. Again, this questions the basis of the analysis and, therefore, the validity of the conclusions.

Although Tribal lands are referenced, there is no corresponding Figure I-8b, as referenced in Section 4.4.8.

Response
Since the WM PEIS assessment is conducted at the programmatic level and without reference to any specific location for waste management facilities at individual sites, the environmental justice analysis approaches the assessment at a very broad, general level. Data for this analysis are presented at the census tract level, rather than a more specific level. Analyses at a more specific level would not be productive for a programmatic analysis. The revised environmental justice analysis presented in the Final WM PEIS (see Section C.4.7 in Volume III), indicates that Armagosa Valley is included within a census tract for which low-income populations exceed the national average. Also, the revised analysis shows that NTS is located solely within Nye County.

A definition of the low-income population parameters used in the preparation of this study is provided in Section C.4.7.2.1. The baseline figure of $12,674 represents the national definition of poverty for the basic four-person family unit. It provides a standard that can be consistently applied to the analysis of each of the 17 major site regions of influence assessed in the WM PEIS. Individual sites may differ slightly based on current regional economic conditions or prevailing standards of living. Also, where family size is generally larger or smaller, the definition of poverty would apply to respectively different levels of income.

DOE determined that Tribal lands are not located within 50 miles of an existing waste disposal facility at NTS as used in the analysis of environmental justice.

Comment (3567)
We request that DOE define precisely, in legal, scientific, risk assessment, and lay terms, what "disproportionate" means.

Response
The definition of a "disproportionately high or adverse impact" is provided in Volume I, Section 5.4.7.1. Neither DOE nor the Federal Working Group on Environmental Justice have yet issued final guidance on interpreting the provisions of the Executive Order on environmental justice (Executive Order 12898), nor has there been a judicial interpretation of the term "disproportionate" within the context of environmental justice.

For purposes of the environmental justice analysis in the WM PEIS, "disproportionate" refers to any distribution of impacts across minority, low-income, or Native American census tracts that might be substantially greater in magnitude or quantity than that experienced by the general populations, as described in Section 5.4.7.1 and Section C.4.7.2 (Volume III).

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A high or adverse impact (or risk or rate of impact) for a low-income, minority, or Native American community is disproportionate when it exceeds the risk or rate of occurrence in the general population (for health impacts).

Comment (3576)
By using the 50-mile "zone" approach, the WM PEIS has oversimplified analyzing impacts on not just minority populations, all human populations as well as ecological communities. For the WM PEIS to approach adequate analysis of managing DOE wastes, DOE must reevaluate the current and cumulative impacts not just on minority communities, but on all populations.

Response
The WM PEIS provides a broad programmatic review of the human health and environmental impacts associated with the alternatives for the five waste types. This analysis focuses on risks to the hypothetical maximally exposed individuals around the sites, and on environmental impacts such as those to air quality, that could have direct impacts on members of minority and low-income populations based on the predicted locations of impacts to the maximally exposed individuals and the environment.

DOE does not agree that the WM PEIS has oversimplified analyzing impacts on the general public living near the sites and on ecological receptors. The use of the offsite population living within an 80-kilometer (50-mile) radius of an existing waste management facility or the geographic center of each site was chosen to represent the populations that would be most likely to be exposed to contaminants released to the atmosphere during waste treatment activities. The airborne pathway was assumed to be the most important potential exposure route for human and ecological receptors.

Comment (3582)
The maps of minority populations "are completely out of order, which reflects a disrespect for the communities who live within, have been and will be impacted by DOE facilities. The disarray also makes it difficult to analyze the maps [without] tearing them out." In addition, DOE's assertion regarding the absence of disproportionately high and adverse health risks to minority or low-income groups is invalid without the inclusion of available surveys and comparisons.

Response
The maps provided in Appendix I of the Draft WM PEIS illustrated the geographic location of minority populations, Tribal lands, and low-income populations surrounding each of the 17 major sites. The maps were arranged alphabetically by site for minority populations, then alphabetically by site for low-income populations. Maps of Federally recognized Tribal lands were inserted in the series of minority population maps to highlight the importance of those groups. In the Final WM PEIS, these maps have been incorporated in the same order into the discussion of environmental justice impacts in Section C.4.7, in Volume III. The organization reflects no disrespect for any group; on the contrary, the environmental justice analysis demonstrates DOE's high degree of concern for those groups. A discussion of mapping procedures employed in the analysis is provided in Section C.4.7.2.1.2. In the Final WM PEIS, the environmental justice analysis has been revised to include a more detailed examination of potential effects on minority and low-income populations (see Volume I, Sections 6.10, 7.10, 8.10, 9.10, and 10.10).

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Comment (3585)
The figure for a low-income family of four is outrageous and unrealistic in today's economy. We believe this figure is based on antiquated baseline formulas utilized by the U.S. Bureau of the Census. We strongly urge that DOE reevaluate and formulate a more accurate baseline figure for determining a low-income family of four. In doing so, we contend that the low-income family populations will increase in some areas (e.g., INEL, LANL, NTS, SNL-NM) by several fold.

Response
The baseline income figure of $12,674 represents the national definition of poverty for the basic four-person family unit. It provides a standard indicator that can be consistently applied to the analysis of each of the 17 major site regions of influence assessed in the WM PEIS. Individual sites might differ slightly based on current regional economic conditions and prevailing standards of living. Also, where family size is generally larger or smaller, the definition of poverty would apply to respectively different levels of income.

Use of the low-income indicator is intended to identify areas in a region with a disproportionately large low-income population; it is not intended to be a comprehensive analysis of poverty-related issues in the region. See Section C.4.7.2.1 in Volume III, for a definition of the low-income population parameters used for the WM PEIS environmental justice analysis.

Comment (3586)
We question the narrowed focus on low-income families alone and feel that exclusion of low-income individuals is unprecedented and results in an insufficient analysis of potential impacts on low-income persons. In fact, no explanation is given in the WM PEIS as to why only a family of four is focused upon, at the exclusion of individuals, married couples, families larger than four, single women head of household populations, etc., incomes. The issue of single women head of household populations is another area where minority issues/populations interface. We do not have figures at this moment to accurately portray the higher percentage of low-income women as minority heads of household or women as non-minority heads of households, but feel it is incumbent on DOE to analyze the potential disproportionate impacts on all such populations.

Response
The criterion used to establish the threshold income for the definition of "low-income" households was based on the average household size in the U.S., which is 3.84 persons (or four). Although DOE recognizes the limitations inherent in using averages for this analysis, use of average household size does provide an adequate basis for the comparison of the effects of the alternatives. The criterion is used for this analysis as an "indicator" of those areas in which the low-income population is above average and not as a study of the poverty conditions per se. The analysis assumes that where the number of four-person household units living in poverty exceeds the national norm, then the poverty figures for all other such groupings, including single persons, will also be high and therefore defines a low-income area.

Choice of the size of low-income households did not influence the findings of the environmental justice impacts analysis. The findings are based on whether any individual might experience high and adverse impacts. Where that was concluded to be the case, as discussed in Sections 6.10, 7.10, 8.10, 9.10, and 10.10 in Volume I, it was also concluded that minority or low-income groups could potentially be

disproportionately affected, but that sitewide or project-level analyses would be required to determine if this would be true.

Comment (3587)
The "eco-justice" analysis in regards to Native Nations is not only insufficient but inaccurate. Collectively, the impact of the nuclear weapons industry on Native Peoples is already disproportionate. There are approximately two million Native Peoples in the U.S., of which 1/2 reside on reserve lands and another 1/4 frequent reserve lands. With this basic context in mind, 7 out of 17 of just the major sites are within 50 miles of Native Nations. All of the major sites are contaminated and have serious environmental restoration problems. At NTS alone, 14 individual Native Nations live, and have lived in this area before the U.S. existed. (Benton Paiute Reservation, Timbisha Shoshone Reservation, Bishop Paiute Shoshone Reservation, Big Pine Paiute Indian Colony, Chemehucvi Reservation, Colorado River Reservation, Paiute Indian Tribe of Utah, Kaibab Paiute Reservation). This in and of itself is an existing and historical impact particular to Native Nations and no other minority group in the entire U.S. The potential cumulative impacts in addition to past impacts could lead to devastating results to any one of the Native Nations near the major sites or along the transportation routes.

Response
Most DOE facilities were sited in the 1940s and 1950s, during World War II and the Cold War. The locations for DOE facilities were chosen based in large part on security concerns, which contributed to the choice of locations that are remote from populated areas. DOE's site waste management strategies are being developed to address potential future releases at all DOE sites to minimize health and environmental effects. The WM PEIS focuses on the potential impact of decisions to be made regarding future waste management activities. Cumulative impacts from past, present, and reasonably foreseeable future actions at each DOE site are discussed in Chapter 11.

To identify the potential for disproportionate impacts to minority and low-income populations, the WM PEIS includes an environmental justice analysis as required by Executive Order 12898. The WM PEIS addresses Native Americans as minority populations in the environmental justice analysis. This analysis indicates that in no case are minority or low-income populations in the region surrounding NTS expected to experience high and adverse health effects from waste management actions for any waste type managed at NTS.

Comment (3588)
The "eco-justice" analysis does not satisfy the unique considerations, needs, and rights of Native Nations as communities or as Nations. It is important to remember that Native Nations include people who continue a land-based lifestyle and the natural resources that sustain this lifestyle such as wildlife, surface waters, medicinal plants, timber, fish such as salmon, etc., are protected by treaties, are rights, and often these resources are protected on unceded lands. This is particularly applicable to the Pacific Northwest where the Hanford Site is located and impacts two-thirds of the Yakama Nation's treaty protected unceded lands and one-third of the Umatilla Nation's unceded treaty protected lands.

As stated by Mary Christian Atwood in *Fulfilling the Executives Trust Responsibility Toward the Native Nations on Environmental Issues: A Partial Critique of the Clinton Administration's Promises and Performance*,

"Statutory protection is often woefully inadequate to protect tribal interests, particularly in environmental matters. The statutes passed by Congress have, by and large, failed in significant ways to arrest the deterioration of the environment in many regions of the country. Moreover, the standards they contain were promulgated to meet the needs of a highly industrialized majority society with vastly different needs than those of tribes continuing a land-based way of life. Due to the unique nature of tribal land tenure and tribal culture, tribes cannot simply relocate to new areas when their reservation lands become contaminated, or their water polluted, or their wildlife resources decimated as a result of ecological abuse by the non-Indian sector. The transience and mobility that provide short-term solutions to members of the majority society do not provide options to tribes where their way of life is threatened."

Response
DOE's site waste management strategies are being developed to minimize the health and environmental effects from potential future releases. DOE is committed to continuing to address the concerns and interests of stakeholders at the DOE sites in all its decisionmaking. DOE seeks input from Native peoples through the NEPA process and has instituted and follows the DOE American Indian Policy, as well as the American Indian Religious Freedom Act, the National Historic Preservation Act, the Native American Graves Protection and Repatriation Act, and Executive Order 13007 regarding sacred sites, in addition to any separate agreements DOE has entered into with particular Native American Tribes. For the WM PEIS, extensive scoping meetings were held for stakeholders to discuss and influence the course of the project prior to document preparation. All Federally recognized Tribes were sent a copy of the Notice of Intent to prepare the PEIS and a notification of the scoping meetings. After the Draft PEIS was issued, DOE held another extensive series of public hearings, and Federally recognized tribes received invitations to comment. DOE Field Offices routinely consult with interested Tribal Governments on DOE activities and plans. These consultations have included briefings on the development of the WM PEIS.

The WM PEIS compares waste management alternatives on the basis of added risk from proposed waste management operations. The exposure pathways that were examined used conservative assumptions that include the potential for exposure to the general public from airborne contaminants. However, DOE did not evaluate effects of exposures through land-based life-style (subsistence) routes of exposure, such as the commentor has suggested, in the PEIS. Such analyses can be credibly conducted only at the site or project level, where specific facility locations, waste source terms, and unique dietary exposure scenarios can be analyzed. DOE did qualitatively examine the relative potential for such subsistence life-style effects to occur at the 17 major sites, and determined that Hanford and other sites where Native American lands occur near the sites are more likely to experience such risks and that the potential for those risks should be considered in further site-level decisionmaking. The results of the WM PEIS assessment of facility land requirements indicate that DOE would have sufficient flexibility in locating proposed waste management facilities on the sites to avoid disproportionately affecting Native Americans at the sites. Sitewide or project-level NEPA reviews would analyze any potential impacts on Native Americans at specific sites in more detail.

Comment (3590)
Because Native Peoples consume fish, plants, wildlife, etc., and depend on surface waters that harbor fish, the relationship of Native Peoples with the land, air, and water is much more intimate than non-Native Populations. Thus, Native Peoples are at higher risk of exposure and cumulative health impacts from both regulated and unregulated releases. For instance, according to the Umatilla Nation, the

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Pacific Northwest Nations can consume up to 10 times more fish out of the Columbia River than the "average" non-Native. These basic facts cannot be glossed over and ignored, or relegated as insignificant.

According to the Umatilla Nation, the salmon runs in the Colombia river have shrunk from approximately 200,000 million per run per year to 2 million. What is particularly important about the Hanford area and the Columbia River is that the only free-flowing water appropriate for salmon spawning is located within the 52 mile stretch along the Hanford Site.

Response
DOE is committed to the principles of environmental justice, as defined in Executive Order 12898. The WM PEIS provides an evaluation of environmental justice suitable for a programmatic review. The PEIS analyzes human health and environmental impacts associated with the alternatives for the five waste types. The analysis focuses on risks to the hypothetical maximally exposed individuals in offsite populations around the sites, and on environmental impacts, such as those to air quality, that could affect offsite populations. Environmental justice concerns are noted in the PEIS (see Volume I, Sections 6.10, 7.10, 8.10, 9.10, and 10.10) where the analysis indicates that the maximally exposed individual might experience high and adverse impacts, or where other environmental impacts might be significant. This applies at any site where Native American groups or minority or low-income populations are present within 50 miles from the center of each of the smaller DOE sites or 50 miles from existing waste management facilities at each of the larger DOE sites, such as the Hanford Site. However, DOE did not evaluate the potential human health risk to subpopulations that may derive a portion of their food supplies from native plants and animals. Because the results of such an analysis depend on the locations of facilities within sites and the specific exposure routes and dietary habits involved, this analysis would be included in the scope of site-specific and/or project-level NEPA reviews. Section 5.4.7.2.2 in Volume I was revised to clarify this information.

Based on the programmatic analysis of land requirements at the sites to implement any of the waste management alternatives, DOE believes it will have sufficient flexibility to avoid or minimize any environmental or human health impacts found to be significant, including any shown to potentially pose disproportionately high and adverse impacts to Native Americans, minorities, or low-income populations, through selection of different waste management technologies or facility locations.

Comment (3591)
Because the WM PEIS suggests that the Hanford Site might become an interim storage site for high-level waste in addition to other activities, it is particularly important to look at past and potential cumulative impacts. Waiting for a site-specific analysis would not be in compliance with NEPA requirements where impacts must be evaluated *before* resources are committed. Moreover, because the Hanford Site is one of the Nation's most severe Superfund sites, the area is not ready to deal with additional waste problems. The same applies to the NTS site, which is located on Western Shoshone unceded lands.

Each Native Nation is unique as a culture and as a Nation. The location of one DOE nuclear industrial site by just one Native Nation is absolutely disproportionate. There is only one Yakama Nation (Hanford), one Shoshone-Bancock Nation (INEL), one Umatilla Nation (Hanford), one San Idelfonso Nation (LANL), one Western Shoshone Nation (NTS), etc., whose lives and lands loom in the shadow of the nuclear weapons industry and have suffered from past and current contamination. One accident,

regulated releases, continual use of sites for production, etc., all can have and already are having substantial long-term impacts on Native Nations socially, economically, environmentally, etc.

Response
Most DOE facilities were sited in the 1940s and 1950s, during World War II and the Cold War. The locations for DOE facilities were chosen based in large on security concerns, which contributed to the choice of locations that are remote from populated areas.

Section 4.4.4 in Volume I of the WM PEIS summarizes existing environmental and human health conditions at the Hanford Site, which are accounted for in the impacts analysis for that site. The existing environmental conditions at the Hanford Site (and other sites) include those resulting from other DOE and non-DOE activities. The estimated health risks in the WM PEIS from the implementation of the proposed waste management actions are generally quite small. Therefore, they would present little additional incremental risk to the existing baseline risks at the various sites.

The WM PEIS classifies Native Americans as minority populations in a numerical context to describe the demographic characteristics of the regions surrounding the DOE sites. This information is used in the environmental justice analysis, as summarized in Section 5.4.7, Volume I, and detailed in Section C.4.7 in Volume III. This designation is not intended to contradict the discussion of the unique government-to-government relationship between the U.S. and Tribes or the Federal Government trust responsibility. Results of the environmental justice analysis are contained in Volume I, Sections 6.10, 7.10, 8.10, 9.10, and 10.10. In only a single instance, in the case of INEL under transuranic waste Regionalized Alternative 3, do any of the four sites noted by the commentor show a potential for high and adverse health effects disproportionately affecting minority or low income populations under any of the proposed waste management alternatives. The Hanford Site, INEL, and LANL are also considered to have a higher possibility of subsistence consumption of fish or wildlife; NTS an intermediate possibility, as described in Section 5.4.7.2 in Volume I. Potential health effects from subsistence pathways of exposure would be addressed in additional NEPA analyses.

The WM PEIS analysis focuses mainly on alternatives addressing national-level strategic issues. The individual character of Native American cultures at DOE's sites, and the specialized nature of each Tribe's concerns in site activities, while considered in the WM PEIS at the programmatic level, is more productive as part of a site-level analysis. Sitewide or project-level NEPA reviews will be better able to address existing baseline health risk information, including any ongoing dose reconstruction studies.

The WM PEIS has considered cumulative impacts from past, present, and reasonably foreseeable future actions to the extent possible (see Volume I, Chapter 11). At individual sites, DOE believes it will have sufficient flexibility to avoid or minimize any human health or environmental impacts found to be potentially significant, including those that otherwise could potentially pose disproportionately high and adverse impacts to Native American Tribes, minorities, or low-income populations, through selection of a different waste management technologies or facility locations.

Comment (3592)
The environmental justice discussion in Section 5.4.7.2 in Volume I states that special exposure pathways were evaluated with respect to subsistence consumption of fish, game, or native plants. Given the conclusions of the environmental justice analysis, the assertion of this process is highly doubtful, if not largely inadequate. In fact, the WM PEIS contradicts that such evaluations were

conducted. Specifically, in Appendix D, DOE identifies "Potentially Exposed Populations." These populations do not include subsistence families or other persons the WM PEIS states have been evaluated. This is an unacceptable omission.

In addition, the WM PEIS assumes that exposure to offsite populations will result from primarily airborne contaminants and states that the consumption of fish was eliminated as an exposure route of concern for the PEIS because postulated surface-water contamination was found to be minimal. In addition, it was assumed that all members of the offsite populations have the same dietary habits and consumption rates. Further, the WM PEIS states that from the perspective of human health risk, there would be little reason to assess risks differently for minority or low-income populations unless dietary habits or other factors were to cause their exposures to be substantially different from that of the population as a whole. DOE has conveniently excused itself from looking at the reality of the current and potential impacts of its weapons facilities and waste management schemes by eliminating fish as an exposure route to Native populations (nonetheless, misrepresenting evaluating these impacts). DOE further excuses itself from a more comprehensive analysis of environmental justice impacts through the assertion that such an analysis would require detailed site-level information beyond the scope of the programmatic document.

DOE's excuse for not fully assessing such impacts as fish consumption on Native Peoples is not acceptable. This discussion should be separate from overall "minority" issues.

Response

DOE is committed to the principles of environmental justice, as defined in Executive Order 12898. The WM PEIS provides an evaluation of environmental justice suitable for a programmatic review, in its evaluation of human health and environmental impacts associated with the alternatives for the five waste types. The analysis focuses on risks to the hypothetical maximally exposed individuals in offsite populations around the sites, and on environmental impacts, such as those to air quality, that could affect offsite populations. Environmental justice concerns are noted in the PEIS (see Volume I, Sections 6.10, 7.10, 8.10, and 10.10) where the analysis indicates that the maximally exposed individual might experience disproportionately high and adverse health effects or where other environmental impacts might be significant at any site where Native American groups or minority or low-income populations are present within 50 miles of an existing waste management facility or the geographic center of the site.

DOE did not specifically address impacts to aquatic life or to subsistence fishermen at the sites because of the array of assumptions that would have to be made about site-specific variables involved in such an analysis. This level of analysis would require identifying specific locations of proposed waste management facilities, which is not part of the programmatic decisionmaking. Further, because the analysis would be subject to extreme variability based on the analysis assumptions and facility location selection, DOE believes that the results of such an analysis would not factor into programmatic decisionmaking. Sitewide and project-level NEPA reviews would be the appropriate context for this type of analysis. DOE is currently consulting with the Seneca Nation on just such a sitewide NEPA review, the EIS for completion of the West Valley Demonstration Project and closure or long-term management of the Western New York Nuclear Service Center. However, DOE did qualitatively compare the 17 major sites in terms of factors that would be associated with subsistence consumption of fish and wildlife, including the presence of Native American groups and generally rural populations.

5.12 Environmental Justice

This analysis is described in Volume III, Appendix C, Section C.4.7 and summarized in Volume I, Chapter 5 of the PEIS.

Based on the programmatic analysis of land requirements at the sites to implement any of the waste management alternatives, DOE believes it will have sufficient flexibility to avoid or minimize any environmental or human health impacts found to be significant, including any shown to potentially pose disproportionately high and adverse impacts to Native Americans, minorities, or low-income populations, through selection of different waste management technologies or facility locations.

Comment (3594)
As the document indicated, Executive Order 12898 requires that the review of impacts must also address environmental justice concerns. It is important to note that the West Valley Demonstration Project is located upstream on the Cattaraugus Creek from the Cattaraugus Reservation of the Seneca Nation of Indians. Evaluation of this site should pay particular attention to any environmental impacts that may affect this Reservation, such as adverse impacts to the river and resident aquatic life where its residents do subsistence fishing. In addition, it is important to ensure that the Reservation is given full opportunity to participate in the National Environmental Policy Act process.

The hypothetical farm family is an assumption that could be costly and dangerous not only to Native Peoples, but all populations that depend on or incorporate livestock as a primary source of food or economic means. The WM PEIS hypothetical farm family does not satisfy current assessments of the health conditions of livestock-dependent peoples and cumulative impacts from the past, present, and future exposure from regulated and unregulated releases on livestock and livestock-dependent peoples. DOE used primarily a Euro-centric model of agriculture as a basis for analysis of subsistence lifeways, exposure routes to humans, and no models for livestock lifeways exposure routes are considered. What is also missing is an analysis of lifeways that depend on gathering and hunting, another direct and high risk exposure route. The narrow focus of this model, thus, excludes Native Peoples who are at high risk from exposure routes from sheep herding and various livestock lifeways, as well as gathering and hunting.

We recommend that all of the above considerations and critical factors be incorporated into DOE's cumulative impacts analysis. We would also like to remind DOE that there are particular cultural considerations that must be regarded and incorporated. For instance, some Native Nations feel that the liver and other livestock soft-tissue organs (which absorb radionuclides and concentrate in such organs) must be given to the elders of the Nation, community, and/or family. Thus, the elders are exceptionally at risk from exposure to radionuclides. DOE must be mindful of such cultural nuances and absolutely respectful in analyzing such cultural patterns that could result in higher risk exposure. We recommend that DOE cooperate fully with the Nations and accept assessments and recommendations from the Nations themselves so that cultural integrity can be maintained and respected. DOE would be in violation of treaty and trust obligations if it ignores or diminishes the concerns and needs of Native Nations.

Response
DOE encourages all of its stakeholders to participate fully in the NEPA process. DOE has and will continue to provide Native American Tribes every opportunity for participation in the NEPA process, in accordance with the CEQ regulations on scoping and public involvement (40 CFR 1503.1 and 1506.6, respectively). The Seneca Nation of Indians was invited to comment on the Draft WM PEIS

and will continue to receive information pertinent to the WM PEIS. Further, the West Valley Area Office conducts regular consultations with the Seneca Nation, including the Cattaraugus Tribe, on current and potential activities affecting the West Valley Site. Section 1.4.5 in Volume I of the WM PEIS acknowledges DOE's trust and treaty obligations to Native American Tribes, and identifies the consultation requirements between DOE and Tribes under NEPA and other statutes, with which DOE has fully complied. Section 1.4.5 also describes the consultation activities DOE has undertaken in recent years with Tribes.

DOE is committed to the principles of environmental justice, as defined in Executive Order 12898. The WM PEIS provides an evaluation of environmental justice suitable for a programmatic review. The PEIS analyzes human health and environmental impacts associated with the alternatives for the five waste types. The analysis focuses on risks to the hypothetical maximally exposed individuals in offsite populations around the sites, and on environmental impacts, such as those to air quality, that could affect offsite populations. Environmental justice concerns are noted in the PEIS (see Sections 6.10, 7.10, 8.10, 9.10, and 10.10 in Volume I) where the analysis indicates that the maximally exposed individual might experience high and adverse impacts or where other environmental impacts could be significant at any site where Native American groups or minority or low-income populations are present within 50 miles of the site. However, DOE has not evaluated the human health risk to subpopulations that live near DOE sites that might derive a portion of their food supply from native plants, animals, and fish because of the array of assumptions that would have to be made about site-specific variables involved in such an analysis and because the analysis would depend on the specific locations of proposed waste management facilities, which is not known, and is not appropriately part of the programmatic decisionmaking. Because the analysis would be subject to extreme variability based on the analysis assumptions and the actual location of facilities, DOE believes that the results of such an analysis should not factor into programmatic decisionmaking. Sitewide and project-level NEPA analyses would be the appropriate context for this type of analysis. DOE is currently consulting with the Seneca Nation on just such a sitewide NEPA review, the EIS for completion of the West Valley Demonstration Project and Closure or Long-Term Management of the Western New York Nuclear Service Center. Further, based on the programmatic analysis of the relatively small land requirements for waste management facilities at the sites, DOE believes it will have sufficient flexibility to avoid or minimize any environmental or human health impacts found to be significant, including any that could have the potential to pose disproportionately high and adverse impacts to Native Americans, minorities, or low-income populations, through selection of different waste management facility locations.

Comment (3662)
The WM PEIS states that the assessment of potential environmental justice impacts associated with transuranic waste management indicated no substantive potential for disproportionately high and adverse health risks or environmental impacts to minority and low-income groups at any of the transuranic waste sites except WIPP. This statement is unfounded. The WM PEIS also states that the potential at WIPP can be mitigated by selection of an alternative treatment technology or employment of more efficient emissions controls. Will DOE have to prepare another NEPA document to do this? What alternative treatment technology or emissions controls will be used that are not part of the current plan?

Response
DOE is committed to the principles of environmental justice, as defined in Executive Order 12898. The WM PEIS provides an evaluation of environmental justice suitable for a programmatic review in

its assessment of human health and environmental impacts associated with the alternatives for the five waste types. In the Final WM PEIS, the environmental justice analysis has been revised to include a more detailed, census-tract level examination of the potential for high and adverse health effects to regional minority and low-income populations. The analysis, detailed in Section C.4.7 in Volume III, focuses on risks to the general public and to hypothetical maximally exposed individuals in offsite populations around the sites, and on environmental impacts, such as those to air quality, that could affect offsite populations. Environmental justice concerns are noted in the PEIS where the analysis indicates that the general public or a maximally exposed individual might experience high and adverse impacts or where other environmental impacts might be significant at any site where Native American groups or minority or low-income populations are present within 50 miles of a sites geographic center or existing waste management facility.

The revised transuranic waste environmental justice analysis indicated that, depending on the alternative, INEL or WIPP may have a minority or low-income population that experiences high and adverse health effects as a result of transuranic waste treatment. Effects at WIPP would occur under the Centralized Alternative when WIPP treats all transuranic waste. Because disproportionate health risks and air quality impacts might occur at those sites, use of an alternative technology or more efficient emission controls than assumed for the generic treatment facility would reduce the impacts. Sitewide or project-level NEPA reviews would include in-depth assessments of potential environmental justice impacts.

Comment (3944)
DOE's assumption of no disproportionate high risk and adverse health impacts to minority and low-income populations does not include DOE's and its predecessors' decisions to site major nuclear defense facilities near rural and low-income populations.

Response
Most DOE facilities were sited in the 1940s and 1950s, during World War II and the Cold War. The locations for DOE facilities were chosen based in large part on security concerns, which contributed to the choice of locations that are remote from populated areas.

The WM PEIS focuses on the potential impact of decisions to be made regarding future waste management activities. Cumulative impacts from past, present, and reasonably foreseeable future actions at each DOE site are discussed in Volume I, Chapter 11.

Comment (3946)
DOE's "poverty-level" selection of a family of four with an income of $12,764.00 is arbitrary and does not accurately reflect the poverty level of impacted regions within 50 miles of DOE sites. By DOE definition neither Brown nor Adams Counties in Ohio are considered "pockets of poverty" even though by Ohio statewide standards these two counties rank among the poorest of 88 counties.

Response
There are several measures of poverty status available to a study such as the WM PEIS, and the level of income at which poverty is defined also varies by the size of the family or household unit. For a study of this size, given the total number of sites, counties in the site regions of influence, and census tracts within counties, it was necessary to develop analytical criteria and threshold limits that could be universally and uniformly applied to all 17 sites on a national basis. Therefore, for purposes of this

analysis, DOE did not attempt to adjust for local cost of living or to use relative state rankings in its determination of poverty status communities. DOE used national, rather than State or local, statistics to assure that the criteria and method of collection were the same for all sites, thus allowing for a fair comparison of impacts across all of the sites considered. Data provided by the U.S. Bureau of the Census satisfies this requirement.

Since the average household size in the U.S. is 4 persons (3.88 rounded), median income level for a household unit of four was assumed to represent a standard measure to compare sites. (See WM PEIS Volume III, Section C.4.7, and the WM PEIS Environmental and Socioeconomics Impacts Technical Report, Section 6.7, for additional information about this analysis.)

DOE recognizes the potential for variation from the national statistics at individual sites. Although, the WM PEIS focuses primarily on national-level comparison of the relative effects of alternatives, sitewide and project-level NEPA reviews would more fully explore site-specific concerns, such as "pockets of poverty," which may be considered important at specific sites.

Comment (3965)
DOE's use of "minority population" as more than 50 % of the total population based on figures collected by the U.S. Bureau of the Census fails to identify significant minority populations in the regions surrounding the PGDP and the Portsmouth and sites. The Appalachian region, which includes both facilities, consists of a population of Appalachian heritage and culture and is a minority within the larger U.S. population.

Response
For the Final WM PEIS, DOE has revised the criteria for the environmental justice analysis to define minorities and low-income populations to consist of census tracts where those populations are greater than their respective national averages. Minority populations were identified as census tracts with 24.1% or greater minority populations rather than the 50% criterion for individual census tracts. Section C.4.7.2.1.1 in Volume III was revised accordingly.

The identification of minority sub-cultures is subject to multiple and sometimes contradictory definitions, depending on the perspective of the observer. However, for purposes of the WM PEIS, it was necessary to employ a categorization that was uniform and universally applicable to all sites across the complex. Data provided by the U.S. Bureau of the Census met these criteria and, because minority status is self-reported by individuals during the census, avoids any inherent bias in the identification process itself. The importance of regional sub-cultures would be addressed in more detailed sitewide or project level NEPA reviews.

Comment (3968)
DOE use of "minority population" to categorize various and diverse Native American cultures in regions surrounding DOE facilities throughout the West is erroneous and minimizes the impact of the loss of a unique culture when one Native American Tribal community is severely impacted.

Response
DOE's characterization of Native American populations for the WM PEIS recognizes the unique government-to-government relationship that each Native American Tribal Government has with the Government of the United States. This relationship is defined by treaties, statutes, court decisions, and

the U.S. Constitution. DOE is committed to continuing to address the concerns and interests of stakeholders at the DOE sites in all its decisionmaking and recognizes that each Tribal entity has significant interests at a number of DOE sites. DOE recognizes that it must consider not only the interests of Native American groups and their Tribal lands as represented by recognized Native American Tribal Governments, but also the interests of individual Native Americans who are minority members of the community at large. To ensure this, DOE reviewed both the presence of recognized Native American Tribes and U.S. Bureau of the Census data on minorities, which include residents who identify themselves as Native American, whether or not they are actually included in specific regional tribes. The WM PEIS classifies Native Americans as minority populations in a numerical context to describe the demographic characteristics of the region surrounding DOE sites.

Comment (3970)
DOE identifies a poverty level of 19.9% for the Portsmouth Plant and 12.4% for PGDP. Do these levels apply only to counties where 90% of the work force resides or where sites are located?

Response
The summary information provided in WM PEIS Volume I, Table 4.3-3, for the Portsmouth Plant and PGDP facilities represent aggregate data for all counties included in the 80-kilometer (50-mile) site radius defined as the region of influence for the environmental justice analysis. A more detailed county-by-county breakdown of the information contained in this table can be found in WM PEIS Affected Environment Technical Report, Section 2.9.5 for PGDP and Section 2.11.5 for Portsmouth. The methodology used in the environmental justice analysis is described in Section 5.4.7 (Volume I) and Section C.4.7 (Volume III).

Comment (4000)
I truly believe that certain DOE alternatives, including its alternative of 100% of treated waste to be sent for disposal at NTS, does disproportionately impact one population identified by DOE as a "minority," but which is composed of unique Native American cultures living in close relationship to the Earth who must care for their traditional homes in spite of past and present environmental abuses for the national defense.

Response
DOE's site waste management strategies are being developed to minimize the health and environmental effects from potential future releases across the complex. The WM PEIS compares waste management alternatives on the basis of added risk from proposed waste management operations. The exposure pathways that were examined used conservative assumptions that include the potential for ingestion of radioactivity. DOE does not have specific data, however, to address past health effects across the complex.

In developing the Final WM PEIS, a more detailed evaluation of potential environmental justice impacts was conducted. For the WM PEIS, DOE mapped the minority, low-income, and Native American Tribal communities within an 80-kilometer (50-mile) radius of an existing waste management facility or the geographic center for each of the 17 sites, including NTS, that were evaluated for waste management activities. The results of the risk analysis, which identified adverse or high risks to the maximally exposed individual were compared with these maps to evaluate whether any disproportionate impacts would occur. The methodology for this analysis is described in Section C.4.7 in Volume III, with the results by waste type discussed in Volume I, Sections 6.10, 7.10, 8.10, 9.10 and 10.10.

5.12 Environmental Justice

However, DOE is aware of the impacts, including those on Native American cultures, that DOE site activities have had on the surrounding environmental settings. The results of the WM PEIS assessment indicate that DOE would have sufficient flexibility in locating proposed facilities on the sites to avoid disproportionately affecting minority or Native American interests at the sites, including NTS. Sitewide or project-level NEPA reviews would analyze any potential impacts on Native American Tribal cultures at the sites in more detail.

Environmental remediation to cleanup past releases is being addressed separately at each DOE site. The CERCLA process ensures that stakeholders at NTS, including potentially affected Native American groups, have input in the remediation decisionmaking.

Comment (4008)
The environmental justice considerations in the WM PEIS are critically flawed and must be addressed at the programmatic level because: (1) Although the total number of American Indians on reservations in the U.S. is 900,000, or only 0.35% of the total U.S. population, more than half of the DOE sites (9 out of 17) that are candidates for managing high-level waste, receiving offsite waste, or hosting disposal facilities are located adjacent to a concentrated population of American Indians. (2) The WM PEIS employs a convoluted analysis that minimizes human health risk and then concludes that there are no disproportionate risks because no adverse health impacts are expected from the management of waste. An environmental justice analysis should be used to evaluate the risks, however large or small, to see if they fall disproportionately on a particular segment of the population.

Response
Most DOE facilities were sited in the 1940s and 1950s during World War II and the Cold War. The locations for DOE facilities were chosen based in large part on security concerns, which contributed to the choice of locations that are remote from populated areas.

DOE is committed to the principles of environmental justice as defined in Executive Order 12898, which directs Federal agencies to address, as appropriate, potential disproportionately high and adverse human health or environmental effects on minority and low income populations as a result of the agency's actions. The WM PEIS demonstrates this concern in its evaluation of environmental justice undertaken for each of the 17 major sites considered at the programmatic level. In the Final WM PEIS, DOE tried to make this discussion more meaningful. A discussion of the environmental justice methodology is contained in Section 5.4.7 in Volume I. The expanded discussion now describes the methods used to evaluate the distribution of Native American populations and Tribal lands, as shown in the maps in Volume III, Section C.4.7, in relation to the results of the health and air quality impacts analysis. It also discusses the implications of the analysis in relation to the populations of interest in the regions around the sites. (See Section C.4.7.2 in Volume III). DOE is committed to continuing to address the concerns and interests of Native Americans and Tribal Governments at the DOE sites in all its decisionmaking.

The number and proximity of Tribal lands to DOE sites are considered in the environmental justice analysis as an important aspect of the assessment. The presence of these lands and cultural properties is documented in the affected environment for each site and considered separately from the general distribution of minority groups in the region of influence.

5.12 Environmental Justice

DOE's waste management strategies will address the potential for future releases across the complex with the goal of minimizing and mitigating health and environmental effects. The PEIS analyzed human health and environmental impacts associated with the alternatives for the five waste types. This analysis focuses on risks to the hypothetical maximally exposed individuals in offsite populations around the sites, and on environmental impacts, such as those to air quality, that could have a direct impact on people living nearby. The WM PEIS compares waste management alternatives on the basis of added risk for waste management operations. Cumulative health risk from current and planned DOE operations other than waste management are addressed in Chapter 11 in Volume I.

Comment (4010)
Commentors stated that the environmental justice analysis of transportation is flawed because of the conclusion that the collective population fatalities are expected to be approximately uniformly distributed along the transportation corridors, and because the impacts are randomly distributed, disproportionate impacts are not expected on any particular segment of the population. This conclusion ignores the natural concentration of transport vehicles at sites at the beginning and end of each trip. This means that transportation risks are concentrated at DOE's waste management sites and are in addition to any risks from the storage or disposal of the waste at the sites. Therefore, the high concentrations of American Indians near DOE receiving sites will suffer a disproportionate risk from transportation of wastes. One commentor observed the use of the term "significant" several times in Section 8.10 of the PEIS.

Response
The tendency of waste shipments to concentrate into transportation "funnels" at receiver sites was addressed in the WM PEIS analysis. The potential for increased risk and other impacts to resident populations and a description of the environment around transportation funnels where shipments from several sites concentrate is considered by the analysis. However, DOE did not attempt to determine the likelihood that the exposed individuals may be members of minority or low-income communities. Tables E-13, E-18, E-25, and E-31 in Volume IV address cumulative dose and lifetime risk to the maximally exposed individual along a site entrance route. These tables indicate risk related impacts for the top five sites, in terms of total shipments (both incoming and outgoing) for each of four major waste types. Table 10.20-1 in Volume I identifies the site with the maximum number of shipments for each waste type. The analysis assumes these sites conservatively represent conditions at all other sites. Sites having fewer total shipments would experience correspondingly lower impacts.

U.S. Department of Transportation routing regulations for public highways are contained in 49 CFR 397 (also known as HM-164). There are no corresponding Department of Transportation rail regulations. A truck transporting a shipment of radioactive materials is required to use the interstate highway system, except under defined circumstances. Carriers are required to use interstate circumferential or bypass routes, if available, to avoid populous areas. Any State or Native American Tribe may designate other "preferred highways" to replace or supplement the interstate systems.

The term significant was used in Section 8.10 of the Draft WM PEIS (environmental justice impacts for transuranic waste). However, Section 8.10 and other discussions of environmental justice in the Final WM PEIS were revised to delete the use of this term, since its meaning was unclear within the context of the analysis.

5.12 Environmental Justice

Comment (4452)
The analysis of risks to minorities is supposed to focus on risks to the maximally exposed individual, according to Section 3.2.6 in the Draft WM PEIS Summary document. DOE should provide in the WM PEIS quantitative information on such risks to minorities (some of whom eat large quantities of fish and wildlife), and differences in exposure assumptions for minority populations and individuals compared to members of the general public due to differences in behavior (some people eat considerably more wild game and plants, or fish, than others because of differences in lifestyle). For example, African-American subsistence fishermen and their families eat bass contaminated by SRS, resulting in potential exposure of 3.1 mrem, according to the 1992 Site Environmental Report; Seneca Indian subsistence fishermen and their families eat large quantities of fish from a creek contaminated by WVDP; members of the Fort Hall Shoshone-Bannock Nation should be evaluated for patterns of exposure to contaminated wildlife from INEL that are greater than exposure patterns in the majority population. Some minority populations might be at a higher risk than indicated by exposure patterns based on studies of the general public. This needs to be taken into consideration when exposures are estimated to such populations and when environmental justice considerations are evaluated. DOE should follow the Presidential Order concerning environmental justice.

In addition, DOE should include in the PEIS numbers of fatalities in minority versus general population, as well as the average chance of fatality for minorities versus other members of the general public within 50 miles. Furthermore, socioeconomic impacts on minority populations should be evaluated, particularly as they relate to measures such as keeping indigenous people off Tribal land on which a treatment, storage, and disposal facility might be located, versus assuming access. Associated legal and treaty issues also need to be covered.

Response
Subsistence consumption was not analyzed because of the array of assumptions about site-specific variables involved in such an analysis and because the analysis would require identifying specific locations of proposed waste management facilities, which is not part of programmatic decisionmaking. Because the analysis would be subject to extreme variability based on the analysis assumptions and location selection, DOE believes that the results of such an analysis should not factor into programmatic decisionmaking and, therefore, that analysis is not appropriate in the WM PEIS. Sitewide and project-level NEPA reviews would be the appropriate context for this type of analysis. DOE did not specifically assess impacts to aquatic life or to subsistence fishermen at the sites. DOE conducted a qualitative review of factors that would be related to the likelihood of risk through subsistence hunting or fishing exposure. A qualitative evaluation of site factors in Chapter 5, Section 5.4.7 in Volume I and Appendix C, Section C.4.7 in Volume III indicates most sites with Federally recognized Native American groups would have a higher possibility of subsistence consumption.

DOE is committed to the principles of environmental justice as defined in Executive Order 12898, which directs Federal agencies to address, as appropriate, potential disproportionately high and adverse human health or environmental effects on minority and low income populations as a result of the agency's actions. The WM PEIS demonstrates this concern in its evaluation of environmental justice impacts undertaken for each of the 17 major sites considered at the programmatic level. In the Final WM PEIS, DOE has tried to make this discussion more meaningful. A discussion of the environmental justice impacts methodology is contained in Section 5.4.7 in Volume I. The expanded discussion now describes the methods used to evaluate the distribution of Native American populations and Tribal

lands, as shown in the maps in Volume III, Appendix C, in relation to the results of the health and air quality impacts analysis. It also discusses the implications of the analysis in relation to the populations of interest in the regions around the sites. (See Section C.4.7 in Volume III).

The WM PEIS provides an evaluation of environmental justice suitable for a programmatic review in its evaluation of human health impacts associated with the alternatives for the five waste types. The Final WM PEIS contains a revised environmental justice analysis, that evaluates at the census-tract level health risks to the offsite population receptor group (population risk) and to the offsite population maximally exposed individual (MEI risk) from the routine operation of waste treatment facilities. Specific estimates of risk were used as screening criteria for triggering environmental justice analysis (a population risk greater than or equal to one latent cancer fatality from treatment facility operations or an MEI cancer fatality probability of 1×10^{-6} or greater from incident-free treatment facility operations). The results of the environmental justice analysis are provided in Volume I, Sections 6.10, 7.10, 8.10, 9.10, and 10.10 of the WM PEIS.

Based on the programmatic analysis of land requirements at the sites to implement any of the waste management alternatives, DOE believes it will have sufficient flexibility to avoid or minimize environmental or human health impacts found to be potentially significant, including any shown to potentially pose disproportionately high and adverse impacts to Native Americans, minorities, or low-income populations, through the selection of different waste management technologies or facility locations. Sitewide or project-level NEPA reviews would be conducted that would more fully address specific Native American concerns, including Tribal land access and treaty and legal issues, related to the respective sites.

Comment (4550)
A population impact of less than 0.5 is not *de minimis*. DOE should address in the environmental justice analysis whether minority populations would be exposed to disproportionate risks compared to the general population.

Response
DOE revised the WM PEIS environmental justice analysis, as described in Section 5.4.7 in Volume I. The results of the analysis, listed in Sections 6.10, 7.10, 8.10, 9.10, and 10.10, identify any locations where minority or low-income populations could potentially experience disproportionately high and adverse health risks or environmental impacts. If the maximally exposed individual at a candidate site would be at low risk, DOE concluded that no individual at that site would be at high risk, even an individual from a minority or low-income population. If risk potential was identified, the 80-kilometer (50-mile) radius of an existing waste management facility on the site or the geographic center of the site was evaluated for potential disproportionately high and adverse impacts to minority and low-income populations.

5.12 Environmental Justice

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6. Other Topics of Interest to the Public

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(No comments were received for this section)

6.1 Emergency Preparedness and Response

Comment (23)
Commentors are concerned about costs to local communities to pay for damage resulting from waste treatment, storage, and disposal activities (including accidents) at the DOE sites. One commentor asked, if an accident at a DOE site makes the area uninhabitable, who will pay the tax bill? Who will pay the tax bills for our State? According to another commentor, DOE should analyze the negative effects on property values and potential liability to DOE in the event of an accident.

Response
Potential damage resulting from waste treatment, storage, and disposal activities (including accidents) was analyzed for DOE sites in the WM PEIS. Sections 6.4, 7.4, 8.4, 9.4, and 10.4 in Volume I of the WM PEIS describe that health risk impacts can result from exposure to radiation and/or chemicals and from physical trauma associated with constructing and operating treatment and disposal facilities or transporting waste. Health effects were evaluated for routine operations and accidents. Appendix F describes the accident analysis. The WM PEIS analysis shows the risk of damage occurring during routine treatment, storage, and disposal activities of any of the five waste types analyzed would generally be low.

With respect to accidents, DOE sites already have plans and equipment to respond to damage on sites resulting from treatment, storage, and disposal accidents. DOE requirements for emergency response preparedness are described in DOE Order 151.1, described in Section 1.4.3 in Volume I of the WM PEIS. Most minor damage can be responded to at a site level. If major damage were to occur as a result of a radioactive waste accident, DOE could use the statutory indemnity described by the Price-Anderson Act (42 USC 2210). The Price Anderson Act provides for indemnification by DOE for liabilities that may arise from a nuclear incident as a result of activities undertaken by DOE's contractors. This means that if a nuclear incident were to occur, such as a release of radioactive materials from a facility, and damages were incurred as a result of the incident, DOE would indemnify its contractors from liability. In other words, DOE would take responsibility for ensuring that such damages were appropriately compensated under the liability provisions of the Price Anderson Act. In addition, the Price Anderson Act Amendments of 1988 subject indemnified contractors to civil and criminal sanctions if they violate any applicable nuclear safety requirements at any facility under the contractor's control. Potential damage to the environment can also be reduced or mitigated through the implementation of programmatic and site-specific mitigation measures described in Volume I, Chapter 12.

DOE recognizes the possibility of negative public perceptions associated with its Waste Management Program. For example, the proximity of a DOE waste management facility might be perceived negatively. It is possible, therefore, that the value of real estate in the vicinity of the facility might decline and land development patterns and tourism might be negatively affected. However, assessing the impact of "stigma" generally is problematic because it does not necessarily depend on the actual physical effects or risks of the proposed action, but on the negative perception of these effects or risks by certain members of the public. Moreover, the extent of impacts from such perceptions is extremely speculative, and NEPA does not require analysis of potential impacts that are speculative; therefore, analysis of such stigma and the possible mitigation of its impacts is inappropriate for inclusion in NEPA reviews, including this WM PEIS. DOE works with local communities to understand and mitigate potential negative perceptions of DOE operations.

6.1 Emergency Preparedness and Response

Comment (49)
Commentors are concerned about emergency response and medical and emergency equipment in case of a nuclear incident at a site. One commentor stated that DOE needs to inform the public about school evacuation plans in the event of an accident.

Response
DOE sites already have emergency plans and equipment to respond to accidents and other emergencies. DOE requirements for emergency response preparedness are contained in DOE Order 151.1, Comprehensive Emergency Management System (1995), which is described in Section 1.4.3 in Volume I of the WM PEIS. DOE participates with other Federal agencies, Tribal Nations, and State and local authorities to sponsor and occasionally fund radiological emergency response training in the United States. Training is usually provided for those responsible for public safety and emergency response to natural disasters or accidents. DOE provides Radiological Assistance Program teams of trained experts who are equipped and prepared to respond quickly to an accident involving a shipment of radioactive material and assist local emergency response personnel, if requested. DOE, the U.S. Department of Transportation, and the Federal Emergency Management Agency assist in review and modification of State and local emergency response plans, if requested.

Comment (1819)
Provide advance notification to municipalities before transporting wastes through their regions. For example, any transportation of wastes through the Hampton Roads metropolitan area should be preceded with advance notification to the Virginia Department of Emergency Services and the affected localities so that adequate safety precautions can be taken. The localities should be notified in advance of any notification to the news media.

Response
DOE complies with all applicable hazardous and radioactive materials transportation regulations. The regulations are described in Section 1.4.4 in Volume I of the WM PEIS. National transportation activities for DOE are described in Section 4.3.10. Transportation regulations do not require advance notification for hazardous waste, low-level waste, or low-level mixed waste shipments. However, DOE works with State, Tribal, and local authorities to develop notification requirements on a site by site basis prior to beginning shipping activities. Advance notification is required for transuranic waste and high-level waste.

DOE believes emergency planning and preparedness is best done when actual shipping activities are in the planning stages. More detailed transportation planning will be performed at the site level when specific actions are decided. Such site-level plans will be better able to appropriately address the emergency planning measures required as determined by the specific waste to be shipped and the actual route(s) to be used, as described in Appendix E, Section E.4.2, in Volume IV of the WM PEIS. At large DOE sites, there is already a high level of emergency planning and preparedness in place, as discussed in Appendix E, Section E.9. Notification protocols for State, Tribal, and local authorities for large shipping activities will be determined during site transportation planning activities.

Comment (2314)
The WM PEIS should provide a table listing the number and type of nuclear waste shipment accidents and how they could be handled in the future.

6.1 Emergency Preparedness and Response

Response
DOE has not included such a table in the Final WM PEIS because the few accidents involving radioactive shipments over the years are not a large enough sample to predict future accidents. Like other kinds of shipments, radioactive materials in transit have been involved in accidents. In most cases, there was no release of any radioactive material into the environment. When releases have occurred, the material has been cleaned up with no identifiable harm to people or to the environment. No one has ever been killed or seriously injured in an accident involving radioactive materials because of the nature of the cargo.

Emergency planning and preparedness is best done when actual shipping campaigns are in the planning stages. This includes coordinating notifications to State, Tribal, and local authorities where required. The WM PEIS is a programmatic document that uses representative routes (see Section E.4.2 in Volume IV) and source terms (Section E.6.1) to obtain a nationwide perspective on the risks associated with transporting hazardous waste within the DOE complex. More detailed transportation planning will be performed at the site level when specific actions are decided. Such planning will be able to appropriately address the emergency planning measures required as determined by the specific waste to be shipped and the actual route(s) to be used, as described in Section 4.2 in Volume I. Especially for the large DOE sites, there is already a high level of emergency planning and preparedness in place, as discussed in Section E.9 in Volume IV.

State and local police and fire departments have primary responsibility for responding to events that could endanger the health and welfare of their citizens. Most States maintain specialized teams capable of responding to hazardous materials incidents. Through the capabilities these teams currently possess for dealing with potential accidents involving other hazardous materials (e.g., hazardous chemicals), they should already have the capability to deal with most plausible accidents involving low-level waste and low-level mixed waste. Thus additional training for low-level waste and low-level mixed waste would most likely be minimal. However, some states would require additional training to respond to potential radioactive hazards resulting from transuranic waste or high-level waste transportation accidents. Currently, to assist in planning and preparedness for an unlikely, but theoretically possible, transportation emergency involving any radioactive shipments, DOE does offer a variety of emergency response resources and information to complement existing emergency preparedness programs, and would continue to maintain a comprehensive emergency management system, particularly for radiological emergencies. The emergency management system includes training courses, Regional Coordinating Offices, and DOE Radiological Assistance Program teams.

Comment (2930)
Regarding Brookhaven National Laboratory (BNL) as a potential waste management site, a commentor stated that the WM PEIS fails to note that an operating certificate was denied to the Long Island Lighting Company's Shoreham nuclear power plant because of the impossibility of devising an adequate evacuation plan for the at-risk population.

Response
The accidents that could occur at waste treatment, storage, and disposal facilities are very different in type and magnitude than potential accidents from a commercial nuclear power plant. Therefore, the comparison of BNL to Shoreham is not valid.

BNL has measurable quantities of low-level mixed waste and low-level waste. The current small waste inventories at BNL (see Appendix I in Volume IV of the WM PEIS) and the physical forms of the

waste would not result in the need to rapidly evacuate the surrounding area in response to any waste management facility accident. For example, as indicated in Section 6.4.3 in Volume I of the WM PEIS, the maximum reasonably foreseeable low-level mixed waste treatment facility accident at BNL was estimated to result in an offsite population dose of 20 person-rem and a radiation dose of 2 mrem for the maximally exposed individual. These exposures would result in less than one excess latent cancer fatality in the offsite population. The maximally exposed individual would have a probability of excess latent cancer fatality of about 1 in 1 million in their lifetime as a result of the exposure. These estimates assume that the accident will occur. However, the estimated annual frequency or probability of occurrence for the accident evaluated is between 1 in 1 million and 1 in 10,000. Details of the waste management facility accident analyses are presented in Appendix F in Volume IV of the WM PEIS. Under the protective action guides (PAGs) developed by EPA and adopted by DOE, an evacuation of the general population would not be appropriate unless the projected dose to an offsite individual reached 1 rem. The estimated dose here is a factor of 500 lower for the worst low-level mixed waste facility accident. Therefore, there is very little likelihood of an evacuation of the public from such an accident.

Comment (3129)
In Appendix E, it would be very helpful to emergency responders if the maximally exposed individual in accident conditions were related to the risks associated with initial emergency response.

Response
It should be understood that the WM PEIS accident consequence estimates for maximally exposed individuals following a potential accident are not intended for emergency response. As discussed in Section E.5.1.2.2 in Volume IV, the estimates are made for assumed weather conditions to give readers an idea of what might happen to a member of the general public during the maximum consequence accident analyzed. The accidents generally involve fire, which causes greater dispersion due to initial plume rise and deposition further downwind, affecting more people. The maximally exposed individual is located in the worst possible position, that is, where the plume initially comes back down to ground level. For a transportation accident, there is no forewarning and the plume from such an accident would pass the maximally exposed individual location within approximately a few seconds to minutes, depending on weather conditions, generally too little time for mitigative response at that location. Also, the risks are highly dependent on the specific nature of the radioactive material being transported. The WM PEIS transportation risks are based on average compositions for a given site and are unlikely to correspond directly with any one actual shipment. It should be noted that none of the postulated transportation accidents in the WM PEIS would result in acute radiological fatalities (i.e., generally occurring within weeks to months) following an accident.

Emergency responders are trained to deal with transportation accidents to protect themselves and the public, especially during the initial stages of emergency response to an accident.

Comment (3711)
DOE would need to provide financial support to local communities for training and special equipment if Argonne National Laboratory-East (ANL-E) were to have permanent storage facilities.

Response
DOE sites have emergency plans and equipment to respond to accidents and other emergencies. DOE requirements for emergency response preparedness are contained in DOE Order 151.1 described in

6.1 Emergency Preparedness and Response

Section 1.4.3 in Volume I of the WM PEIS. DOE participates with other Federal agencies and State and local authorities to sponsor and occasionally fund radiological emergency response training throughout the United States. Training is usually provided for those responsible for public safety and emergency response to natural disasters or accidents. DOE provides Radiological Assistance Program teams of trained experts who are equipped and prepared to respond to an accident involving a shipment of radioactive materials and assist local emergency response personnel, if requested. DOE, the U.S. Department of Transportation, and the Federal Emergency Management Agency assist in review and modification of State and local emergency response plans, if requested.

Comment (3897)
DOE needs to explain if there is a coincidence between the new Army facility near ANL-E and DOE's proposal. Should the public be concerned about espionage and theft?

Response
There is no relationship between an Army Reserve Training Center, which is used to maintain heavy vehicles, and DOE's planning for waste management. The land where the Army Reserve Training Center is located was declared surplus by DOE in 1984 and was transferred to the General Services Administration in 1985. Three years later the title was transferred to the U.S. Army Corps of Engineers. Construction of the Army Reserve Training Center was originally scheduled to begin in 1989. However, because of lack of funding, construction was not begun until 1994. The Center has an occupancy of about 20 persons on weekdays and about 200 persons on weekends. It includes a garage where maintenance is performed on heavy vehicles.

Section 4.3.12 in Volume I of the WM PEIS, Safeguards and Security, which has been added to the Final WM PEIS, describes DOE's Safeguards and Security Program to protect DOE interests from theft or diversion of special nuclear material; sabotage, espionage, loss or theft of classified matter or government property; and other hostile acts that could cause unacceptable adverse impacts on national security or on the health and safety of employees, the public, or the environment. Waste management activities are protected from espionage and theft under the DOE Safeguards and Security Program.

Comment (3919)
DOE needs to explain at what nuclear exposure level the public would be notified.

Response
In accordance with DOE's Comprehensive Emergency Management System (DOE Order 151.1), described in Section 1.4.3 in Volume I, each DOE site/facility has the general requirement to notify DOE and offsite officials when operational emergencies occur. Specifically, the Order requires that sites/facilities "promptly notify local, State, Tribal, DOE, and other regional Federal agencies when events categorized as Operational Emergencies occur". (DOE Order 151.1, Section 4.c(1)).

When events occur that represent a specific threat to workers or the public due to the release or potential release of significant quantities of radioactive or hazardous material, an Operational Emergency is declared and classified as either an Alert, Site Area Emergency, or General Emergency, in order of increasing severity. Alert is the lowest classification of an Operational Emergency. As such, the minimum criteria for declaring an Alert represents the threshold level of radioactive release for which notifications of Operational Emergencies are required.

6.1 Emergency Preparedness and Response

An Alert is declared when the radiation dose exceeds either "the applicable Protective Action Guide...at or beyond 30 meters from the point of release to the environment OR a site-specific criterion corresponding to a small fraction of the applicable Protective Action Guide...at or beyond the facility boundary or exclusion area boundary," and "it is not expected that the applicable Protective Action Guide...will be exceeded at or beyond the facility boundary or exclusion zone boundary." (DOE Order 151.1, Chapter V, Section 3.a) These criteria define the Alert and, hence, the threshold level of radioactive release.

Increasing in severity, exceeding the Protective Action Guide at or beyond the facility boundary or exclusion zone boundary will result in the declaration of a Site Area Emergency and corresponding notifications to State and local emergency response organizations. (DOE Order 151.1, Chapter V, Section 3.b) Similar notifications are made when Protective Action Guides are expected to be exceeded at or beyond the site boundary resulting in the declaration of a General Emergency. (DOE Order 151.1, Chapter V, Section 3.c)

Protective Action Guides for releases of radioactive materials are specified in the EPA's *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* (EPA 400-R-92-001, October 1991). Notifications of Operational Emergencies involving releases of radioactive materials are made to State and local emergency response organizations within 15 minutes of the declaration of the emergency. (DOE Order 151.1, Chapter VIII, Section 4.a) The State and local emergency response organizations notify the public accordingly. DOE does not typically directly notify the public of radioactive releases, but notifies the public indirectly through notifications to State, Tribal, and local organizations. Additional guidance concerning emergency notifications is available in the Emergency Management Guide, *Interim Guidance for Notification* (7/18/92), which is currently being revised to correspond to DOE Order 151.1.

DOE does, however, recognize the need to provide accurate, candid, and timely information to site workers and the public during all emergencies, and requires the establishment of an Emergency Public Information Program. Requirements for this program are described in DOE Order 151.1, Chapter IX. Additional guidance concerning emergency public information is available in the Emergency Management Guide, *Guidance for Public Information* (6/26/92), which is currently being revised to conform to DOE Order 151.1.

6.2 Safeguards and Security

Comment (84)
Commentors are concerned about sabotage or terrorist activities involving radioactive and hazardous waste.

Response
The WM PEIS evaluates the impacts of several types of accidents at treatment and storage facilities (e.g., fires, explosions, earthquakes, aircraft crashes). Table F.2-3 in Volume IV of the WM PEIS contains descriptions of accident initiators. The WM PEIS also includes a detailed assessment of the risks of a complete range of credible transportation accidents for both rail and truck transportation. The potential impacts of these transportation accidents include the kinds of impacts that potentially could result from acts of terrorism or sabotage. DOE has added Section 4.3.12 to Volume I of the WM PEIS to provide a discussion of DOE's Safeguards and Security Program. The procedures and guidelines of the Safeguards and Security Program are applied to waste management activities for radioactive and hazardous waste.

DOE has extensive security systems in place at all its facilities that handle nuclear materials. Security precautions, including emergency response team notification, are routine for all shipments of DOE nuclear material. For more than 40 years, DOE security precautions have been successful in preventing the theft or sabotage of DOE nuclear material.

Comment (534)
DOE needs to ensure that security is adequate for waste shipments, specifically spent nuclear fuel, in light of national security concerns.

Response
DOE has added Section 4.3.12 to Volume I of the WM PEIS to provide a discussion of DOE's Safeguards and Security Program. Section 1.4.4 in Volume I of the WM PEIS describes the hazardous and radioactive waste transportation regulations followed for radioactive and hazardous waste shipments. These regulations include security precautions required for each waste type. Low-level waste, low-level mixed waste, and hazardous waste generally require minimum security requirements. Transuranic waste and high-level waste require more detailed security precautions.

The procedures and guidelines of DOE's Safeguards and Security Program are applied to DOE's waste management activities. For more than 40 years, security precautions have prevented the theft or sabotage of DOE nuclear material and waste.

Management of spent nuclear fuel is outside the scope of the WM PEIS. DOE addressed security for the transportation of spent nuclear fuel in the SNF/INEL EIS (DOE 1995).

Comment (2084)
How many workers are necessary to guard the waste and will more workers be needed for operations or treatment?

Response
DOE's existing Safeguards and Security Program applies to its waste management activities. The five WM PEIS waste types, which are defined in Volume I, Section 1.5, of the WM PEIS contain such small quantities of special nuclear materials or the materials are in such a form, that they do not require

any additional safeguards. DOE does not plan to add security measures beyond those already in place at its sites. DOE added Section 4.3.12 in Volume I of the WM PEIS to provide a discussion of safeguards and safety.

DOE anticipates minimal changes to the operational workforces at the sites after the startup of the proposed waste management facilities. However, some retraining of personnel could be necessary. More detail on the potential socioeconomic impacts associated with various alternatives is provided in Volume I, Sections 6.8, 7.8, 8.8, 9.8, and 10.8 of the WM PEIS.

Comment (3716)
Public safety should be DOE's number one concern.

Response
Indeed, public and worker safety is DOE's number one concern. The WM PEIS considers public safety concerns in numerous ways, ranging from the identification of the affected environment to programmatic analyses of health risks. Further, the minimization of environmental impacts, including risks to public health and safety, is an important decisionmaking criterion.

Comment (4448)
The Draft PEIS Summary document does not fully address high-level waste storage and treatment risks from accidents. Acts of terrorism can have much more severe consequences than accidents. Vulnerability to terrorist attacks is an important consideration concerning even temporary storage of large quantities of radioactive and/or toxic wastes.

Most of the high-level waste has not been vitrified and placed in canisters. Risks from accidents and deliberate sabotage and from such waste in treatment should be considered, along with the preparedness of DOE and other national and local emergency preparedness organizations, for the potential associated consequences.

Response
The WM PEIS evaluates the impacts of several types of accidents at waste management facilities, for example, fires, explosions, earthquakes, and aircraft crashes. The potential impacts of these accidents include the kinds of impacts that potentially could result from acts of deliberate terrorism. The WM PEIS evaluates "generic" or "conceptual" facilities. DOE would describe actual facility designs, which would include specific safety and security measures, in sitewide or project-level NEPA reviews, as described in Section 9.1.1 in Volume I.

The WM PEIS only analyzes the impacts of stored vitrified high-level waste. The environmental impacts of continued storage of liquid high-level waste in tanks and the vitrification of high-level waste have been assessed in previous DOE EISs identified in Section 1.8.1 and Section 9.1.2 in Volume I of the WM PEIS. These previous EISs also consider the environmental impacts of accidents involving the storage of liquid high-level waste. Cumulative impacts of the preferred alternatives in these other environmental analyses, combined with existing conditions and the WM PEIS impacts, are described in Chapter 11 in Volume I of the WM PEIS.

DOE sites have emergency plans and equipment to respond to accidents and other emergencies. DOE requirements for emergency response preparedness are contained in DOE Order 151.1 described in

6.2 Safeguards and Security

Section 1.4.3 in Volume I of the WM PEIS. DOE participates with other Federal agencies, Tribal Nations, and State and local authorities to sponsor and occasionally fund radiological emergency response training throughout the United States. DOE provides Radiological Assistance Program teams of trained experts who are equipped and prepared to respond to an accident involving a shipment of radioactive materials and assist local emergency response personnel, if requested. DOE, the U.S. Department of Transportation, and the Federal Emergency Management Agency assist in review and modification of State and local emergency response plans, if requested.

Section 4.3.12 in Volume I of the WM PEIS, Safeguards and Security, which has been added to the Final WM PEIS, describes DOE's Safeguards and Security Program to protect DOE interests from theft or diversion of special nuclear material; sabotage, espionage, loss or theft of classified matter or government property; and other hostile acts that could cause unacceptable adverse impacts on national security or on the health and safety of employees, the public, or the environment. Waste management activities are protect from espionage and theft under the DOE Safeguards and Security Program.

6.3 Community Stigma

Comment (22)
Many commentors stated that the Final WM PEIS should assess the impacts of stigma or negative perceptions on business, tourism, the gaming industry, property values, and industrial development. Commentors suggested that the analysis include impacts of the distribution of risk on property values and land development patterns in the regions around the sites. Some commentors requested analysis of how negative impacts would be mitigated or compensated for, if they occur. For mitigation, commentors stated that the impact assessment should consider the use of insurance and other compensation programs, such as buying properties of nearby residents, along with such administrative actions as the distribution of compensation to individuals, organizations, or public sectors negatively impacted. Commentors asked that plans to mitigate and minimize cases of stigma be explained in enough detail so that costs and final impact outcomes can be estimated. Commentors expressed concern that property values will decrease near candidate sites, while communities await DOE's WM PEIS decisions. One commentor stated that the influence of greater perceived risk on Indian Reservation communities should be a consideration in the WM PEIS.

Response
The WM PEIS analysis focuses on the assessment of alternatives for addressing national-level strategic issues. The results allow DOE to compare impacts across sites and to make programmatic decisions. To the extent possible, the WM PEIS analysis estimates the potential effects of the proposed actions.

The prosperity or economic development of an area depends on the characteristics or factors that define the particular economic region. Such factors as industrial development, entertainment resort destination, gambling, nuclear complexes, etc., can be perceived to be either positive or negative, depending on the underlying value systems of the individuals forming the perception. DOE recognizes the possibility of negative public perceptions associated with its Waste Management Program. For example, the proximity of a DOE waste management facility may be perceived negatively. It is possible, therefore, that the value of real estate in the vicinity of the facility might decline and land development patterns and tourism might be negatively affected. However, assessing the impact of "stigma" generally is problematic because it does not necessarily depend on the actual physical effects or risks of the proposed action, but on the negative perception of these effects or risks by certain members of the public.

Moreover, the extent of impacts from such perceptions is extremely speculative, and NEPA does not require analysis of potential impacts that are speculative; therefore, analysis of such stigma and the possible mitigation of its impacts is inappropriate for inclusion in NEPA reviews, including this WM PEIS. DOE works with local communities to understand and mitigate potential negative perceptions of DOE operations. DOE also works with Tribal Nations to the same end, in addition to fulfilling its trust and treaty obligations with Native American communities.

Comment (3371)
DOE has an obligation under NEPA to disclose indirect effects. If there is going to be an increase in cancers and other health effects from the handling of this waste during the next 20 years and beyond, what is the impact of this increase going to be on the health care system, and on the economies of the areas around such facilities. How will the location of a nuclear waste facility affect tourism, hunting, fishing, and other qualities of a potentially affected area, such as wilderness areas, research natural areas, wild and scenic rivers, national natural landmarks, and other significant natural features?

6.3 Community Stigma

Response

The WM PEIS analysis focuses on the assessment of alternatives for addressing national-level strategic issues. The results of this study allow DOE to compare impacts across sites and to make programmatic decisions on the selection of waste management sites and appropriate methods for waste treatment and disposal. To the extent possible at the programmatic level, the WM PEIS analysis estimates the potential effects of the proposed actions that are reasonably foreseeable. Therefore, DOE has attempted in this PEIS to analyze reasonably foreseeable, quantifiable environmental impacts that could result from the alternatives, including both operations and accident consequences. The impact parameters include health risks, air quality, water resources, ecological resources, socioeconomics, population, environmental justice, land use, infrastructure, cultural resources, and costs. The methodologies are detailed in Chapter 5 in Volume I of the WM PEIS. The analysis is discussed in the waste-type chapters (6 through 10) in Volume I.

In general, the WM PEIS analysis finds that the increase in health risks (for example, cancer cases) resulting from waste management activities would be small. Therefore, potential impacts on the health care system would be small.

The socioeconomic impact assessment employed three measures of economic activity--change in employment, change in personal income, and change in industry output--as indicators of the relative sensitivity of both regional and national economies to potential changes resulting from the implementation of the alternatives. Changes in demographic shift in regional populations were established as representative indicators of the potential for the alternatives to affect the size, density, stability of local communities, the provision of community services, or the availability of community resources. These indicator values formed the basis for the comparison of the effect of alternatives at each site and are used as representative of the regional economies and social structure for the purposes of estimating impact.

DOE recognizes its obligations under NEPA to disclose indirect, as well as direct and cumulative effects. However, NEPA does not require analysis of indirect impacts that are not reasonably foreseeable. The potential indirect effects of the proximity of a waste management facility on tourism, hunting, and other quality-of-life indicators are speculative and, therefore, not reasonably foreseeable. Moreover, at the programmatic level, the analysis of socioeconomic impacts is both broad and very general. No attempt was made as a part of this assessment to address more specific direct effects at individual sites, such as the potential direct effect on tourism, hunting, fishing, and other recreational or quality-of-life issues, or the provision of health care services, beyond this broad analysis. Sitewide or project-level NEPA reviews would address these issues.

6.4 Regional Equity

Comment (396)
Several commentors encouraged DOE to factor equity into the WM PEIS decision process. Specific suggestions were that waste management activities should be shared, with each State or region having a share; States or regions identified to host waste management activities should be technically capable of handling the waste; western States, such as Washington and Nevada, have been overburdened in the national defense effort and should not be turned into the nation's nuclear waste "dumping grounds." One commentor stated it was unreasonable to ask the citizens of the Northwest to take on more of the burden of the legacy of nuclear weapons production. Commentors also suggested that the decision process provide for negotiations that could mitigate or otherwise offset potential impacts on host States or regions, and that decisions be coordinated with States and regions. One commentor suggested that without considerations of equity in decisionmaking, transportation or environmental justice issues could arise.

Response
The WM PEIS does not analyze "equity," per se, because it is not an environmental effect, but rather a characteristic of the distribution of impacts. However, as one of many factors described in Volume I, Section 1.7.3, equity is a factor to be considered in the decisionmaking process; DOE will favor alternatives that distribute waste management facilities in ways that are equitable. In general, Decentralized Alternatives tend to spread potential impacts across a larger number of geographic areas than Regionalized or Centralized alternatives. As the number of potential host sites decreases from Decentralized to Regionalized to Centralized Alternatives, the number of regions potentially impacted by treatment and disposal activities decreases. On the other hand, risks associated with transportation could increase with Regionalized and Centralized Alternatives.

What is perceived as equitable by one State or region might not be perceived as equitable by another. DOE, nevertheless, considered the distribution of potential impacts across the nation in the selection process for preferred alternatives. DOE also has considered other appropriate factors that have an important bearing on the selection process. These include regulatory compliance, cost, capabilities for mitigating potential impacts, national priorities, environmental justice, consistency with DOE missions, and public concerns.

The cumulative impacts analysis in Volume I, Chapter 11, of the WM PEIS consolidates the potential impacts of waste management activities at each site with past, present, and reasonably foreseeable future activities. This analysis also aided DOE in selecting preferred alternatives identified in the PEIS and will also be useful in gauging site equity considerations in making final decisions.

Facilities or projects needed to implement decisions based on the WM PEIS would be subject to additional review under NEPA. Such reviews would provide another opportunity for public input to DOE's decisionmaking process. DOE will proceed with a reasoned approach to decisionmaking that includes all appropriate factors, including equity. This process would include discussions with affected States and Tribes regarding these projects and facilities.

Comment (4556)
DOE should look at the cumulative impacts of everything associated with all activities at DOE sites and all actions planned or under consideration in the Draft WM PEIS. One consideration when making waste management siting decisions is something called environmental equity. Many people consider it unfair to have their health sacrificed to benefit others, and the possibility of spreading the risk around

6.4 Regional Equity

should be considered, along with whatever such actions might do to total fatalities in the general public and risks to the most exposed member of the general public.

Determining the total number of fatalities would involve determining the total predicted fatalities, for various combinations of alternatives, from existing DOE sites and transportation activities (within perhaps a 50-mile radius from the sites), including the impact of radon from waste material and contaminated soil, impacts of the alternatives analyzed in the WM PEIS, and impacts of actions not analyzed in the WM PEIS (including environmental restoration, spent nuclear fuel, tritium, stockpile stewardship, fissile materials, etc.).

Impacts at locations more than 50 miles from sites from transportation associated with the alternatives, from any DOE transportation, and from transportation in general should also be covered. Special attention should be given to rest stops, refueling facilities, rail switching yards, and other locations that may be at risk, along with potential mitigating measures.

The analysis should cover all routes of exposure (not just air emissions, excluding radon, radiation, and radionuclides from accelerators).

Response
NEPA does not require DOE to look at impacts of everything associated with all activities at DOE sites. NEPA and CEQ implementing regulations recognize that separate NEPA reviews might be warranted for an agency's programs due to timing or the need for specificity or in-depth analyses. To this end, NEPA allows for separate analyses "tiered" from programmatic reviews such as the WM PEIS. By preparing separate environmental impact analyses on a number of extremely complex subjects, DOE has not prevented a comprehensive analysis as suggested in the comment, but rather has developed a more in-depth body of information. Moreover, the cumulative impacts analysis in this WM PEIS (Volume I, Chapter 11) includes the impacts for the preferred alternative described in the NEPA analyses prepared for other DOE programs, enabling an evaluation of impacts from DOE operations as a whole.

The necessity to prepare separate documents on separate but related programs includes a corresponding necessity for coordination among the programs to ensure a consistent presentation of information. DOE, therefore, has made every effort to ensure that the WM PEIS is consistent with other related EISs, including those cited in the comment. Section 1.8 in Volume I of the WM PEIS discusses these related EISs, as well as other DOE programs, and their relationship to the WM PEIS.

DOE reviews every proposal to prepare a NEPA document to determine if the decision is sound and in compliance with CEQ criteria on segmentation and interim actions. Any decision to prepare a NEPA document, including those listed by the commentor, must comply with those criteria. DOE believes that the preparation of one environmental impact statement on all DOE activities (operations, environmental restoration, and waste management) would necessarily be so broad that it would result in an essentially meaningless analysis. DOE has committed, as a matter of policy, to prepare sitewide EISs for large, multi-facility sites. DOE believes that sitewide analyses result in a meaningful assessment of all of DOE activities at a particular location.

The WM PEIS does not analyze "equity," per se, because it is not an environmental effect, but rather, a characteristic of the distribution of impacts. The PEIS analyzes the potential health, environmental,

and socioeconomic impacts of a range of waste management alternatives. In general, Decentralized Alternatives tend to spread potential impacts across a larger number of geographic areas than Regionalized or Centralized Alternatives. As the number of potential host sites decreases from Decentralized to Regionalized to Centralized Alternatives, the number of regions potentially impacted by treatment and disposal activities decreases. On the other hand, risks associated with transportation through non-host regions could increase with Regionalized and Centralized Alternatives. Recognizing that what is perceived as equitable by one State or region might not be perceived as equitable by another, DOE, nevertheless, has considered the distribution of potential impacts across the Nation in the selection process for the preferred alternative. Equity concerns are among the decision factors listed in Section 1.7.3 in Volume I of the Final WM PEIS.

The WM PEIS transportation risk analysis considers all possible modes of exposure, including external radiation from passing shipments as well as external radiation, inhalation, and ingestion exposure as the result of potential accidental release. Exposures received by the public at areas such as rest stops and workers at refueling stops and railroad yards are considered in the analysis, as discussed in Section E.5.1 in Volume IV. For each waste type and alternative, Appendix E in Volume IV of the WM PEIS presents cumulative transportation risks to the public, to workers, and to maximally exposed individuals for both truck and rail transportation. In addition, DOE has revised Chapter 11 in Volume I to include consideration of other DOE actions (including those mentioned in the comment) that are considered reasonably foreseeable.

6.5 Waste Management Program Costs and Schedules

Comment (200)
Treatment alternatives for transuranic waste are costly; therefore, DOE needs to consider what assurances exist that funding for these treatment alternatives is available.

Response
NEPA requires that reasonable alternatives be evaluated in an EIS. Therefore, to conduct the analysis for the WM PEIS, DOE had to assume that funding would be available for these treatment alternatives. If funds are not available, implementation could be delayed. DOE is unable to guarantee full funding for any of its projects and programs. The budget for the Waste Management Program, like all Federal programs, is ultimately controlled by the President and Congress.

Comment (505)
DOE should take credit for the cost savings of possible technological advances in treatment, because DOE is considering the added costs of regulatory requirements, such as permitting.

Response
DOE based the costs presented in the WM PEIS on current available technologies so it could analyze alternatives consistently. Factoring potential cost savings related to technology advancements into this analysis would be speculative and would not provide a more credible basis for decisionmaking.

Comment (2032)
In the Final WM PEIS, DOE should provide the breakdown of the cost basis for various low-level mixed waste treatment options.

Response
The WM PEIS does not evaluate treatment options or costs of alternative technologies, and decisions on treatment technologies will not be made as a result of the WM PEIS. The WM PEIS analysis uses a generic treatment process for each site to evaluate the impacts of treating all onsite and offsite low-level mixed waste, as required by the respective alternatives. The resultant costs are broken out by life-cycle component and by treatment unit process in Volume I, Table 6.14-2. The treatment costs are listed under the unit process costs. Using the generic treatment process, the waste streams are routed to each technology as required by the characteristics of the waste, and resultant treatment costs are the sum of costs at each treatment process module, at each site, for the wastes managed in the alternatives. This level of cost presentation is considered appropriate for the programmatic level of the WM PEIS and the objective to make preliminary determinations about where to locate waste management facilities.

The bases for establishing facility costs were obtained by evaluating DOE facilities, primarily at Idaho National Engineering Laboratory (INEL), and commercial facilities costs. These facilities were surveyed to obtain capacity, cost data, and other information needed to support the cost methodology data. Before using these costs, the data were adjusted to account for capacity differences and escalation. To the extent possible, equipment costs for each facility were compared with data from existing facilities to establish a cost confidence level with the boundaries established for programmatic life-cycle cost estimates.

Additional assessment activities included a review of existing DOE facility capital and operating costs for comparison with the cost methodology data. Existing DOE facilities that were evaluated include the Waste Experimental Reduction Facility (incineration, shredding, and compaction) at INEL, the Controlled Air Incinerator at LANL, the Toxic Substances Control Act Incinerator at ORR, the

Supercompactor and Repackaging Facility at RFETS, the Radioactive Waste Management Complex (low-level waste disposal) at INEL, and the Transportable Waste Water Treatment Unit from the Uranium Mill Tailings Remedial Action Project. Planned DOE facility costs at INEL were also evaluated for the Radioactive Waste Storage Facility, the Waste Characterization Facility, the Idaho Waste Processing Facility, and the Mixed Low-Level Waste Treatment Facility. Other facilities evaluated include the Illinois Compact Low-Level Engineered Disposal Facility and the Commonwealth of Massachusetts Low-Level Radioactive Waste Disposal Facility.

Cost estimates for facility components were adapted from commercial sources as follows: Commercial facilities evaluated include conceptual designs and cost estimates for a radiological and hazardous material measurement system provided by Lockheed Martin; size reduction and baler system data from Stock Equipment Company of Chagrin Falls, Ohio; SGS assay system data from Atlan-Tech Corporation, Inc., of Roswell, Georgia; open, dump and sort devices, and robotic arms in consultation with personnel from DOE contractors involved with the Office of Technology Development, Robotic Technology Development Program; incineration package from Joy Energy Systems of Charlotte, North Carolina, and ABB Raymond, Inc., of Lisle, Illinois; dry off-gas filters from Pall Advanced Separation Systems of Cortland, New York; wet scrubbing unit from Croll-Reynold Company of Westfield, New Jersey; concentrator unit from LCI Corporation of Charlotte, North Carolina; air- and area-monitoring unit from Eberline Corporation of Santa Fe, New Mexico; stack monitoring unit from Eberline Corporation of Santa Fe, New Mexico; preparation and feed units from vendor quotes; melter from Ajax Corporation and Retec Corporation; dry and wet off-gas treatment trains from NGK-Locke, Inc., and Callidus Technologies; selected solidification unit from Stock Equipment Company; solidification module assemblies from Stock Equipment Company; drying equipment from Wyssmont Co., Inc., of Fort Lee, New Jersey; blending equipment from Velmac Associates, Inc., of Novato, California; extruder equipment from Sterling Extruders, Davis-Standard Division of Edison, New Jersey; and processing equipment from the U.S. Navy low-level waste processing facility of Lynchburg, Virginia.

See Volume I, Section 5.3.3, for a description of how DOE estimated costs for treatment. The details of the cost estimation methodology as applied to low-level mixed waste are in the Waste Management Facilities Cost Information for Mixed Low-Level Waste Technical Report (INEL-95/0014).

Comment (2338)
The argument concerning economies of scale, which is used throughout the WM PEIS, assumes that larger but fewer facilities will keep costs low; this is not entirely correct. When economies of scale are allowed, a "natural monopoly" occurs, and wastes that are less profitable to manage may be left out of the system. Small competitors cannot survive. This will make it necessary for DOE to maintain its regulatory role.

Response
For the purpose of cost comparison, the WM PEIS analysis assumes that DOE will build and operate its own waste management facilities. Accordingly, economies of scale would apply for these facilities. However, as discussed in Volume I, Section 1.7.4, DOE assumes the impacts of using a privatized facility on a DOE site would be the same as those of using a DOE facility at that site.

In addition, the WM PEIS does project small volumes of waste to be treated by portable treatment units. This treatment is discussed in Volume I, Sections 5.2.3 and 6.2.3, and details are provided in

6.5 Waste Management Program Costs and Schedules

supporting technical reports. Wastes that are less profitable to manage, could be treated by portable treatment units, by small competitors, or large DOE contractors. In either case, DOE will maintain its regulatory role for onsite activities.

Comment (2602)
Labor rates vary significantly among DOE sites and could affect the life-cycle cost of facilities.

Response
There is some regional variation in labor rates [full-time equivalent (FTE) costs]. Sharp changes can occur over time in these rates as economic conditions change or sudden shortages develop, particularly in labor categories, either regionally or nationally. DOE considered these regional variations and potential for change within regions in developing its cost estimates; however, precise predictions of labor rates costs over time are not possible.

DOE has revised Section 5.3.3 in Volume I to state that the indirect and overhead costs (which would include labor) used in the WM PEIS analysis were based on those at INEL, because they fall in the middle range of costs at several DOE sites.

As described in Volume III, Section C.3, DOE estimated labor costs by assuming an annual fixed cost of $140,000 per FTE. Based on previous experience with these cost-estimating techniques, DOE established a confidence level of plus or minus 30% (as noted in Section 5.3.3), which is sufficient for an overall comparison of alternatives and for comparisons of the effects of different alternatives at a single site.

Comment (2821)
The statement in the Draft WM PEIS Summary document that costs decrease as the number of treatment and disposal sites decrease might not apply to all waste streams. Chemical/physical treatment technologies that can be applied on a small scale might be more cost-effective than centralization. Please clarify.

Response
The cited statement correctly summarizes the general trend reflected in Table 4.3-2 of the Summary document. The WM PEIS does evaluate treatment of small volumes of waste by portable treatment units. This treatment is discussed in Volume I, Sections 5.2.3 and 6.2.3, and details are provided in supporting technical reports. The cost savings realized by using portable treatment units are included in the cost calculations presented in Section 4.3.6 of the Summary document. DOE revised Volume I, Sections 6.14, 7.14, and 8.14, to clarify this point.

Comment (2927)
The Final WM PEIS should better address economies of scale in the discussion of alternatives.

Response
Sections 6.14, 7.14, 8.14, 9.14, and 10.14 in Volume I of the WM PEIS discuss economies of scale in the cost analysis. Each cost section begins with a summary that succinctly describes the economies of scale for each waste type. Cost clearly differentiates the economies of scale analysis, specifically for facility size, transportation, and siting alternatives.

6.5 Waste Management Program Costs and Schedules

Section 1.8 in Volume I describes the factors that DOE used to screen, evaluate, and narrow the number of alternatives. Economies of scale are assessed in the cost, transportation, DOE mission, and site mission factors.

Comment (2931)
DOE must make cost estimates of different options available. Otherwise, it is impossible to evaluate the trade-offs between cost and level of risk reduction involved.

Response
Sections 6.14, 7.14, 8.14, 9.14, and 10.14 in Volume I of the WM PEIS compare potential costs by alternative for each waste type. In addition, Volume II contains tables that provide cost information for each site.

Comment (2939)
Is any consideration given to asset reclamation from DOE facilities?

Response
In April 1996, DOE published *Charting the Course: The Future Use Report*, which provides land-use recommendations developed by 16 sites. Identifying future uses for DOE sites and facilities has evolved as a central issue in recent years. First, in addition to directing reconfiguration plans, land-use determinations play a key role in guiding one of DOE's primary efforts--the remediation of contaminated properties and the disposition of Cold War inventory wastes. Second, land-use considerations are essential in helping DOE and affected communities identify and implement beneficial reuse of Federal land, facilities, and equipment that are no longer needed as a result of defense downsizing and changing missions.

In general, reuse of DOE facilities is limited by a number of factors, and evaluation of the potential for asset reclamation would be made on a site by site basis. The WM PEIS accounts for decontamination and decommissioning costs for existing and newly constructed waste management facilities in the cost analysis, but does not identify what asset reclamation will take place. Reclamation of the facilities will be addressed under the environmental restoration programs at the sites.

Comment (3066)
Section 5.3.3 states that only the operations and maintenance costs were estimated for existing facilities. DOE should include decontamination costs for existing facilities.

Response
DOE revised Section 5.3.3 in Volume I of the WM PEIS to clarify that decontamination costs were estimated for existing facilities. A detailed explanation of the cost-estimating methodology for existing facilities is presented in Section C.3.2.1.4 (Volume III). The detailed costing included decontamination and decommissioning (D&D) costs for existing facilities, although these costs were not presented separately in the cost summary data (Volume II Cost Tables) as they were for newly constructed facilities. The existing facility D&D costs were rolled into the Volume II summary "Operations" cost category, which was used to estimate cost impacts.

6.5 Waste Management Program Costs and Schedules

Comment (3139)
Transportation cost estimates in the WM PEIS should include the costs of training and equipment for emergency response planning for State, county, Tribal, and local agencies. The Appendix E analysis of mitigative measures related to transportation fails to identify the costs and other impacts that might be borne by State, local, and Tribal Governments to maintain the levels of emergency planning and preparedness associated with the major shipping campaigns that some alternatives contemplate.

You have not talked about helping to finance transportation and emergency response teams in the localities where you might be depositing these tremendous amounts of waste. This has to be considered.

Response
Emergency planning and preparedness is best done when actual shipping activities are in the planning stages. This includes coordinating notifications to State, Tribal, and local authorities where required. The WM PEIS is a programmatic document that uses representative routes (see Section E.4.2 in Volume IV) and source terms (Section E.6.1) to obtain a nationwide perspective on the risks associated with transporting hazardous waste within the DOE complex. More detailed transportation planning will be performed at the site level when specific actions are decided. Such planning will be able to appropriately address the emergency planning measures required as determined by the specific waste to be shipped and the actual route(s) to be used, as described in Section 4.2 in Volume I. Especially for the large DOE sites, there is already a high level of emergency planning and preparedness in place, as discussed in Section E.9 in Volume IV.

State and local police and fire departments have primary responsibility for responding to events that could endanger the health and welfare of their citizens. Most States maintain specialized teams capable of responding to hazardous materials incidents. Through the capabilities these teams currently possess for dealing with potential accidents involving other hazardous materials (e.g., hazardous chemicals), they should already have the capability to deal with most plausible accidents involving low-level waste and low-level mixed waste. Thus additional training for low-level waste and low-level mixed waste would most likely be minimal. However, some states would require additional training to respond to potential radioactive hazards resulting from transuranic waste or high-level waste transportation accidents. Currently, to assist in planning and preparedness for an unlikely, but theoretically possible, transportation emergency involving transuranic waste or high-level waste radioactive shipments, DOE does offer a variety of radiological emergency response resources and information to complement existing emergency preparedness programs, and will continue to maintain a comprehensive emergency management system, particularly for radiological emergencies. The emergency management system includes training courses, Regional Coordinating Offices, and DOE Radiological Assistance Program teams.

Determinations of training for transuranic waste and high-level waste shipments will be made during the transportation planning process. Any potential training or equipment needs for State, Tribal, or local entities could vary greatly. Additionally, who funds the training could also vary. Thus, analyzing the costs of potential training or emergency equipment was considered too speculative; therefore, those costs are not included in the cost estimates in Section 5.3.3 in Volume I of the WM PEIS. DOE does not believe these costs will affect the programmatic decision process.

6.5 Waste Management Program Costs and Schedules

Comment (3227)
The WM PEIS states that for the low-level waste (LLW) Regionalized Alternatives, alpha low-level waste (LLW) would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, Rocky Flats Environmental Technology Site (RFETS), Los Alamos National Laboratory (LANL), and the Savannah River Site (SRS). Given that approximately 99% of the low-level waste at RFETS is alpha low-level waste, please clarify specifically what this would mean for RFETS.

Response
The WM PEIS LLW Technical Report indicates that, according to the 1992 Integrated Data Base, LLW generated at RFETS would be largely alpha- and uranium/thorium-contaminated. As specified in the footnote to Table 5-10 of the LLW Technical Report, treated alpha LLW would be disposed of at the closest alpha LLW disposal site. This would mean that treated RFETS alpha LLW would be disposed of onsite. The technical report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS.

Comment (3288)
The Draft PEIS states that costs and risk reductions for the operation of waste treatment, storage, and disposal facilities were calculated based on the assumption that there will be a 50% reduction in the annual generation for each year of the time span considered in the PEIS (Appendix G). However, the costs to achieve such a high reduction have not been factored in.

Response
As stated in Volume IV, Section G.2.2.2, of the WM PEIS cost savings from pollution prevention reductions are estimated for treatment, disposal, and transportation. Because site-specific goals are as yet unavailable, it is assumed that pollution prevention practices reduce new source generation by the same percentage (50%) throughout the DOE complex. There may be additional costs to waste generators to effect such waste generation reductions; however, the costs of making reductions are beyond the scope of this WM PEIS. The savings from waste generation reduction considered here are the waste management cost savings, which may be higher than the net savings.

Comment (3307)
How reliable are the estimates of truck and rail transportation costs?

Response
The cost analysis for truck and rail transportation of wastes between sites provides data that should fall within plus or minus 30% of actual costs. Cost information and assumptions are detailed in Sections C 3.2.2.6 and C.3.2.2.9 in Volume III and described in Volume I, Section 5.3.3, of the WM PEIS.

Comment (3619)
Has or when will repackaging of transuranic waste commence at each applicable site?

Response
Under the No Action Alternative, because there is no disposal of transuranic waste, there would be no reason to retrieve and repackage stored waste. For other alternatives, DOE assumed that retrieval of stored transuranic waste and repackaging after treatment would begin after treatment facilities are constructed.

6.5 Waste Management Program Costs and Schedules

Comment (3699)
Truck transportation is less expensive per load per mile than rail transportation. DOE should not spend taxpayer money on the higher rail transportation costs when such costs are not attributable to any safety or regulatory requirements.

Response
See Volume III, Section C.3.2.2, for a description of the WM PEIS cost-estimating methodology. When selecting transportation modes, DOE will look not only at costs, but at other factors, such as the minimization of impacts to human health and the environment. Transportation planning is described in Section 4.3.10 in Volume I and Appendix E in Volume IV.

Comment (4005)
DOE's insistence that transportation costs are minor in comparison to onsite treatment alternatives has not been documented in the WM PEIS.

Response
DOE believes that the cost estimates presented in the WM PEIS show that transportation costs would be small compared to storage, treatment, and disposal facility life-cycle costs. Volume I, Section 5.3.3, describes the costs evaluated in the PEIS, which included life-cycle costs of facilities plus transportation costs. Sections 6.14, 7.14, 8.14, 9.14, and 10.14 in Volume I of the PEIS describe the costs to manage each waste type. Volume III, Section C.3.2.2, describes the WM PEIS cost-estimating methodology.

6.6 Waste Transportation, General

Comment (344)
Given the City of Tracy's proximity to three freeways, there could be severe consequences to citizens of Tracy if there is a transportation accident. Commentors expressed concern that there are inadequate safeguards for transport of wastes in California.

Response
Actual transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process described in Volume I, Section 4.3.10. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

As shown in Volume I, Section 11.20 of the WM PEIS, shipping waste by truck would result in a combined total of between 12 and 69 potential fatalities from shipping low-level mixed waste, low-level waste, transuranic waste, and hazardous waste over the next 20 years, and for shipping high-level waste over the next 40 years, as shown in Volume IV, Appendix E, and Section 11.20. Shipping low-level mixed waste, low-level waste, transuranic waste, and high-level waste by rail, and hazardous waste by truck would result in a combined total of between 2 and 6 potential fatalities over the same periods.

The results of the transportation analyses conducted in Appendix E show that impacts relating to the transport of waste analyzed in the WM PEIS, which include fatalities from radiation exposure, diesel exhaust emissions, and physical trauma from accidents, are low when compared to nationwide vehicle transportation yearly impacts. Comparatively, from 1971 to 1993, over one million persons were killed by physical trauma in vehicular accidents in the U.S.

DOE is committed to managing its wastes, including transportation of waste, safely and in ways that protect human health and the environment. This includes a commitment to emergency preparedness. DOE participates with other Federal, Tribal, State, and local authorities to sponsor and occasionally fund radiological emergency response training courses throughout the United States. These courses are usually for the benefit of local, State, and Tribal authorities responsible for public safety and emergency responses to accidents or natural disasters.

DOE sites already have emergency plans and equipment to respond to accidents and other emergencies. DOE Order 151.1, provides for Radiological Assistance Program teams consisting of trained experts equipped and prepared to respond to an accident involving a shipment of radioactive materials and assist local emergency response personnel, if requested. State and local authorities require emergency response plans to deal with emergency situations. DOE, the U.S. Department of Transportation, and the Federal Emergency Management Agency can assist in the review and modification of these plans, if necessary.

The WM PEIS Affected Environment Technical Report describes shipping radiological and other hazardous material using interstate highways or rail terminals for each site. In addition, Sections 6.4.2, 7.4.2, 8.4.2, 9.4.2, and 10.4.2 in Volume I, and Appendix E in Volume IV, describe transportation-related impacts.

Comment (1487)
The potential impacts of DOE's proposal to not move waste do not fit with its claims about an excellent transportation record.

6.6 Waste Transportation, General

Response
NEPA requires that DOE evaluate reasonable alternatives, regardless of whether they involve transportation of wastes. The WM PEIS presents alternatives that would minimize waste transportation (Decentralized Alternatives) and that would maximize waste transportation (Centralized Alternatives). DOE also evaluated the option of transporting wastes by rail or truck. In this way, DOE believes that the PEIS analysis includes the impacts of transporting wastes and will permit valid comparisons of potential impacts. DOE is committed to the safe transportation of its waste.

Like other kinds of shipments, radioactive materials in transit have been involved in accidents. In most cases, there was no release of any radioactive material into the environment. When releases have occurred, the material has been cleaned up with no identifiable harm to people or to the environment. No one has ever been killed or seriously injured in an accident involving radioactive materials because of the nature of the cargo.

As shown in Volume I, Section 11.20 of the WM PEIS, shipping waste by truck would result in a combined total of between 12 and 69 potential fatalities from shipping low-level mixed waste, low-level waste, transuranic waste, and hazardous waste over the next 20 years, and for shipping high-level waste over the next 40 years, as shown in Volume IV, Appendix E, and Section 11.20. Shipping low-level mixed waste, low-level waste, transuranic waste, and high-level waste by rail, and hazardous waste by truck would result in a combined total of between 2 and 6 potential fatalities over the same periods.

The results of the transportation analyses conducted in Appendix E show that impacts relating to the transport of waste analyzed in the WM PEIS, which include fatalities from radiation exposure, diesel exhaust emissions, and physical trauma from accidents, are low when compared to nationwide vehicle transportation yearly impacts. Comparatively, from 1971 to 1993, over one million persons were killed by physical trauma in vehicular accidents in the U.S. Estimates of transportation impacts by waste type and alternative are found in Volume I in Tables 6.4-17 and 6.4-18 (low-level mixed waste); Tables 7.4-14 and 7.4-15 (low-level waste); Tables 8.4-8 and 8.4-9 (transuranic waste); Table 9.4-7 (high-level waste); and Tables 10.4-6 and 10.4-7 (hazardous waste).

DOE will consider the impacts of transporting waste, along with many other factors, in the process of making final decisions on the future configuration of the waste management complex.

Comment (1607)
The PEIS should analyze truck transport in relation to the level of service roads in Nevada, and should coordinate with the transportation analysis for NTS now in draft form.

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. During the transportation planning process the level of service roads and routing is normally addressed. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

6.6 Waste Transportation, General

Section 11.20 in Volume I of the WM PEIS describes combined and cumulative impacts which could occur regionally or Nationally from the transportation of waste. Tables 11.20-1 and 11.20-2 in Volume I summarize the range of combined impacts. The largest number of shipments to or from a single site could occur at NTS, namely a total of 267,000 truck shipments or 100,620 rail shipments (107 and 40 per day, respectively). This number of shipments is well within the capacity of the current transportation network.

The PEIS describes other ongoing DOE NEPA reviews and discusses the relationship of the WM PEIS to those reviews (see Volume I, Section 1.7.4), including the NTS sitewide EIS. The NTS cumulative impacts are described in Chapter 11 (Volume I) of the WM PEIS.

Comment (1618)
The Record of Decision should decide upon the primary use of rail transport (since it is a clear winner and cost factor) and whether intermodal transportation makes sense for all wastes. This is a prime time to address transportation routing, especially to reduce risks, by local consultation on routing.

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Transportation planning would also include discussion of intermodal transportation if necessary. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Table 1.5-1 and Section 1.7.3 in Volume I describe the decisions DOE intends to make as a result of the WM PEIS. DOE does not propose to make programmatic decisions on the mode of transport to be used for any wastes. As discussed in Volume IV, Section E.4.2.1, of the WM PEIS, transportation risk analyses used representative routes. These routes are representative because they are consistent with current routing practices. However, these might or might not be the routes actually used. DOE has revised Section 4.3.10 in Volume I to explain how it would select the actual transportation routes for shipping activities. At the time DOE selects a given alternative, it would determine the transportation routes in consultation with the States and other stakeholders.

Although rail shipments appear to result in a lower number of expected fatalities in comparison to truck shipments, in general the risks from both types of transportation would be small. Moreover, even though the estimated risks for rail transportation are lower than those estimated for truck transportation, there is no significant difference in the calculated radiological risks between the two transport modes because of the uncertainties involved in the calculations. "Roadside residents" are not expected to receive a higher exposure from truck shipments than from rail shipments because most truck transportation is expected to occur over the interstate highway system where large setbacks from the roadside exist. On the other hand, the motoring public might receive a higher exposure from truck shipments than members of the public sharing the rail transportation routes. The risks of physical trauma fatalities directly related to traffic accidents suggest rail transport might be less hazardous than truck transport. These differences between impacts of truck and rail transportation become significant only when there are a large numbers of shipments, such as for low-level waste in the Centralized Alternative. Section 7.4.2 in Volume I was revised to incorporate this discussion.

6.6 Waste Transportation, General

Furthermore, a number of factors have been specifically addressed in the transportation assessment conducted for the WM PEIS. First, waste to be shipped by rail could require an additional intermodal transfer (truck/rail) for sites without rail access, which would contribute to the overall risk. (A review of the transportation facilities at 35 DOE sites indicated that 15 have direct rail access on the site, 12 have access within 10 miles, and 8 have access between 10 and 100 miles.) Second, a number of other factors could make rail shipments less desirable than truck shipments. For example, to be cost-effective, rail shipments probably would require the shipment of a large amount of waste at one time. Moreover, rail operations are less flexible or responsive to individual site needs than truck operations. Volume IV, Section E.8.5, describes uncertainties in the comparison of truck and rail transportation modes.

As shown in Volume I, Section 11.20 of the WM PEIS, shipping waste by truck would result in a combined total of between 12 and 69 potential fatalities from shipping low-level mixed waste, low-level waste, transuranic waste, and hazardous waste over the next 20 years, and for shipping high-level waste over the next 40 years, as shown in Volume IV, Appendix E, and Section 11.20. Shipping low-level mixed waste, low-level waste, transuranic waste, and high-level waste by rail, and hazardous waste by truck would result in a combined total of between 2 and 6 potential fatalities over the same periods.

The results of the transportation analyses conducted in Appendix E show that impacts relating to the transport of waste analyzed in the WM PEIS, which include fatalities from radiation exposure, diesel exhaust emissions, and physical trauma from accidents, are low when compared to nationwide vehicle transportation yearly impacts. Comparatively, from 1971 to 1993, over one million persons were killed by physical trauma in vehicular accidents in the U.S.

DOE has used trains in the past including during shipments of foreign research reactor spent nuclear fuel from Charleston, South Carolina, to the SRS in 1994 and 1996, and when shipping low-level waste from FEMP to the Envirocare Site in Utah. The decision to use truck or trains would be addressed during the transportation planning process at each site. Section 4.3.10 in Volume I describes DOE's transportation elements. Tables 4.3-6 and 4.3-7 provide the number of current rail and truck shipments to and from the major DOE sites based on the 1993 Shipment Mobility/Accountability Collection and the Waste Manifest System FY 1993.

Comment (1624)
DOE should explain how truck transport of wastes will have markers and identification symbols.

Response
The characteristics of a material determines how it is to be packaged and labeled for shipping. As discussed in Volume IV, Sections E.3.1 and E.13, DOE will ship all its radioactive and hazardous material according to U.S. Department of Transportation (DOT) and/or NRC regulations identified in Section 1.4.4 in Volume 1 of the WM PEIS. Title 49 of the Code of Federal Regulations, Part 173, delineates DOT shipping requirements that include the proper labeling of a radioactive or hazardous material shipment. The NRC regulations can be found in 10 CFR 71. In addition, any State-specific or Tribal-specific requirements would be addressed at the time of shipment.

6.6 Waste Transportation, General

Comment (1629)
The WM PEIS is not clear about how transportation routing issues are addressed. What is needed in the WM PEIS is a sensitivity to local traffic conditions (e.g., Las Vegas) as opposed to just a highway model.

Response
The WM PEIS transportation analysis is generic and based on programmatic models to enable decisionmakers to compare programmatic management options. Actual transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. The implementation of programmatic waste management decisions at the sites will consider such factors as historical transport modes at waste management sites, existing infrastructures, emergency response training programs and practices, and management skills of local and regional officials.

In conducting transportation activities, DOE will adhere to applicable Federal regulations to ensure that the waste is transported safely and will minimize the potential for impacts to the public and the environment. The U.S. Department of Transportation (DOT) is responsible for national routing regulations, and DOE complies with those regulations. DOT has no railroad regulations. Railroads are private corporations and are not as regulated as the Federal highway system.

DOE used the routing model HIGHWAY 3.1 to determine the representative truck routes and INTERLINE 5.0 to determine the representative rail routes. More information on representative transportation routes is contained in Volume IV, Appendix E, and detailed route characteristics are provided in the technical reports prepared for each waste type. These technical reports are available in the DOE public reading rooms listed in Section 1.9 in Volume 1 of the WM PEIS.

In the WM PEIS analysis, the highest traffic volumes would be generated by a Centralized Alternative for low-level waste. Approximately 125 shipments per day would be expected under this alternative. This number of shipments is well within the capacity of the current transportation network. However, in addition to its commitment to the safe transportation of its radioactive waste, DOE is also concerned with the minimization of impacts to local communities around the sites and along transportation corridors. DOE will be proactive in working with regional entities, States, and carriers in ensuring that the safest routing alternatives are utilized. Transportation planning is described in Volume I, Section 4.3.10, and in Volume IV, Appendix E.

Comment (1645)
DOE should ensure that its process for transporting wastes includes redundant systems to address any potential risks that might occur.

Response
Regulations that govern the transportation of radioactive and hazardous materials are designed to protect the public from the potential loss or dispersal of radioactive and hazardous materials, as well as from routine doses of radiation during transport. The primary regulatory approach for ensuring safety is by specifying standards for the packaging of radioactive and hazardous materials.

6.6 Waste Transportation, General

Although several Federal and State organizations are involved in regulating the transportation of radioactive waste, the U.S. Department of Transportation (DOT) and NRC have primary regulatory responsibility. In addition, DOE has formalized agreements with the NRC and DOT to delineate responsibilities of each agency. All transportation-related activities must be in accordance with applicable regulations of these agencies identified in Section 1.4.4 in Volume I of the WM PEIS.

DOT and EPA regulations have been established to ensure that shipping hazardous waste is accomplished safely and with minimum risk to transportation workers and the public. These regulations, which DOE has adopted as part of DOE Order 1450.1C, cover the packaging, handling, and transporting of hazardous material.

See Section E.3 in Volume IV of the WM PEIS for more information on packaging and transporting radioactive and hazardous wastes.

Comment (1647)
DOE should favor transporting wastes the minimum distance, pending complete elimination.

Response
Transportation requirements will be a factor in comparing different WM PEIS alternatives (see Volume I, Section 1.7.3). DOE is required to analyze reasonable alternatives in the WM PEIS, the following would have the lowest number of shipments: the No Action Alternative for low-level mixed waste (none for truck and rail); the Decentralized Alternative for low-level waste (24,420 for truck and 9,210 for rail); the No Action Alternative for transuranic waste (none for truck and rail); the No Action Alternative for high-level waste (19,872 for truck and 3,975 for rail) and the No Action Alternative for hazardous waste (34,000 for truck as the predominant transportation mode).

As shown in Volume I, Section 11.20 of the WM PEIS, shipping waste by truck would result in a combined total of between 12 and 69 potential fatalities from shipping low-level mixed waste, low-level waste, transuranic waste, and hazardous waste over the next 20 years, and for shipping high-level waste over the next 40 years, as shown in Volume IV, Appendix E, and Section 11.20. Shipping low-level mixed waste, low-level waste, transuranic waste, and high-level waste by rail, and hazardous waste by truck would result in a combined total of between 2 and 6 potential fatalities over the same periods.

The results of the transportation analyses conducted in Appendix E show that impacts relating to the transport of waste analyzed in the WM PEIS, which include fatalities from radiation exposure, diesel exhaust emissions, and physical trauma from accidents, are low when compared to nationwide vehicle transportation yearly impacts. Comparatively, from 1971 to 1993, over one million persons were killed by physical trauma in vehicular accidents in the U.S. Thus, while the PEIS does not consider eliminating transportation, the analysis finds that the potential transportation impacts would be low when compared to yearly vehicular accidents.

DOE is strongly committed to pollution prevention, which is achieved through (1) reducing the amount of waste generated and (2) recycling wastes. Source reduction by waste generators in Defense Programs, Energy Research, and other DOE programs will reduce the amount and radioactivity level of waste sent to the Waste Management Program, the cost of constructing and operating these waste management facilities, the amount of transportation, and the health risks to the public and workers. Each DOE site has

Waste Minimization and Pollution Prevention Programs and plans in place. Appendix G (Volume IV) of the WM PEIS addresses pollution prevention at a programmatic level.

Comment (1651)
For low-level mixed waste, the Regionalized Alternative involves too much transportation, although it is common knowledge that transportation puts the most people at risk. It would be better to wait until treatment technologies are available that reduce health risks.

Response
Deciding what role various DOE sites will have in waste management activities will involve trade-offs of many factors, including transportation risk and cost of facility construction. In general, minimizing transportation risks maximizes the number (and cost) of treatment facilities.

It takes time to develop new technologies and waiting for new technologies would result in untreated wastes being stored for a longer period. This might not be acceptable to residents near the sites or to regulators. RCRA, the Federal Facility Compliance Act, and the Site Treatment Plans encourage DOE to treat mixed waste rather than indefinitely storing them until new technologies would make treatment less problematic.

Comment (1670)
Increased use of rail transportation could significantly reduce both risk and cost for all alternatives except in the case where there is no offsite transportation; therefore, the risks of all alternatives for low-level waste disposal would be comparable with regard to health risks. Cases show cost reductions ranging from $30 million to $2 billion. Risks reductions range from 8% to 80%. In the current analysis, the motoring public and roadside residents would experience the greatest portion of total risk in order to achieve relatively modest reductions in future risks to communities that are near DOE facilities. Alternatives using rail transportation more than they are used at present should be considered, including maximum use of train transportation reasonably possible.

Regarding NTS, rail transportation could reduce concerns about the environmental management activities in Nevada. Currently, truck shipments travel primarily through the largest cities in Nevada and then to NTS, due to routing restrictions imposed by U.S. Department of Transportation regulations. Rail shipments could allow greater DOE discretion in the development of alternative routes that could avoid these areas, because currently there are no rail routing regulations.

There should be a rail system for transporting low-level waste and high-level waste to Nevada, and the WM PEIS should consider transporting waste to the NTS only by rail.

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Although rail shipments appear to result in a lower number of estimated potential fatalities in comparison to truck shipments, in general the risks from both types of transportation are small.

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Moreover, even though the estimated risks for rail transportation are lower than those estimated for truck transportation, there is no significant difference in the estimated radiological risks between the two shipping modes because of the uncertainties involved in the calculations. "Roadside residents" are not expected to receive a higher exposure from truck shipments than from rail shipments because most truck shipping are expected to travel over the interstate highway system where large setbacks from the roadside exist. On the other hand, the motoring public might receive a higher exposure from truck shipments than members of the public sharing the rail transportation routes. The risks from injury directly related to traffic accidents suggest rail transportation might be less hazardous than truck transportation. Section 7.4.2, Volume I, of the Final WM PEIS was revised to incorporate this information.

Furthermore, a number of factors have been specifically addressed in the transportation assessment conducted for the WM PEIS. First, waste to be shipped by rail could require an additional intermodal transfer (truck/rail) for sites without rail access, which would contribute to the overall risk. (A review of the transportation facilities at 35 DOE sites indicated that 15 have direct rail access onsite, an additional 12 have access within 10 miles, and 8 more have access between 10 and 100 miles.) Second, a number of other factors could make rail transportation less desirable than truck transportation. For example, to be cost-effective, rail transportation probably would require the shipment of a large amount of waste. Moreover, rail operations are not very flexible or responsive to individual site needs. A discussion of uncertainties involved when comparing the truck and rail transportation impacts is presented in Appendix E, Section E.8.5, in Volume IV of the WM PEIS.

Regarding NTS, because rail lines do not currently extend onto that site, a rail line would have to be built. The construction and operation of this rail line could result in significant environmental impacts. Therefore, appropriate NEPA review would be needed before construction of a rail line could begin.

Comment (1783)
A commentor was "disheartened that a systematic consideration of the potential dangers of transporting materials to" WIPP and Yucca Mountain was not included in the WM PEIS. The commentor lives in Colorado and is also concerned that Interstate 70 and Interstate 25 will become major routes for the transportation of nuclear wastes.

Response
Radioactive materials are shipped every day on U.S. interstate highways. Most shipments involve small quantities of material with low levels of radioactivity. A small percentage of shipments involve materials with higher levels of radioactivity, such as commercial radioactive spent fuel from nuclear power plants. Safety is built into the transportation system for radioactive material shipments to protect the public, transportation workers, and the environment. DOE has an excellent record of safely transporting waste and nuclear materials over the last 40 years.

Chapters 6 through 10 in Volume I of the PEIS provide information and results of potential transportation-related impacts. Appendix E in Volume IV contains transportation analyses, including an evaluation of the impacts of all transuranic waste that would go to WIPP and all high-level waste that would go to Yucca Mountain. However, DOE will not make the decisions whether to use WIPP or Yucca Mountain on the basis of the WM PEIS. DOE has prepared the WIPP SEIS-II to evaluate disposal at WIPP. The Yucca Mountain EIS is currently being prepared.

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Transport of spent nuclear fuel to a geologic repository is outside the scope of the WM PEIS, although these shipments were considered in Section 11 (Volume I) on cumulative impacts. Shipment of spent nuclear fuel to Yucca Mountain is being evaluated in the Yucca Mountain Repository EIS.

Comment (1954)
A commentor advised against transporting high-level radioactive wastes through population centers and suggested establishing repositories close to sources until a final system of transportation and disposal, avoiding population centers, is agreed upon.

Response
Transportation mode and routing decisions for high-level waste will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

DOE must comply with U.S. Department of Transportation (DOT) and NRC regulations identified in Section 1.4.4, Volume I of the WM PEIS, to transport high-level radioactive waste. A high-level waste shipment requires advance approval from DOT-designated State agencies for alternative routes that would be used for highway shipments. If approved by NRC and DOT, high-level waste could be transported through population centers if an alternative route is not available.

Comment (2054)
Moving wastes between sites is problematic.

Response
NEPA requires that DOE evaluate reasonable alternatives when preparing an EIS. In this PEIS, four categories of alternatives are analyzed for each waste type including No Action, Decentralized, Regionalized, and Centralized. The number of transportation shipments were evaluated for each alternative. A Centralized Alternative requires the most shipments and a No Action Alternative requires the least. The cost sections in each waste-type chapter, Sections 6.14, 7.14, 8.14, 9.14, and 10.14 in Volume I of the WM PEIS, show the costs associated with siting and transportation decisions. In many alternatives it is more cost-effective to transport waste to another site, rather than to build a facility.

Transportation is an integral component of the alternatives being considered for each type of waste considered in the WM PEIS. For some alternatives, radioactive waste would be shipped between the DOE sites at various stages of the treatment, storage, and disposal process. The magnitude of transportation-related activities range from minimal for decentralized approaches to significant for some centralized approaches.

The WM PEIS includes a detailed assessment of the risks of a complete range of credible transportation accidents for both rail and truck transportation, including low-probability/high-consequence and high-probability/low-consequence accidents. Both radiological and nonradiological causes contribute to the overall transportation risk. In general, the radiological risks from waste shipments (i.e., risks associated with the radioactive nature of the waste) tend to be less than or equal to the nonradiological risks (i.e., risks from traffic accidents unrelated to the radioactive cargo). For high-level waste, the radiological and

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nonradiological risks are roughly equal. For the other waste types, radiological risks are less than the nonradiological risks. Thus, the greatest risk tends to be from physical trauma.

With respect to the radiological risk, by far the dominant component would be exposure to external radiation during routine conditions. The accident component of the radiological risk (which takes into account probability and consequence) would generally be very small. Accident risks would be small because accidents are rare in general, most accidents would not involve significant releases of radioactive material, and the consequences of most accidents would not be severe.

Even though the overall accident risks would be small, the PEIS presents the consequences of the most severe credible transportation accidents (assuming they occurred)--which are of very low probability--for each waste type to indicate the maximum foreseeable accident. Finally, all risks would be directly proportional to the total shipment mileage.

Appendix E in Volume IV of the PEIS contains a detailed the transportation risk assessment.

Comment (2309)
A major problem not evaluated in the WM PEIS is transportation of the waste. DOE's strategy should (1) involve site-specific advisory boards, local communities, and the public to ensure minimal transportation impacts when routes are selected; (2) stop total reliance on DOE regulations, and (3) review the New Mexico Supreme Court decision *Komis v. The City of Santa Fe*. Otherwise, there is a potential for considerable litigation and delay of final decisions.

Response
The transportation of each waste type for treatment and disposal is an integral component of the alternatives considered in the WM PEIS, including both truck and rail transportation. To support programmatic decisions, the analysis of transportation routing is generic. Before new waste management facilities are sited, sitewide or project-level NEPA reviews would analyze transportation issues in greater detail.

Both the programmatic and site-specific NEPA analyses provide opportunities for the public to provide input. Scoping meetings, workshops, and public hearings on the Draft WM PEIS involved the public and interested stakeholders. DOE is developing a "National Dialogue" initiative, which includes the waste management programs as well as other DOE programs concerning intersite management of nuclear materials. The objective is to enhance integrated decisionmaking, exchange information, and provide a forum for discussion of public concerns. This initiative is discussed in Section 1.8.2 in Volume I of the Final WM PEIS.

DOE complies with U.S. Department of Transportation and NRC transportation regulations, which contain safety standards that have been very effective in the past. Like other kinds of shipments, radioactive materials in transit have been involved in accidents. In most cases, there was no release of any radioactive material into the environment. When releases have occurred, the material has been cleaned up with no identifiable harm to people or to the environment. No one has ever been killed or seriously injured in an accident involving radioactive materials because of the nature of the cargo. Section 4.3.10.1 has been revised to better describe the process DOE uses in planning transportation activities.

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Sections 4.3.10, 6.2.4, 7.2.4, 8.2.4, 9.2.4, and 11.20 in Volume I, and Appendix E in Volume IV provide more detail on transportation issues.

The decision of New Mexico's Supreme Court in *Santa Fe v. Komis*, 845 P.2d 753 (N.M. 1992), addressed the issue of damages due landowners whose property had been condemned for a highway to the Waste Isolation Pilot Project. The decision does not implicate the analysis of potential impacts of transporting wastes under NEPA, and is unlikely to apply in situations that do not involve a government's use of its power of eminent domain to condemn private property.

Comment (2653)
Does Table 8.4-8 in Volume I include the effects of transportation to WIPP for disposal, which might help to discriminate between alternatives? If so, why aren't the impacts of regionalization alternatives (which would include shipment of some material between sites and then to WIPP) greater than those of centralization at WIPP (which would only include shipping everything to WIPP one time)?

Response
The estimated number of traffic-accident fatalities presented in Table 8.4-8 are a function of the total number of miles traveled by the trucks. Table E-21 in Volume IV, provides a summary of mileage and shipment information for TRUW truck shipments. The total mileage traveled under the Regionalized Alternatives would be: Regionalized Alternative 1, 38.3 million; Regionalized Alternative 2, 34 million; and Regionalized Alternative 3, 37.2 million. DOE estimates 38.7 million miles for the Centralized Alternative. Therefore, the potential traffic-accident fatality estimates for the Regionalized and Centralized Alternatives are similar.

The transportation mileage estimates include shipments to WIPP for disposal. One reason the risks are so high for the Centralized Alternative versus the Regionalized Alternatives is that, under the Centralized Alternative, the remote-handled TRUW would still be shipped to Hanford or ORR for treatment before it is shipped to WIPP; shipments of remote-handled TRUW account for more than half of the total shipments. Of the contact-handled TRUW shipments, all sites would ship untreated waste to WIPP under the Centralized Alternative. Under the Regionalized Alternatives, the sites with the majority of the contact-handled TRUW would not ship waste for treatment. As a result of treatment, these sites would ship a smaller volume of treated waste to WIPP, thereby reducing the number of shipments necessary. This would then result in an overall decrease in the number of shipments under Regionalized Alternatives 2 and 3.

Comment (2659)
Is waste from PGDP representative of the waste that could possibly be involved in the other accident scenarios? See Volume IV, Section E.7.4.4.

Response
As stated in Section E.7.4.4, Volume IV, of the WM PEIS the low-level mixed waste from PGDP would result in the highest transportation accident doses for the most severe accidents. This is due to the higher level of alpha-emitting radionuclide contamination in the organic liquid low-level mixed waste, and the characteristics of the shipping route. Therefore, results using low-level mixed waste from PGDP would be an upper limit on the impacts from accidents involving low-level mixed waste from other sites. That is, low-level mixed waste from the other sites would be expected to result in lower doses for the same type of accident. Details of the low-level mixed waste accident analysis are

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presented in supporting technical reports that are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the WM PEIS.

Comment (3123)
It is not clear why DOE says the analysis done for the PEIS is *not* to replace results of previous transportation analyses, given that the PEIS includes both new International Commission on Radiological Protection factors and new data on waste inventories.

Response
Appendix E, Volume IV, of the WM PEIS contains the radioactive and hazardous waste transportation risk assessment for the WM PEIS. Section 1.8, Volume I, describes the WM PEIS relationship to other DOE actions and programs. The reason for not replacing results of previous transportation analyses with the transportation analyses in Appendix E is because: some decisions have already been made and actions are underway or completed; site-specific EIS documents could contain actual transportation routes rather than the generic routes analyzed in the WM PEIS; or the radiological profiles used for site transportation analyses are more specific than the maximum allowable external dose rates for exclusive-use shipments identified in Section E.3.1 (Volume IV). The results of the transportation analyses conducted in Appendix E show that impacts relating to the transport of wastes analyzed in the WM PEIS are low when compared to nationwide vehicle transportation yearly impacts.

The results of the transportation analyses conducted in Appendix E show that impacts relating to the transport of waste analyzed in the WM PEIS, which include fatalities from radiation exposure, diesel exhaust emissions, and physical trauma from accidents, are low when compared to nationwide vehicle transportation yearly impacts. Comparatively, from 1971 to 1993, over one million persons were killed by physical trauma in vehicular accidents in the U.S.

Actual transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Comment (3124)
The transportation risk assessment should examine traffic and infrastructure impacts, given that there could be a total of 295,000 truck shipments or 106,000 rail shipments (56 and 21 per day, respectively) to Yucca Mountain or NTS. This level of shipments could create additional risks due to traffic increases or infrastructure deterioration.

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Section 11.20 in Volume I of the WM PEIS describes combined and cumulative impacts which could occur regionally or Nationally from the transportation of waste. Tables 11.20-1 and 11.20-2 in Volume I summarize the range of combined impacts. The largest number of shipments to or from a

single site could occur at NTS as a result of shipments of low-level mixed waste (Regionalized Alternative 3) and low-level waste (Centralized Alternative 2), and the shipments of high-level waste if Yucca Mountain is found to be suitable for the disposal of defense high-level waste (all alternatives).

Traffic and infrastructure impacts would be expected to be minimal at NTS. NTS has a well-established transportation network. Compared to the existing traffic volumes, the impacts from potentially added shipments resulting from waste management operations appear to be minimal. The average *hourly* traffic volumes on the major access roads to the site are well above the *daily* estimates of 56 and 21 truck and rail shipments expected for the waste management alternatives considered.

Comment (3127)
The discussion of the single-canister truck cask does not refer to DOE's development of spent fuel casks or to the Multi-Purpose Canister EIS. Is there any linkage between the Office of Environmental Management high-level waste program and these other efforts?

Response
Several casks for shipment of civilian spent nuclear fuel have been licensed by NRC. The Final Evaluating Container Systems for the Management of Naval Spent Nuclear Fuel EIS (formerly, Multi-Purpose Canister EIS) was published in November 1996. The EIS was prepared by the Navy, with DOE as a cooperating agency. That EIS addresses only naval spent nuclear fuel. Storage and disposition of spent nuclear fuel are outside the scope of the WM PEIS. There is no linkage between the Navy's evaluation of the multi-purpose canister and DOE's evaluation of its High-Level Waste Program.

Comment (3209)
The Draft WM PEIS states that the transportation risk assessment does not address how increased levels of transportation might affect *local* traffic flow, noise levels, logistics, or infrastructure. However, given that many of the proposed alternatives result in a tremendous volume of shipments, the increased traffic and potential infrastructure degradation does need to be addressed in some manner.

Response
As a national and programmatic study, the WM PEIS assumes representative transportation routes by rail and truck. The WM PEIS explores ranges of alternatives and is intended to assist decisionmakers and the public in comparing the transportation risks associated with the alternatives considered. The representative routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines.

Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Section 11.20 in Volume I of the WM PEIS describes combined and cumulative impacts, which could occur regionally or nationally from the transportation of waste. Tables 11.20-1 and 11.20-2 in Volume I summarize the range of combined impacts. The largest number of shipments to or from a single site could occur at NTS, namely a total of 267,000 truck shipments or 100,620 rail shipments

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(107 and 40 per day, respectively). This number of shipments is well within the capacity of the current transportation network.

Comment (3217)
A commentor expressed satisfaction with DOE's acknowledgment in Appendix E that WIPP protocols are "representative" of those likely to be adopted for future DOE shipping campaigns. In addition, in Section E.9, the Draft WM PEIS states that the transportation plan developed for the WIPP campaign "can be representative of those for future major DOE programs for waste transportation." Some commentors strongly agree with this statement. However, the WIPP transportation plan includes more than the features listed. One very important component of the WIPP transportation safety program is the fact that DOE pre-designated routes from each generator site to the WIPP facility several years prior to the beginning of shipments. This allows the States and Native American Tribes along the transport corridor to focus their training and other emergency preparedness activities along those routes, instead of having to divide their time and resources among all the potential routes that would qualify using Federal routing criteria. This must be done both for highway and rail routing to allow a focus on emergency preparedness efforts.

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized. Training and emergency preparedness are addressed during the transportation planning process.

As discussed in Section E.4.2.1 in Appendix E (Volume IV) of the WM PEIS, transportation risk analyses used representative routes. These routes are deemed representative because they are consistent with current routing practices but may or may not be the routes actually used if the shipping campaign were to occur in the future. Section 4.3.10 in Volume I has been updated to explain how DOE would select the actual transportation routes for shipping activities. Most transportation routes for radioactive waste shipments occur over interstate highways and are consistently used regardless of the waste type being shipped.

Comment (3221)
Many of DOE's wastes do not have approved transport packaging licensed to meet regulatory standards.

Response
Any waste shipped by DOE will meet existing packaging requirements as set forth by the U.S. Department of Transportation, EPA, and NRC, as applicable. The radioactive wastes considered in the WM PEIS already have approved packaging or have designs ready for approval. A discussion of the types of packaging considered for each waste type can be found in Volume IV, Section E.3.

Comment (3239)
DOE should (1) directly involve corridor States and Tribes in preparing for large-scale nuclear waste/material shipments; this would include developing rail and truck transportation plans, preferred routes, and procedures prior to shipment (similar to that developed by DOE and the Western States

Governors' Association for transuranic waste shipments to WIPP); (2) use only shipping containers that can be manufactured to meet current Federal transportation safety requirements; and (3) provide accurate projected shipment information (quantities, schedules, etc.), as well as necessary assistance and lead time for State/Tribe emergency response preparation. These recommendations are based on the following concerns:

- Transuranic shipment routes in California traverse densely populated urban regions, such as the Los Angeles Basin, that are subject to long traffic delays and congestion.

- DOE has used outdated packaging (Polypanther) for transuranic waste shipments in California that provide far less protection than the double-contained TRUPACT II planned for transuranic waste shipments to WIPP in New Mexico.

- Emergency response capability to handle a potential accident involving transuranic materials needs improving.

- DOE needs to provide the State with accurate, reliable information on planned transuranic waste shipments and provide adequate lead time for emergency response preparation.

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process described in Section 4.3.10, in Volume I of the WM PEIS. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Due to its programmatic nature, the WM PEIS uses representative routing for purposes of analysis and comparison of siting options. For the WM PEIS, representative truck and rail routes were determined for all possible pairs of origin and destination sites. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines; however, because the routes were determined for the purposes of risk assessment, they do not necessarily represent actual routes that would be used to transport waste in the future. Transportation planning is described in Section 4.3.10 in Volume I.

Specific transportation issues, including the determination transportation mode(s), will be addressed when actual waste management facilities are sited after sitewide or project-level NEPA review. The implementation of programmatic waste management decisions regarding actual transportation routes, modes, etc., will consider within its analysis of risks to human health and the environment such factors as historical transport modes at waste management sites, existing infrastructures, emergency response training programs and practices, and management skills of local and regional officials.

The route characteristics most important to risk assessment include the total shipping distance between each origin-and-destination pair and the fractions of travel in rural, suburban, and urban zones of population density. The route selected determines the total potentially exposed population along a route and the expected frequency of transportation-related accidents. U.S. Department of Transportation (DOT) routing regulations for public highways are contained in 49 CFR 177 (also known as HM-164). DOT has no rail routing regulations. A vehicle transporting a shipment of a "highway route controlled quantity" of

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radioactive materials is required by HM-164 to use the interstate highway system except under defined circumstances. Carriers are required to use interstate circumferential or bypass routes, if available, to avoid populous areas. Any State or Native American tribe may designate other "preferred highways" in place of or to supplement the interstate system. However, DOT can prohibit State and local restrictions. Further information on representative transportation routes is contained in Volume IV, Appendix E, and detailed route characteristics are provided in the technical reports prepared for each waste type.

Section E.3.1 describes packaging requirements. All transportation-related activities must be in accordance with applicable regulations of DOT and NRC specified in 49 CFR 173 and 10 CFR 71. Section E.3.2 identifies representative packing and shipment/configurations by waste type.

DOE is concerned the need for emergency preparedness in an around its sites. Emergency response plans are required on sites and in the surrounding communities by Federal, State, and local authorities that deal with emergency situations such as floods, tornadoes, and other natural or man-made disasters. These plans are continually updated. DOE, DOT, and the Federal Emergency Management Agency are available to assist with review of State and local authorities with their emergency plans.

Emergency planning and preparedness is best done when actual shipping activities are in the planning stages. This includes coordinating notifications to State, Tribal, and local authorities where required. The WM PEIS is a programmatic document that uses representative routes (see Section E.4.2 in Volume IV) and source terms (Section E.6.1) to obtain a nationwide perspective on the risks associated with transporting hazardous waste within the DOE complex. More detailed transportation planning will be performed at the site level when specific actions are decided. Such planning will be able to appropriately address the emergency planning measures required as determined by the specific waste to be shipped and the actual route(s) to be used, as described in Section 4.2 in Volume I. Especially for the large DOE sites, there is already a high level of emergency planning and preparedness in place, as discussed in Section E.9 in Volume IV.

State and local police and fire departments have primary responsibility for responding to events that could endanger the health and welfare of their citizens. Most States maintain specialized teams capable of responding to hazardous materials incidents. Through the capabilities these teams currently possess for dealing with potential accidents involving other hazardous materials (e.g., hazardous chemicals), they should already have the capability to deal with most plausible accidents involving low-level waste and low-level mixed waste. Thus additional training for low-level waste and low-level mixed waste would most likely be minimal. However, some states would require additional training to respond to potential radioactive hazards resulting from transuranic waste or high-level waste transportation accidents. Currently, to assist in planning and preparedness for an unlikely, but theoretically possible, transportation emergency involving transuranic waste or high-level waste radioactive shipments, DOE does offer a variety of radiological emergency response resources and information to complement existing emergency preparedness programs, and will continue to maintain a comprehensive emergency management system, particularly for radiological emergencies. The emergency management system includes training courses, Regional Coordinating Offices, and DOE Radiological Assistance Program teams.

DOE sites have plans and equipment to respond to accidents and other emergencies. DOE requirements for emergency response preparedness are contained in DOE Order 151.1.

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Comment (3272)
The WM PEIS should fully address the economic and environmental impacts of routing waste shipments through the Las Vegas urban area and smaller communities in Clark County. DOE should obtain significant input by local government and Tribal stakeholders and should address a number of transportation-related issues including the cumulative impacts of rail or truck shipment of wastes from different DOE programs through Clark County; the health and safety risks associated with routing waste shipments along interstate highways that come close to or through densely populated urban areas; the need for local development of institutional controls and preparation for transportation emergencies, which could drain public funds; the potential for land along designated transportation routes to be devalued and changed from more to less desirable uses, and for tourism to decline; and the additive impacts on air quality due to traffic increases, congestion, and travel time.

Response
The health and safety risks associated with routing waste shipments along interstate highways and through urban areas is small, as identified in Appendix E. Section E.2.4 of the WM PEIS states that the impacts of transporting radioactive materials were evaluated for both routine transportation and for transportation accidents. The estimated health risk associated with routine transportation results from the potential exposure of individuals to low-levels of external radiation near the surface of shipments. The risk from transportation accidents involves the potential release and dispersal of radioactive material into the environment, with individuals exposed through a number of pathways, including inhalation and ingestion of contaminated food.

Chapter 11 of the WM PEIS provides the cumulative impacts from other programs. The impacts from transportation are among those considered. More information on cumulative impacts for NTS can be found in Section 11.10. Other sources of risk include the shipments of DOE and commercial spent nuclear fuel, other DOE nuclear materials, radioisotopes used in medicine and other activities, and commercial waste. Table 11.20-3 summarizes existing and reasonably foreseeable shipments of radioactive materials that have been included in the assessment of cumulative transportation impacts, but are not a part of the alternatives. A discussion of these other shipments is contained in DOE, 1995d.

Emergency preparedness for transportation of radioactive wastes is a vital part of the transportation planning process. State and local police and fire departments have primary responsibility for responding to events that could endanger the health and welfare of their citizens, including transportation accidents. Most States maintain specialized hazardous materials response teams that could be activated to provide technical assistance and mitigation during emergencies. State teams are activated at the request of an Incident Commander or other appropriate State or local authority. The carrier also would provide technical response assistance to emergency responders as required by event scene conditions.

DOE sites already have emergency plans and equipment to respond to accidents and other emergencies. DOE requirements for emergency response preparedness are contained in DOE Order 151.1. DOE also participates with other Federal agencies and State and local authorities to sponsor and occasionally fund radiological emergency response training throughout the United States. Training is usually provided for those responsible for public safety and emergency response to natural disasters or accidents. DOE provides Radiological Assistance Program teams of trained experts who are equipped and prepared to respond to an accident involving a shipment of radioactive materials, and to assist

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State, local, and Tribal emergency response personnel, if necessary. DOE, the U.S. Department of Transportation, and the Federal Emergency Management Agency assist in review and modification of State and local emergency response plans, if requested.

Emergency planning and preparedness is best done when actual shipping activities are in the planning stages. The WM PEIS is a high-level programmatic document that uses representative routes (see Section E.4.2) and source terms (see Section E.6.1) to obtain a nationwide perspective on the risks associated with transporting hazardous waste within the DOE complex. More detailed transportation planning will be performed at the site level when specific actions are decided. Such planning will appropriately address the emergency planning measures required as determined by the specific waste to be shipped and the actual route(s) to be used, as described in Section E.4.2. Especially for the large DOE sites, there is already a high level of emergency planning and preparedness in place, as discussed in Section E.9.

DOE believes it has fully analyzed at the programmatic level, the human health, environmental, and socioeconomic impacts of the waste management alternatives. DOE recognizes that siting of waste management facilities might be perceived negatively by some persons; however, DOE believes that analysis of economic impacts of such negative perceptions would be too speculative. DOE is committed to managing its wastes to protect human health and the environment and will work with local communities to help ensure that negative perceptions and potential negative impacts are minimized.

Sections C.4.2.1.2.1.3 and C.4.2.1.2.2.2 in Volume III of the WM PEIS identify the transportation sources assumptions that were used in the air quality impacts analysis. DOE believes the additive impacts on air quality due to traffic increases, congestion, and travel time are generally small to moderate, as shown in the Volume II Site Data Tables for NTS.

Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process described in Section 4.3.10, in Volume I of the WM PEIS. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Comment (3309)
The WM PEIS estimate that rail transport would save $1.7 to $1.8 billion in 1994 dollars does not reconcile with DOE Nevada's judgment that rail provides no benefit for the types of low-level wastes currently disposed of at the Nevada Test Site (NTS). What costs per ton-mile are assumed in estimates of rail transport costs, and how do these compare with the industry average for freight shipment (2.5 cents per ton-mile in 1993)? A $1.7 to $1.8 billion savings in operations costs (present value of about $1 billion over 20 years) would probably build a rail spur to NTS. The total costs of Centralized Alternatives 2 and 4 (which include the $1.7 to $1.8 billion additional costs of truck transport) could cover the capital costs of a rail spur. Is this an option that is available for consideration?

Truck transport costs for low-level wastes are estimated at about $1,520 per cubic meter ($2.25 billion under Centralized Alternative 2, divided by 1,480,000 cubic meters), but at only $265 per cubic meter for low-level mixed waste disposal ($0.06 billion under Regionalized Alternative 3, divided by

226,000 cubic meters). What accounts for the difference? Is the source reduction in mixed waste treatment greater than that in low-level waste treatment?

Response
The WM PEIS is a programmatic analysis of alternatives for treating, storing, and disposing of DOE waste. It does not compare specific transportation routes because decisions on routes will not be made based on the WM PEIS analysis. Therefore, it is beyond the scope of the WM PEIS to consider a possible rail spur to NTS. The routes in the PEIS were used for comparison of impacts across sites, and are intended to be representative of possible routes.

The transportation cost analyses described in Volume I, Section 5.3.3, of the WM PEIS show that costs are identified on a national level by DOE waste types. Cost savings shown in Sections 6.10, 7.10, 8.10, 9.10, and 10.10 in Volume I, for example, when truck is compared to rail, are based on a variety of assumptions identified in Appendix E in Volume IV. Therefore, transferring national savings to one site in order to make a construction decision is not appropriate.

Centralized Alternative 2 for low-level waste identifies a cost difference of $1.82 billion between truck and rail transport. The commentor suggests utilizing this savings to build a rail spur at NTS. The $1.82 billion dollar cost savings is based on all sites using rail transport from Centralized Alternative 2 for low-level waste. Thus, the savings cannot be transferred just to NTS.

Other factors also affect the rail transport cost estimates. First, Volume I, Section 5.3.3, describes that the cost analysis provides data that should fall plus or minus 30% of actual costs using the waste volumes quantified in the alternatives. Second, waste to be shipped by rail could require an additional intermodal transfer (truck/rail) for sites without rail access, which would contribute to the overall cost. Third, a review of the transportation facilities at 35 DOE sites indicated that 15 have direct rail access on the site, 12 have access within 10 miles, and 8 have access between 10 and 100 miles. Other factors could also make rail shipments less desirable than truck shipments. For example, to be cost-effective, rail shipments probably would require the shipment of a large amount of waste at one time. Moreover, rail operations are less flexible or responsive to individual site needs than truck operations.

Although Centralized Alternative 2 for low-level waste results in a cost savings using rail over truck, rail transport is more expensive than truck transport for high-level waste. Therefore, a rail spur at NTS cannot be justified on a national savings cost comparison.

Actual transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Transportation costs were calculated based on the number of shipments, the mass quantities requiring shipment, and the mileage between generator sites and treatment sites, generator sites and disposal sites, and treatment sites and disposal sites. Thus, the transportation costs also vary between the Regionalized and Centralized Alternatives based on the number of facilities to be used. Regionalized Alternative 3 for low-level mixed waste would require approximately 11,000 truck shipments.

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Centralized Alternative 2 for low-level waste would require approximately 257,000 truck shipments. This information is contained in Volume I, Tables 6.16-2 and 7.16-2, respectively.

The commentor's comparison of costs between Centralized Alternative 2 for low-level waste and Regionalized Alternative 3 for low-level mixed waste cannot be made using just summary table transportation cost information. Volume I, Section 5.3.3, describes that trip price and cost-per-mile prices were established by reviewing transportation industry tariffs and practices. In order to compare transportation costs, information contained in Appendix E (Volume IV) is required. For the comparison cited by the commentor, the Centralized Alternative 2 for low-level waste (Volume IV, Table E-15) will include approximately 257,270 shipments covering 505 million miles. Volume IV, Table E-28, identifies that Regionalized Alternative 3 will include approximately 10,990 shipments over 14.9 million miles. By dividing the total costs by mileage, the cost of transporting for Centralized Alternative 2 low-level waste is $4.95 per mile and the cost of transporting Regionalized Alternative 3 low-level mixed waste is $4.03 per mile. The number of shipments also factors into the cost. Thus, the comparison identified by the commentor is not valid. The cost evaluations should rather be based on information contained in Appendix E.

The cost methodology is summarized in Volume III, Section C.3.2.2.6, and is explained in greater detail in a technical report cited in Appendix C.

Comment (3397)
Volume I, Table 10.16-1: Mileage figures for Regionalized Alternative 2 seem wrong. Waste would be shipped the greatest distance for treatment at DOE sites, yet the total mileage figure is among the lowest.

Response
The mileage for Regionalized Alternative 2 is less than the mileage for Regionalized Alternative 1. It might appear at first glance in comparing the hazardous waste alternatives presented in Figures 10.3-1 through 10.3-4 in Volume I of the WM PEIS that waste would be shipped the greatest distance under Regionalized Alternative 2. Because only 10% of nonwastewater hazardous waste is shipped to commercial treatment centers under Regionalized Alternative 2, the number of shipments is 34,000 rather than 50,000 under Regionalized Alternative 1 (see Table 10.4-7); therefore, the number of miles shipped under this alternative is actually less than under Regionalized Alternative 1. Fewer shipments equate to fewer miles. The additional 16,000 shipments under Regionalized Alternative 1 accounts for the vast mileage difference between Regionalized Alternatives 1 and 2.

Comment (3402)
Commentors are concerned about the condition of the rail system in and out of PGDP. There are several crossings that do not have crossing lights. The rails are in questionable condition in some places. There have been accidents with radioactive materials on these rail lines.

Response
If transportation of waste is required, DOE will consult with State and local officials prior to shipment. Any unique transportation concerns for a site will be considered during these consultations. Any measures necessary to mitigate potential transportation risks will be implemented after these consultations. The comments regarding the condition of the rail system in and out of PGDP have been forwarded to the DOE PGDP site office.

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Comment (3613)
There are no transportation maps found within the entire WM PEIS in regards to transportation of any type of waste. These maps/routes must be included along with a full analysis of the potential impacts from exposure, unregulated releases, and accidents in order for the WM PEIS to approach meeting NEPA requirements. Analysis must also include alternative routes in the case of a major accident irreparably damaging a route, particularly in cases where only one direct route might be available."

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process described in Section 4.3.10, in Volume I of the WM PEIS. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

As discussed in Volume IV, Section E.4.2.1 of the WM PEIS, transportation risk analyses used representative routes that are consistent with current routing practices. However, these will not necessarily be the actual routes used. DOE has revised Volume I, Section 4.3.10, to explain how DOE would select the actual transportation routes for waste shipments. Since actual routes are not known, no maps were provided in the WM PEIS. However, a full analysis of the transportation impacts is provided in the WM PEIS in Appendix E. The analysis covers routine exposures to maximally exposed individuals and the collective population, accident risks to the collective populations along the shipping routes, and consequences to maximally exposed individuals and generic local population groups from the postulated most severe accident for each waste type

NEPA requires DOE to evaluate reasonable alternatives when preparing an EIS. NEPA does not require DOE to look at all possible transportation alternative routes. The transportation planning process, described in Section 4.3.10 in Volume I of the PEIS, will identify alternative routes where necessary. Since the transportation activities for the WM PEIS could occur over the 20-year period of analysis, new highways will be constructed and highways currently in use could close. Thus, DOE will continue to be proactive in the transportation planning process to ensure safe transportation throughout.

Comment (3615)
Historically, there have been problems with the TRUPACT Type B container for contact-handled transuranic waste. Are the problems still the same? If not, how exactly have the past problems been resolved? What tests have been conducted to assure that the changes are adequate, and to what degree is safety certain?

Response
The original TRUPACT-I project was abandoned due to potential licensing issues. The TRUPACT-II project has replaced the TRUPACT-I project. The TRUPACT-II canister would be used to transport contact-handled transuranic waste. These containers have been certified by NRC. To achieve NRC approval, these containers must endure fire, water, immersion, and free drops without leakage. Each container has the capacity to hold fourteen 55-gallon drums, two standard (0.9-meter x 1.4-meter x 1.8-meter [3.1-foot x 4.5-foot x 5.9-foot]) waste boxes, or a 10-drum overpack, which fits one standard waste box or ten 55-gallon drums. Each TRUPACT-II has a total payload capacity of 2,835 kilograms (6,250 pounds). Up to three TRUPACT-IIs could be transported on a specially designed trailer, and up to six containers could be carried on a specially-adapted rail car.

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Additionally, during the manufacture of some TRUPACT-IIs, an inspection identified that the welds were inadequate. The TRUPACT-IIs with inadequate welds were rejected for use.

Comment (3616)
Historically, there have been problems with the NUPAC 72B cask. Has the NRC approved this cask for remote-handled (RH) transuranic waste?"

Response
The cask, which was referred to as the NUPAC-72B in the Draft WM PEIS, has been renamed to RH-72B. The original NUPAC-72B cask had not yet received NRC certification. Therefore any "problems" with the NUPAC-72B cask would have occurred while the cask was being developed. DOE currently is awaiting NRC certification of the RH-72B cask. The RH-72B cask must comply with all applicable safety and operational requirements in order to receive certification.

Comment (3667)
What happened to the plan for "parking areas" along the WIPP routes for offsite transportation to reduce the public's exposure?

Response
The WIPP transportation system still incorporates designated parking areas along all routes for use in bad weather. All DOE transportation carriers would be made aware of the WIPP designated parking areas for use in bad weather.

Comment (3672)
How will DOE dispose the absorbent overpacking when hazardous chemicals spill or seep into the packing during routine transportation?

Response
The absorbent overpacking is only needed for shipments of liquid waste, of which there would be very few between sites. If hazardous chemicals were to spill or seep into this packing during routine transportation, the packing itself would then be considered a hazardous material and would be handled according to the type of material it absorbed, and according to applicable regulations.

Comment (3676)
The WM PEIS scope does not include a number of public concerns that have been submitted to DOE in comments to various transportation-related PEIS, SEIS, and DEIS documents--such as safety concerns for the testing of the TRUPACT container, including the fact that the burn test is not done until last. While we understand that NRC regulations state the order of the testing series and burning is last, a worst-case scenario accident in the southwestern portion of the country would be an accident with a gas or propane transport truck where temperatures could reach 1400°F. Yet the burn test only rises to 1275°F.

Response
The burn test is done last because any transportation-related fire would occur after impact. The burn test specified by the NRC in 10 CFR 71.73 requires "an average flame temperature of at least 800°C (1475°F)," which is higher than 1400°F.

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Comment (3696)
The WM PEIS lacks any discussion of the historical transport modes that have been employed by DOE's various proposed sites. Historical modes are significant, since local and regional emergency response officials tend to be trained and familiar with, and have often already committed substantial resources to, managing shipments within such historical modes and routes. Thus, it might not make sense for DOE to suggest that a transport mode be shifted at a particular location based on small variations in modeled accident consequence probabilities if local and regional officials are much more prepared for and skilled in managing the existing transport mode.

Response
Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. Historical transport modes will be a major factor in determining a site's transportation mode. In the transportation planning process, DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Historical transportation emergency response capabilities of a region affect routing and safe-haven decisions. DOE will consult with local and regional officials prior to large shipping activities. Section 4.3.10 in Volume I of the WM PEIS describes DOE's transportation activities including the transportation planning process.

Comment (3872)
The hazardous waste is dangerous enough. What safety precautions will DOE take during transport of waste in and out of the facilities?

Response
U.S. Department of Transportation and EPA regulations have been established to ensure that shipping hazardous waste is accomplished safely with minimum risk to transportation workers and the public. These regulations, which DOE has adopted as part of DOE Order 1450.1C, cover the packaging, handling, and transporting of hazardous material.

Regulations that govern the transportation of hazardous materials are designed to protect the public from the potential dispersal of hazardous materials. The specification of standards for packaging hazardous materials is the primary regulatory approach for ensuring the public's safety.

As stated in Section E.13 in Volume IV of the WM PEIS, the packaging requirements for a specific hazardous material are determined by the level of hazard the material would present as a result of an accidental release. In the *Hazardous Materials Table* (49 CFR 172.01), which lists more than 4,000 chemicals in alphabetical order by proper shipping name, column eight supplies a reference number to a part of 49 CFR 173. The part specified describes shipping requirements for a particular chemical.

Container acceptability is determined by performance-based tests (e.g., drop strength, leak resistance, hydrostatic pressure, stacking, and vibration) (49 CFR 173). A wide range of performance levels is required because of the broad spectrum of hazard levels presented by different hazardous materials. Hazardous wastes in the DOE complex are shipped mainly by 55-gallon drum or smaller containers,

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and single-unit trucks will likely be the predominant truck type used. Hazardous waste is shipped in accordance with U.S. Department of Transportation regulations.

Part II of Appendix E of the WM PEIS provides more detail on the hazardous waste transportation risk assessment.

Comment (3948)
DOE has arbitrarily omitted barge and air transportation of nuclear materials from its WM PEIS.

Response
DOE did not arbitrarily omit barge and air transportation of nuclear materials. Section E.2.6 in Volume IV states that although radioactive waste can be transported by various modes, all shipments have been assumed to take place either by truck or rail. Shipments by barge, though feasible for some sites, have not been explicitly considered because this mode of transportation is somewhat limited and is not a reasonable programmatic alternative for the PEIS assessment. Similarly, shipment by aircraft was not considered a reasonable alternative due to cost, safety, and logistics.

Comment (3981)
Both the Portsmouth Plant and PGDP have major rail transport infrastructures already in place, obviously between the two facilities. Risk to the public along this rail route, residents within the region of the sites, and workers onsite from accidents and long-term low-dose exposure should be calculated by DOE as a transportation risk for both of these sites. By eliminating accidents onsite during loading and unloading activities, the agency has eliminated a major source of risk from transportation with low probability, but high impact. Historically, loading and unloading of hot canisters of highly enriched uranium has been a major source of accidents with severe consequences at the Portsmouth Plant.

Response
The transportation of non-waste materials is outside the scope of the WM PEIS. "Hot canisters" of highly enriched uranium are not considered waste and, therefore, were not analyzed in the WM PEIS. The Portsmouth Plant and PGDP have procedures in place to safely load and unload fresh highly enriched uranium canisters.

Loading and unloading of waste onsite was analyzed. DOE has not eliminated accidents onsite during loading and unloading activities. Loading and unloading accidents are evaluated in the WM PEIS as facility accidents. Facility accidents are described in detail in Volume IV, Appendix F. Section F.2.4.1 in Volume IV, Selection and Categorization of Accident Initiators, describes that handling accidents were considered a subset of operational events initiated from within the facility that would initiate an accident. These accident sequences were then classified by frequency categories, as shown in Table F.2-2 in Volume IV.

Transportation of waste between PGDP and the Portsmouth Plant was analyzed for Regionalized Alternatives for low-level mixed waste and low-level waste. The risk associated with the transport of low-level mixed waste and low-level waste between PGDP and the Portsmouth Plant was small. Volume IV, Appendix E, of the WM PEIS contains a detailed transportation risk assessment.

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Comment (4148)
Radiation exposure to the public from high-level nuclear waste shipment trucks and to dock workers unloading the waste at public ports should not be self-regulated by DOE. DOE should be required to keep public radiation exposure lower than the standards set by EPA and NRC.

Response
DOE will manage its waste handling and transportation activities in compliance with all applicable laws and regulations. Moreover, it is DOE's policy to maintain exposures at a level that is as low as reasonably achievable.

Under the Atomic Energy Act, DOE has responsibility for developing its own standards for health and environmental protection for radiological materials. These standards are established in DOE Orders and regulations (e.g., 5400.5 and 10 CFR Part 835) that address the maximum allowable radiation doses for members of the general public and for workers, respectively. These levels are generally at least as low as those established by EPA and NRC for similar exposure situations. For hazardous chemical exposures, DOE complies with exposure levels established by EPA and the Occupational Safety and Health Administration.

The U.S. Department of Transportation (DOT) and NRC have primary regulatory responsibility for the transportation of radioactive waste. In addition, DOE has formalized agreements with the NRC and DOT to delineate the responsibilities of each agency. All transportation-related activities must be in accordance with the applicable regulations of these agencies, as specified in 49 CFR 173 and 10 CFR 71. Section 1.4.4 in Volume I of the WM PEIS describes the DOT and NRC transportation regulations.

Comment (4324)
A commentor asked DOE to contact the national Nuclear Waste Transportation Task Force of Citizens' Alert of Reno, Nevada, (702) 827-4200, to see what they have to say about trucking accidents generally and how devastating they are to the general public.

Response
DOE spoke to a representative of Citizens Alert in October 1996 regarding transportation issues and the overall WM PEIS. The representative stated that Citizens Alert agreed with the State of Nevada's comments, which can be located in the Response to Public Comments Index in Volume V of the WM PEIS.

Transportation is an integral component of the analysis of alternatives considered for the WM PEIS. The magnitude of the transportation-related activities increase with each alternative, ranging from minimal transportation for the decentralized approaches, to more significant levels under the regionalized and some centralized approaches. Both radiological and nonradiological causes contribute to the overall transportation risk. The PEIS includes a detailed assessment of these risks for a complete range of credible transportation accidents for both rail and truck transportation, including low probability/high consequence and high probability/low consequence accidents. The results of the transportation analyses conducted in Appendix E show that impacts relating to the transport of waste analyzed in the WM PEIS, which include fatalities from radiation exposure, diesel exhaust emissions, and physical trauma from accidents, are low when compared to nationwide vehicle transportation yearly impacts. Comparatively, from 1971 to 1993 over one million persons were killed by physical

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trauma in vehicular accidents in the U.S. The WM PEIS allows a site to choose either the truck or rail transport mode.

Actual transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with States, regional entities, and carriers during large shipping activities to ensure that safe routing alternatives and safe havens are utilized.

Comment (4453)
DOE should include in its evaluation of transportation costs the costs and risks of loading and unloading waste and associated materials into suitable containers and loading and unloading the containers from vehicles; the cost of planning; and the costs and risks to persons involved in escort services required during shipping. The impacts of alternatives to such escort services should also be evaluated.

Response
The costs of loading and unloading waste are facility operation costs that DOE has included in the support facility costs. No escort services are included for the shipments analyzed in the WM PEIS because the waste materials do not currently require escorts. In addition, information from other programs shows that for the programs that require escort services (i.e., spent nuclear fuel), these services constitute only 20% of transportation costs. Because transportation costs would not be large enough to affect WM PEIS decisions, there is no compelling reason to include the costs of escort vehicles.

The risks of loading and unloading waste are facility operations risks that DOE has included in the description of facility risks. Such risks could be estimated from the scenarios evaluated for maximally exposed individuals. The risk for escort services would be much less than the risks for operators of the transportation vehicles.

Comment (4475)
The reference in Section 9.1 of the Draft WM PEIS Summary document refers to 295,000 truck shipments or more than 106,000 rail shipments of waste that occur at NTS. This seems like an unrealistic ratio, since a single rail shipment can have many cars of waste, while trucks typically have only one trailer (or three at most).

Response
The ratio of 295,000 truck shipments to 106,000 rail shipments is reasonable based on the discussion in Section E.3.2.1 in Volume IV. The number reported for rail transportation is the number of railcars, not the number of trains. The shipment capacity ratio of a single railcar and a single tractor-truck trailer is roughly 3 to 1. Transportation impacts were calculated on a per-railcar basis. DOE considered only regular freight train service with one waste railcar per train, not special or dedicated train service, so that rail impacts would not be underestimated.

6.7 Waste Minimization

Comment (25)
Many commentors urged DOE to stop producing nuclear waste; to consider recycling nuclear waste as part of treatment, and, in general, to focus on reducing waste volumes and waste generation; and to consider waste management alternatives that include the positive impacts of an aggressive pollution prevention program. Some suggested that DOE curtail its proposed Stockpile Stewardship and Management Program and other nuclear weapons research programs to prevent generation of wastes in the future. Some asked why so much more waste will be generated, when DOE facilities are required to set goals under the Hazardous Waste Minimization Plan to reduce the most persistent, bioaccumulative, and toxic constituents by 25% by 2000 and 50% by 2005. Others asked if the DOE site nearest them has a waste minimization or pollution prevention program, and expressed a desire to be kept informed of the status and risks of such programs.

Response
The largest waste generation associated with the production of nuclear weapons resulted from the production of weapons-grade plutonium and highly enriched uranium used in the weapons. Both of these activities used large quantities of hazardous substances and generated a large volume of wastewater. With the end of the Cold War and subsequent reduction of nuclear weapons stockpiles, DOE foresees diminished short-term needs to produce weapons-grade plutonium and highly enriched uranium.

DOE anticipates a continued reduction in the size of the nuclear weapons stockpile and plans to adapt its aging facilities to this new mission. Accordingly, DOE has proposed to consolidate the facilities associated with maintaining nuclear weapons. The alternatives for achieving a downsized nuclear weapons complex are analyzed in the Stockpile Stewardship and Management PEIS. However, nuclear weapons remain the cornerstone of the nation's security policy. Thus, DOE's responsibilities for ensuring the safety and reliability of the nuclear weapons stockpile will continue for the foreseeable future. In other words, DOE does not consider a shutdown of its nuclear weapons programs to be a reasonable alternative at this time. Based on the best available information at the time of the analysis on future waste generation, DOE assumed in the WM PEIS that current waste generation rates would continue for the next 20 years. Volume I, Section 1.8.1, describes DOE programs and actions that generates the waste analyzed in the WM PEIS. Curtailing the weapons program will not prevent production of waste by DOE in the future because waste is produced by other programs, such as energy research.

DOE is strongly committed to pollution prevention and has a very aggressive pollution prevention program in place for several years. DOE strongly endorses pollution prevention, including recycling, where practical. Materials that cannot be recycled are considered waste and would be treated and disposed of, as appropriate.

Appendix G in Volume IV of the PEIS describes the DOE Pollution Prevention Program, estimates source reductions for specific types of waste, and examines the effects on the Waste Management Program of a 50% reduction in future waste generation. Section 1.8.2 in Volume I of the PEIS has been revised to contain a discussion of DOE's Pollution Prevention Program Plan. This program applies to all DOE activities and all types of waste that these activities generate. Source reduction by generators in Defense Programs, Energy Research, and other DOE programs will reduce the amount and radioactivity level of waste coming into the waste management complex, reduce the cost of constructing waste management facilities, and reduce health risks to the public and workers. All DOE

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sites have site-specific waste minimization and pollution prevention programs and plans that have resulted in many source-reduction successes, and the sites make these plans available to the public.

DOE is committed to a policy of open dialogue with a broad range of stakeholders who have a wide variety of interests and concerns. In the process of making decisions, DOE views NEPA as a major vehicle for public information and dialogue on the analysis of environmental impacts.

Comment (904)
DOE should adopt an aggressive LLMW minimization program by examining the efforts of academic, medical, and industrial institutions, and by accessing and incorporating databases and resources from the EPA (e.g., Office of Pollution Prevention and Toxics, Office of Research and Development, Office of Environmental Engineering and Technology Development) provided for generators of hazardous wastes. DOE should take into account waste minimization techniques including separation of waste streams, store-to-decay, etc., in its LLW management strategies in light of the positive experiences in academia, industry, and medical institutions, and in light of the rapid escalation of LLW disposal costs.

Response
DOE has adopted an aggressive pollution prevention program, as required by Executive Order 12856. DOE's pollution prevention program applies to all Department activities and all types of waste that these activities generate. In general, waste reduction is achieved through either source reduction or recycling.

Appendix G in Volume IV of the WM PEIS describes the DOE pollution prevention program in some detail. Among other things, the program has a goal of reducing the generation of all waste types by 50%. DOE has waste minimization and pollution prevention programs and plans in place at all of its sites, and uses the information and experiences of others, including EPA, to achieve waste reduction goals.

Comment (1608)
The PEIS should use more conservative assumptions for the volume reduction treatment of LLW because the 50% reduction assumption appears to be too high.

Response
Volume reduction waste treatment technologies for low-level waste are capable of achieving far greater than 50% reductions in volume. Thus, a 50% volume reduction from treatment would be a conservative assumption. However, DOE assumes that the comment is directed, not toward volume reduction waste treatment, but toward the assumption in Appendix G that there is a 50% decrease in annual generation of waste from pollution prevention efforts, i.e. source reduction.

On August 3, 1993, President Clinton issued Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*. To help ensure that Federal agencies manage their facilities to meet the objectives of the Pollution Prevention Act, a Federal statute, to the maximum extent possible, this Executive Order requires Federal agencies to develop voluntary goals to reduce pollutants by 50%. DOE is committed to complying with this Executive Order; thus, the WM PEIS assumes a 50% reduction in annual generation of waste. DOE understands that reductions in annual generation will vary from waste stream to waste stream. However, an average reduction of 50% is not

necessarily optimistic. For example, Appendix G cites a reduction in the use of naphtha-based solvents of 90% at the Pantex Plant.

Comment (2045)
BNL should be commended for and should continue its waste minimization efforts.

Response
Thank you for your comment.

Comment (2390)
Review and discuss resource and energy recovery plans in the treatment options for all non-radioactive and radioactive chemicals and materials.

Response
DOE's policy is to first reduce generation of potential waste, then recycle (i.e., resource recovery) or reuse the remaining material, where possible. Material that remains after recycling is waste, and is transferred to waste management facilities. The WM PEIS is concerned with waste management--the treatment, storage, and disposal of material for which there is no further use. As recycling allows material to be put to a beneficial use rather than becoming waste, it is not considered a waste management technique, per se, and is not evaluated in the WM PEIS.

However, DOE is strongly committed to pollution prevention, which is achieved through (1) source reduction by reducing the quantity of waste that is transferred to DOE facilities and (2) recycling. Appendix G in Volume IV describes DOE's pollution prevention plans and initiatives. Appendix G also contains estimates of reductions in waste volumes that would go to treatment, storage, and disposal facilities, the cost of constructing and operating these facilities, and the human health risks from a 50% reduction in the annual generation of waste.

Comment (2568)
While it is encouraging to see DOE devote an entire appendix to waste minimization, it is time to go beyond talk and begin serious implementation of this very simple and extremely powerful idea complex-wide. This concept has the potential to save enormous sums of money by ensuring waste is never generated in the first place. Waste not created is waste that doesn't need to be managed and so cannot be mismanaged with all the attendant cost and publicity. DOE needs to tell the public what is being done to minimize generation of radioactive and chemical waste and should take steps to oppose lobbies and to be socially and environmentally responsible.

Additionally, lessons learned and technology developed in implementing waste minimization can be transferred to private industry, enhancing their competitiveness and helping fulfill DOE's technology transfer mission. In addition to the action described in Appendix G, DOE should also (1) develop accounting systems to determine the cost savings associated with waste minimization and, conversely, the costs of continued waste generation, (2) track and publicize the progress or lack of it in achieving challenging waste minimization goals, and (3) develop charge-back systems so that generators "pay" for the storage, treatment, and disposal of the wastes they generate.

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Response
The purpose of Appendix G of the WM PEIS is to discuss how DOE's waste minimization and pollution prevention programs and practices could affect the volumes of waste that waste management facilities receive, and consequently, the need for the facilities. The appendix contains estimates of reductions in waste volumes, risks associated with waste management activities, and waste management costs resulting from pollution prevention. Due to the programmatic nature of the WM PEIS, the approach used reflects one method of estimating waste minimization impacts in the absence of site-specific goals for the reduction of wastes and pollution. The WM PEIS assumes a 50% reduction in the future generation of waste to be handled by the waste management complex. DOE appreciates the suggestion to develop accounting systems to determine the cost savings associated with pollution prevention and the cost of continued waste generation. Costs in this context, however, involve uncertainties. In some instances, such as revamping operations to meet the waste reduction goal, the costs could be substantial and the net dollar gain through pollution prevention would be lower than projected. These latter costs cannot yet be calculated and are considered beyond the scope of the WM PEIS.

Tracking progress in pollution prevention is key to a successful program. The DOE Office of Waste Management is responsible for coordinating and consolidating DOE's Waste Reduction Policy, in accordance with Executive Order 12856. Accordingly, DOE has published the *Annual Report on Waste Generation and Waste Minimization and Pollution Prevention Cross-Cut Plan*. Issues concerning charge-back systems and related incentives for reducing wastes are beyond the scope of WM PEIS, which analyzes programmatic siting options for waste management activities.

Comment (3249)
DOE must do everything feasible to reduce the production of radioactive and hazardous waste in its operations, including substituting less hazardous materials, reclaiming all heavy metals for reuse, using more labor-intensive practices, etc.

Response
On August 3, 1993, President Clinton issued Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*. To help ensure that Federal agencies manage their facilities so that the objectives of the Pollution Prevention Act, a Federal statute, are met to the maximum extent possible, this Executive Order requires Federal agencies to develop voluntary goals to reduce pollutants by 50%. DOE is firmly committed to complying with this Executive Order and has developed the Pollution Prevention Program Plan, which serves as the principal guidance on the program. In addition, DOE sites have developed site-specific pollution prevention plans. This topic is discussed in Section 1.8 of the Summary document and in Volume IV, Appendix G.

Comment (3291)
According to Appendix G of the Draft WM PEIS, in the absence of approved installation-specific waste minimization plans, 'a simple assumption is made that source reduction will result in a 50% reduction in the annual generation of each waste stream for each year of the time spans considered in the WM PEIS." While the statement notes that this is an arbitrary assumption, it also seems like an impossibly optimistic assumption, perhaps resulting in an underestimation of annual waste generation.

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Response
On August 3, 1993, President Clinton issued Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*. To help ensure that Federal agencies manage their facilities so that the objective of the Pollution Prevention Act, a Federal statute, are met to the maximum extent possible, this Executive Order requires Federal agencies to develop voluntary goals to reduce pollutants by 50%. DOE is committed to complying with this Executive Order. The 50% reduction in the annual generation of waste is the goal of the DOE Pollution Prevention Program Plan. It is understood that reduction in annual generation will vary from waste stream to waste stream, and recent DOE experience has shown that a greater-than-50% source reduction is achievable for some waste streams. Therefore, a 50% source reduction assumption for the pollution prevention analysis presented in Appendix G of the WM PEIS is reasonable. For example, Section G.2 in Volume IV cites a reduction in the use of naphtha-based solvents of 90% at the Pantex Plant.

Comment (4354)
If it costs more to treat the waste before burial, it's not worth the extra cost.

Response
A number of factors will contribute to the waste management decisions. Among these are environmental and social impacts, human health risk, and other considerations such as environmental justice. These factors must be weighed in addition to cost, and in many cases, factors such as human health risk must take precedence over cost in making a final determination.

Comment (4569)
Recycling radioactive waste by-products should be a priority for radioactive waste management.

Response
DOE's waste minimization/pollution prevention program, discussed in Appendix G, Section G.1. and briefly in Section 1.8.2, calls first for reducing the waste at its source, then for recycling of material not eliminated through this source reduction. Material that is left after source reduction and recycling is waste. The waste management process begins after source reduction and recycling, where possible, have occurred; therefore, these activities are not discussed as waste management practices in the WM PEIS.

Comment (4572)
National policy should focus on reducing or eliminating the production of radioactive and hazardous wastes.

Response
DOE has established a Pollution Prevention Program pursuant to Executive Order 12856. Appendix G (Volume IV) of the WM PEIS contains a description of this program. It is DOE's policy to prevent or reduce the production of waste to the extent possible. Materials that remain after this waste minimization process are considered waste; certain of these wastes are the subject of the WM PEIS. Pollution prevention is considered as a mitigation measure in Chapter 12 in Volume I of the WM PEIS.

6.8 Privatization

Comment (45)
An alternative should be considered under which DOE would provide seed money in the private sector to help startup companies build LLMW treatment facilities.

Response
Section 1.7.4, which DOE added to Volume I of the WM PEIS, describes the use of commercial or privatized facilities. DOE expects treatment and disposal capacity at commercial facilities to increase in response to demand. DOE's Office of Waste Management has a program to investigate the potential for privatization to result in economic efficiencies. Specific privatization initiatives will be considered at the site level.

Comment (189)
Several commentors oppose the use of private contractors or commercial facilities for conducting waste management activities, particularly at LLNL.

Response
Section 1.7.4, which DOE added to Volume I of the WM PEIS, describes the use of commercial or privatized facilities.

Only DOE sites were analyzed in the WM PEIS as potential locations for waste management facilities. However, the Final WM PEIS does consider, at a conceptual level, the use of commercial waste management facilities. A new section (1.7.4) was added to Volume I to discuss use of commercial facilities. As stated in Section 1.7.4, the impacts associated with DOE waste management facilities are expected to be representative of the impacts associated with private facilities on DOE sites. The impacts at offsite commercial facilities are generally not analyzed. DOE assumes that offsite facilities meet all applicable regulations and are permitted by the appropriate agencies. The regulator is likely to be a State agency or the NRC. The regulator will ensure that commercial facilities comply with all laws and regulations, including those related to safety.

DOE believes that use of commercial contractors for waste management is reasonable, and should be evaluated at a site-specific level. Commercial waste management facilities must comply with all applicable laws and regulations. As discussed in Section 1.7.4 in Volume I of the WM PEIS, impacts of privatized facilities on DOE sites would be the same as those of DOE facilities.

Comment (191)
Several commentors asked DOE to analyze alternatives for privatization and commercialization of waste management for waste types other than hazardous waste. One commentor stated that DOE should identify private-market capacities, comparative costs, and availability; and evaluate the impacts of privatization on environmental health and safety.

Another commentor pointed out that disposal and treatment of low level mixed and low level wastes at privately owned waste management sites are already underway and considered to be more viable than onsite treatment or disposal for many waste streams. In this context, the many alternatives that include significant treatment and disposal at ORR seem unrealistic, especially since the offsite waste streams slated for treatment and disposal at ORR are based on geographic proximity of the generation site to the disposal site, rather than on waste stream characteristics. Another commentor stated that future success using the commercial sector for waste management is anticipated and, therefore, the amounts of waste

that DOE might have to manage from the Portsmouth Plant are likely to be significantly lower than the estimates in Table 4-2.

Response
Decisions on privatization are site-specific in nature, and therefore privatization would be addressed in sitewide or project-specific NEPA documents. However, although only DOE sites were analyzed as potential locations for waste management functions in the WM PEIS, the study did consider the use of commercial and privatized waste management facilities. DOE has revised Section 1.5 in Volume I and has added Section 1.7.4 to discuss the issue of waste management privatization at DOE sites. DOE assumed that these facilities meet all applicable regulations and are permitted by the appropriate agencies. The impacts of private facilities on DOE sites are expected to be similar to impacts associated with DOE-owned waste management facilities, and DOE would maintain the flexibility to use private facilities.

There are many offsite waste management facilities that are operated by private companies. It would be difficult to determine which facilities DOE would use, how much waste they would receive, and what types of waste they would receive. Therefore, the impacts at offsite commercial facilities are generally not analyzed. Again, these impacts would be considered in sitewide or project-specific NEPA documents.

Comment (918)
A commentor supports the DOE preference to not develop additional hazardous waste capacity and continue the use of commercial hazardous waste treatment.

Response
Thank you for your comment.

Comment (2171)
DOE received several comments regarding the authority and responsibility for the Portsmouth and Paducah Plants. One commentor asked DOE to explain who is in charge of the Portsmouth Plant; another commentor wanted DOE to clarify the regulatory relationship between DOE, NRC, and the United States Enrichment Corporation (USEC), and the jurisdiction over the radionuclides. The commentor stated that the permit issued to DOE would be coming up for a hearing in Kentucky and that under the permit, DOE would be solely responsible for waste generated by USEC and managed by DOE. The public would need to understand why USEC-generated wastes are not USEC's responsibility. Another commentor stated that if the low-level waste is generated by ongoing enrichment operations at PGDP, it is USEC's responsibility. Another commentor inquired about a statement by a DOE representative that DOE has been directed by Congress to take USEC wastes. The commentor asked if this was part of a Congressional appropriation and, if so, when was it done.

Response
From startup until July 1 1993, DOE and its predecessor agencies operated the Portsmouth Gaseous Diffusion Plant and the Paducah Gaseous Diffusion Plant. On July 1, 1993, USEC assumed responsibility for operating the Portsmouth Plant. USEC was established as an independent government corporation by the Energy Policy Act of 1992 (P.L. 102-486) as a transitional step toward the goal of fully privatizing uranium enrichment operations. Enrichment activities at the Portsmouth and Paducah Plants, and the wastes generated from these activities, have been managed by USEC since

6.8 Privatization

July 1, 1993. Environmental restoration activities are managed by DOE. Regarding LLW management, as of July 1, 1993, USEC is responsible for LLW that is generated by USEC's ongoing enrichment operations. However, the USEC Privatization Act (P.L. 104-134) provides that, upon request, DOE would accept this waste for disposal and would be reimbursed for its costs. LLW generated prior to July 1, 1993, remains DOE's responsibility and is included in the waste volume estimates for Portsmouth used in the PEIS. DOE is also responsible for the disposal of depleted uranium generated by USEC prior to privatization, as provided in the USEC Privatization Act. Until USEC receives its certificate of compliance from NRC, DOE is responsible for safety oversight with regard to radioactive materials at the Portsmouth and Paducah Plants, and with regard to USEC's operations.

USEC plans to obtain a certificate of compliance from NRC, which would make it subject to NRC nuclear safety requirements. Should USEC become privatized, pursuant to the recently enacted USEC Privatization Act, it still would be subject to NRC safety requirements.

Comment (2195)
Does the WM PEIS address the issue of safety and compliance at commercial waste treatment sites where DOE wastes might be sent?

Response
Only DOE sites were analyzed in the WM PEIS as potential locations for waste management facilities. However, the Final WM PEIS does consider, at a conceptual level, the use of commercial waste management facilities. A new section (1.7.4) was added to Volume I to discuss use of commercial facilities. As stated in Section 1.7.4, the impacts associated with DOE waste management facilities are expected to be representative of the impacts associated with private facilities on DOE sites. The impacts at offsite commercial facilities are generally not analyzed. DOE assumes that offsite facilities will meet all applicable regulations and will be permitted by the appropriate agencies prior to receiving DOE waste. The regulator is likely to be a State agency or the NRC. The regulator will ensure that commercial facilities comply with all laws and regulations, including those related to safety. DOE will not send waste to a facility for treatment that does not have the proper permits.

Comment (3063)
Another way to approach design and output would be to use "building fixed facilities" and "privatization" as paths forward in parallel. Then, compare the two approaches and select the WM activities most suitable to each option.

Response
DOE's policy is to use existing DOE facilities, where possible, to treat waste management wastes. New facilities would be constructed only when the capacities of the existing facilities were exceeded. There are many offsite waste management facilities that are operated by private companies. It would be difficult to determine which facilities DOE would use, how much waste they would receive, and what types of waste they would receive.

Section 1.7.4 has been added to Volume I of the WM PEIS to discuss the issue of waste management privatization at DOE sites. As stated in Section 1.7.4, the impacts associated with DOE waste management facilities are expected to be representative of the impacts of private facilities on DOE sites.

6.8 Privatization

Although DOE identified preferred alternatives in the PEIS, decisions on privatization are site-specific, in nature, and would be addressed in site-specific documents. Under either the Regionalized, Centralized, or Decentralized Alternative categories, DOE would maintain the flexibility to use private facilities.

Comment (3955)
DOE is not fulfilling its responsibility to the public and workers at PGDP and the Portsmouth Plant by allowing privatization with little or no public involvement in the process and no EIS preparation other than considering both sites as major waste management sites. It seems that DOE is responsible for future land-use decisions for waste treatment and disposal, but has no responsibility in current site production operations. The interests of the workers and the public are not being adequately protected by this policy.

Response
As described in Section 2.5 of the WM PEIS Affected Environment Technical Report, on July 1, 1993, the United States Enrichment Corporation (USEC) assumed responsibility for operating PGDP and the Portsmouth Plant, pursuant to legislation passed by Congress (the USEC Privatization Act), not by a policy decision by DOE. USEC became responsible for wastes generated from enrichment activities at these facilities after July 1, 1993. Environmental restoration activities are managed by DOE. DOE is also responsible for managing waste management wastes generated prior to July 1, 1993, the date on which USEC assumed responsibility for operating PGDP and the Portsmouth Plant. DOE is also responsible for safety oversight with regard to radioactive materials at those sites and with regard to USEC's operations.

Given this situation, PGDP and Portsmouth continue to be among the 54 sites for which DOE has some waste management responsibility and that are within the scope of the WM PEIS. See Volume I, Section 1.6.1, for a description of how DOE identified the major sites for evaluation.

While the WM PEIS addresses programmatic waste management (i.e., storage, treatment, disposal, or a combination thereof), issues pertaining to decisions on the privatization of USEC, and the operation of USEC, are not within the scope of the WM PEIS. However, these issues are the subject of other NEPA reviews.

6.8 Privatization

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Comment (2270)
DOE should make a firm commitment or give programmatic direction for subsidiary EISs to commit to mitigate ecological impacts and to use native seed and plant stock for restoration whenever siting or building waste management facilities. In particular, the high shrub habitat at the Hanford Site should not be used because it is a critical habitat.

Response
As discussed in Section 5.4.4 in Volume I, the WM PEIS evaluated the potential for waste management actions to eliminate or disturb portions of existing nonsensitive terrestrial habitats as a result of the site clearing and excavation activities required to build waste treatment, storage, and disposal facilities. However, the WM PEIS does not identify or analyze specific locations for waste management facilities onsite. Therefore, site-specific impacts such as those on terrestrial habitats will be addressed in sitewide or project-level NEPA reviews.

The WM PEIS analysis did assume that the severity of these impacts would generally be related to the amount of land disturbed in building waste management facilities compared to the overall extent of the range of the plant and animal species that constitute these habitats. The WM PEIS discusses the degree to which sites with sensitive habitats could be affected by noise or vibration disturbances, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby waste management construction activities by estimating the percentage of available land required at a site for facility construction under any alternative. Available acreage was estimated from site development plans either by using land designated for waste management operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. See Volume I, Sections 6.7.2, 7.7.2, 8.7.2, 9.7.2, and 10.7.2.

DOE would have a great degree of flexibility in locating facilities on sites and can employ a range of mitigative measures so that site clearing to implement an alternative generally would not affect adjacent sensitive habitats. DOE has modified Section 12.2 in Volume I to include a recommendation that ecological mitigation by the use of native species for restoration be considered. However, selection of appropriate site-specific mitigation actions will be based on site-specific studies and plans.

The high shrub (shrub-steppe) habitat at Hanford is not listed by the U.S. Fish and Wildlife Service as critical habitat; that is, habitat critical to the survival of a Federally listed endangered or threatened species. However, the habitat is considered priority habitat by the State of Washington, which has designated large and small blocks of shrub-steppe as priority habitat, because it possesses unique or significant value to many species. The State makes this classification determination based on the quality of the following attributes: comparatively high fish and wildlife density, comparatively high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, important fish and wildlife movement corridors, limited availability, high vulnerability to habitat alteration, and unique or dependent species.

Almost the entire Hanford Site is classified as shrub-steppe and is, therefore, priority habitat. However, much of the site's habitat, including the habitat of the Central Plateau, the site of nearly all of Hanford's waste management operations, is previously disturbed. The site is criss-crossed with dirt roads; old concrete water tanks are scattered throughout the site; an abandoned gravel pit is centrally located on the site; and an old laydown yard (used during construction of the REDOX plant) is on the western end of the site.

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Unlike the U.S. Fish and Wildlife Service's designations of critical habitat, Washington State's priority habitat designations have no associated legal requirements for habitat protection. However, DOE Order 430.1 requires that DOE consider ecosystem management and preservation values during all phases of Hanford Site operations. DOE intends to limit disturbances to priority habitats through the designation of future Hanford Site land uses. The Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan (DOE/EIS-0222D), which is currently undergoing public review and comment, takes into account the preservation of valuable natural resources when developing broad classes of future land uses. When the ROD for this EIS is issued and land uses are designated, a Hanford Biological Resources Management Plan will be finalized (it is currently in draft form) to provide direction regarding the protection and enhancement of the natural environment.

Comment (2423)
Volume I, Section 1.7.3, states that, in most cases, impacts found significant can be mitigated or eliminated. Chapter 12, Mitigation Measures, covers only seven pages. For a document that covers waste management across the entire DOE complex for the next 20 years, this is a very large assumption and these seven pages are woefully inadequate. A greatly expanded discussion of mitigation measures is needed.

Response
Chapter 12 in Volume I provides general information on measures that are available to mitigate the impacts of alternatives considered in the WM PEIS. Sitewide or project-level NEPA reviews would consider mitigation measures in greater detail. The extent to which risks and impacts can be reduced or eliminated would depend on the facility designs and conditions at individual DOE sites. Chapter 12 in the Final PEIS was revised to incorporate additional mitigation measures.

Comment (3094)
Table 12-1 should include "compensatory" mitigation in case DOE cannot avoid or minimize impacts.

Response
DOE added additional compensatory mitigation measures to Chapter 12 in Volume I of the WM PEIS.

Comment (3203)
Much of the 14,496 acres identified in Section 4.3.8 for waste management at the Hanford Site is located in areas of essential habitat. Reservation of space in the 200 West area for a potential national low-level and mixed-waste repository precluded consideration of that land for siting of the Environmental Restoration and Disposal Facility (ERDF). As a result, that facility was sited in pristine habitat. The ERDF Record of Decision (ROD) commits only to revegetation, not to remediation of the damage or to the use of native plant and seed stock. Many species that are listed or under consideration for listing as rare, threatened, or endangered rely on this precious habitat.

Response
The land area considered for waste management facility construction at the Hanford Site has been revised to include only the 6,000 acre Central Plateau area designated by the site for waste management activities. If new waste management facilities are proposed for Hanford in the WM PEIS Records of Decision, sitewide or project-level NEPA reviews (incorporating site-specific environmental data) will help determine whether a facility can be constructed and operated at a specific location on the site. In

addition, site-specific mitigation of potential adverse environmental impacts would be addressed in such reviews.

The ERDF is on the 6,000 acre Central Plateau area. The CERCLA ROD for ERDF states that mitigation measures to reduce ecological impacts have been incorporated to satisfy the Remedial Action Objectives identified in Section 7(4)(l) through 7(4)(v). In addition, to comply with stipulations in the CERCLA ROD, DOE developed a Mitigation Action Plan in coordination with the Natural Resource Trustees for additional mitigation measures.

A large portion of the site *is* high quality shrub-steppe habitat, but it is criss-crossed with dirt roads; old concrete water tanks are scattered throughout the site; an abandoned gravel pit is centrally located on the site; and an old laydown yard (used during construction of the REDOX plant) is on the western end of the site.

It should be understood that almost the entire Hanford Site is classified as shrub-steppe and is, therefore, priority habitat. In general, the habitat of the Central Plateau previously disturbed and is the site of nearly all of Hanford's waste management operations.

The State of Washington has designated large and small blocks of shrub-steppe as priority habitat, because it possesses unique or significant value to many species. The State makes this classification determination based on the quality of the following attributes: comparatively high fish and wildlife density, comparatively high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, important fish and wildlife movement corridors, limited availability, high vulnerability to habitat alteration, and unique or dependent species.

Although Washington State priority habitat designations have no associated legal requirements for habitat protection, DOE Order 430.1 requires that DOE consider ecosystem management and preservation values during all phases of Hanford Site operations. DOE intends to limit disturbances to priority habitats through the designation of future Hanford Site land uses. The Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan (DOE/EIS-0222D), which is currently undergoing public review and comment, takes into account the preservation of valuable natural resources when developing broad classes of future land uses. When the ROD for this EIS is issued and land uses are designated, a Hanford Biological Resources Management Plan will be finalized (it is currently in draft form) to provide direction regarding the protection and enhancement of the natural environment.

Comment (3293)
Job training and retraining should specifically address the use of workers from the host local community. Also, preference should be given to contracting with businesses in the host local community.

Response
As required by NEPA and CEQ implementing regulations, Chapter 12 in Volume I of the WM PEIS provides general information about measures that are available to mitigate the impacts of alternatives considered in the PEIS. Site-specific mitigation measures could include job training and retraining (to help reduce demand for new employees who would inmigrate to regions and place additional demands

7. Impacts Mitigation

on local infrastructures) and cooperation and communication with existing industries to identify and take advantage of opportunities for diversification. See Table 12-1.

The WM PEIS analysis of socioeconomic effects does consider both the availability of required labor in the region of influence (local hiring) and the potential for DOE-sponsored training and retraining programs to encourage local hiring. See Volume III, Section C.4.6.1.2. The analysis assumes that from 40 to 70% of construction jobs, and from 40 to 60% of operations and maintenance jobs would be filled from the local region. Several factors are assumed to influence the actual level of local hiring, including the current level of regional unemployment, local economic conditions, other local demand for labor skills, and the ability of the local labor force to provide the needed skills. As stated in Section C.4.6.1.2, the analysis also considers job training and retraining programs as a potential mitigation measure where population and demographic pressure due to inmigration might exist. The WM PEIS analysis assumed that at least 40% of available operations and maintenance jobs will go to re-trainees, 30% will go to local workers, and 30% will go to inmigrants.

DOE recognizes the influence that its site operations can have on the economies of the local regions of influence. Wherever possible, DOE will cooperate and communicate with existing business and industry to identify and take advantage of emerging opportunities for local development or diversification of the local economy. However, the establishment of a procurement policy favoring preferential consideration for industries in the local region is outside the scope of the WM PEIS. DOE procurement policy and contracting procedures, like all government contracting, are subject to the provisions of the Federal Acquisition Regulations. A policy to give preference to local business in the host communities would be more appropriate to the implementation phase of the waste management process after the WM PEIS Records of Decision are issued. Such a policy, if implemented, would be expected to conform to the Federal Acquisition Regulations.

Comment (3658)
We hope that DOE will install additional control measures to reduce the radionuclide emissions into the air to acceptable levels (meaning zero) if there are exceedances at LANL and WIPP.

Response
Releases from DOE facilities would comply with all applicable air quality regulations. Air quality analyses in the WM PEIS used generic technologies and scenarios that in some alternatives predicted exceedances of air quality standards at some sites. These predictions indicate that additional control measures would be needed at these sites if these alternatives are chosen. Such control measures might include facility designs and operational procedures to ensure that no air quality standards would be exceeded.

Comment (4435)
The WM PEIS should include a more detailed analysis of mitigation measures and of the extent to which such measures, associated uncertainties, and timing considerations could affect the relative impacts of alternatives. Alternative programs should be included to develop the necessary information, and this information should be reevaluated, in detail, at least every 5 years to determine if a supplemental PEIS or a new PEIS is warranted.

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Response

Chapter 12 in Volume I of the WM PEIS provides general information about measures that are available to mitigate the impacts of alternatives considered in the PEIS. DOE added additional compensatory mitigation measures to Chapter 12 in the WM PEIS. These include programmatic and site-specific actions. However, the PEIS does not describe the effectiveness of these mitigation measures because effectiveness can be determined only from the specific design and application of the measure at a particular site. Sitewide or project-level NEPA reviews would evaluate mitigation measures in greater detail. The extent to which risks and impacts can be reduced or eliminated would depend on conditions at each DOE site.

Disposal facilities are not expected to result in releases that exceed on drinking water standards, given the requirement that these facilities must satisfy performance standards in DOE Order 5820.2A. The mitigation measures and other steps required to meet these performance standards will vary by site, depending on the type and location of the facility. Mitigation measures, such as the design of the disposal unit, and specification of the waste form and other acceptance criteria are developed during the performance assessment process.

DOE recognizes that certain management decisions could preclude other options in the future. However, DOE intends to make reasoned decisions regarding waste management only after consideration of a broad spectrum of information, including the availability of promising new technology and the efficacy of mitigation measures. Research in these areas is ongoing.

Even though an impact statement adequately discusses the environmental impacts of a proposed action, situations can arise in which a supplemental impact statement is necessary. CEQ regulations require supplemental EISs when:

- The agency makes substantial changes in the proposed action that are relevant to environmental concerns;

- There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts (40 CFR 1502.9(c)(1)).

An agency might also prepare a supplemental statement if it decides that it will further the purposes of the Act (40 CFR 1502.9(c)(1)(iii)).

In the notice entitled "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," the CEQ indicates that, as a rule of thumb, if the proposal has not yet been implemented or if the EIS concerns an ongoing program, an EIS that is more than 5 years old should be carefully reexamined to determine if the criteria in Section 1502.9 compels preparation of an EIS supplement (46 Fed. Reg. 18026 (1981)).

In accordance with the CEQ regulations and DOE's NEPA regulations, DOE would prepare a supplemental NEPA analysis for the WM PEIS if significant new circumstances or information relevant to the environment and the proposed action or its impacts arose. If DOE prepared a supplemental analysis, that document would discuss the circumstances that are pertinent to deciding whether to prepare a supplemental EIS. DOE cannot determine at this time whether a supplemental analysis would be required. Although the DOE NEPA regulations suggest that a supplemental NEPA analysis be

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prepared every 5 years for sitewide NEPA documents, they do not contain guidelines for preparing supplemental NEPA analyses for programmatic NEPA documents.

Comment (4456)
What mitigation measures and alternative technologies were considered for the treatment of tritium-containing wastes to reduce the release of the tritium to the environment?

Given the high concentrations of radionuclides in groundwater, treatment of groundwater to correct the radionuclide problem should be considered, in addition to the waste acceptance criteria and the environmental impacts of plausible actions that might be needed to meet potential criteria.

Response
In addition to reducing tritium release to the environment, the WM PEIS considered two approaches to testing with tritium contamination: isotopic separation techniques and separation of tritium-containing wastes for storage until the tritium decays to harmless levels of radioactivity. The first approach was judged prohibitively expensive for bulk treatment. The second approach, however, was considered feasible, given the approximately 12-year half-life of tritium. DOE added this information regarding the tritium problem to Volume IV, Section H.4.1.1, of the WM PEIS.

Comment (4560)
Criteria should be developed for issuing a supplemental WM PEIS (preferably an Environmental Restoration and Waste Management PEIS) to reevaluate the alternatives when enough information becomes available to evaluate the impacts of locating activities at optimized locations on sites. Programmatic alternatives that would develop the data needed for this purpose on different schedules should also be considered.

Response
The CEQ regulations (40 CFR 1500-1508) and DOE NEPA regulations (10 CFR 1021) contain criteria to help DOE determine when it must prepare an EIS. These criteria also apply to preparing a supplement to a NEPA document. Specifically, a supplemental EIS might be needed if there are significant new circumstances or information relevant to environmental concerns. DOE has a policy to reconsider site-specific EIS studies every 5 years, if necessary, but there is no guidance on when to supplement a programmatic EIS.

Comment (4561)
DOE should evaluate programmatic alternatives for development of better methods (and parameters) for risk assessment that could provide better information for programmatic decisionmaking, along with improved methods of displaying risk assessment results.

Uncertainties in the modeling and in the data used for modeling should be quantified, when possible, and used to identify areas where adequate information is currently unavailable to make final programmatic decisions. This information should be used to analyze the role of further monitoring and research in refining DOE's decisionmaking process, and to evaluate alternatives to current programs.

A detailed review of available information should be performed at least every 5 years to determine if enough new information is available to warrant a new or supplemental PEIS.

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Response

The purpose of the WM PEIS is to evaluate the environmental impacts associated with alternatives that address DOE's need to better manage its waste. This management has been defined as treating, storing, or disposing of five types of waste. The environmental impacts to be assessed are those physical impacts that may occur when facilities are constructed or operated. This is further discussed in Chapter 2, Volume I, of the PEIS.

The assessment of these alternatives includes many different methods detailed in Chapter 5 in Volume I, some of which include health risk assessments. The commentor's recommendation that DOE should develop better methods for risk assessment is being considered, but not in the context of alternatives which might cause physical impacts to the environment, and thus require an environmental impact assessment. Rather, better assessment methods are associated with the methodology that could be used to assess impacts. The assessment methods, themselves, will not cause impacts to the environment and do not fall within the definition of major actions requiring National Environmental Policy Act review.

The WM PEIS health risk impacts analysis used conceptual waste management facilities, the best available data at the time of the analysis, state-of-the-art models, and conservative assumptions to develop screening-level estimates of the potential health risks associated with waste treatment, storage, disposal, and transportation. These estimates were used to provide relative comparisons of impacts among the proposed waste management alternatives.

Human health risk assessment results are conditional estimates that are influenced to a large extent by the many assumptions that must be made to account for an insufficient understanding of biological processes or a lack of information on contaminant or receptor behavior. Therefore, in evaluating risk estimate results, it is important to recognize that uncertainties are involved in analysis in order to place the risk estimates in proper perspective. Uncertainties associated with the risk assessment methodology used in the PEIS analyses are discussed in Volume I, Section 5.4, and Volume III, Appendix D.

Sitewide or project-level NEPA reviews will be better able to utilize additional site-specific information on the exact siting of waste management facilities, hydrogeological, meteorological and population demographic parameters, and specific mitigation methods, to provide more refined estimates of potential impacts.

Even though an impact statement adequately discusses the environmental impacts of a proposed action, situations can arise in which a supplemental impact statement is necessary. CEQ regulations require supplemental EISs when:

- The agency makes substantial changes in the proposed action that are relevant to environmental concerns;

- There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts (40 CFR 1502.9(c)(1)).

An agency might also prepare a supplemental statement if it decides that it will further the purposes of the Act (40 CFR 1502.9(c)(1)(iii)).

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In the notice entitled "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," the CEQ indicates that, as a rule of thumb, if the proposal has not yet been implemented or if the EIS concerns an ongoing program, an EIS that is more than 5 years old should be carefully reexamined to determine if the criteria in Section 1502.9 compels preparation of an EIS supplement (46 Fed. Reg. 18026 (1981)).

In accordance with the CEQ regulations and DOE's NEPA regulations, DOE would prepare a supplemental NEPA analysis for the WM PEIS if significant new circumstances or information relevant to the environment and the proposed action or its impacts arose. If DOE prepared a supplemental analysis, that document would discuss the circumstances that are pertinent to deciding whether to prepare a supplemental EIS. DOE cannot determine at this time whether a supplemental analysis would be required. Although the DOE NEPA regulations suggest that a supplemental NEPA analysis be prepared every 5 years for sitewide NEPA documents, they do not contain guidelines for preparing supplemental NEPA analyses for programmatic NEPA documents.

Comment (4562)
Trade-offs between more shielding (resulting in less radiation impacts) and additional volumes of waste with their associated increases in conventional pollution and safety impacts should be analyzed as part of the WM PEIS.

Response
Because of the conservative assumptions in the WM PEIS analysis, potential shielding between the shipment and the receptor is not factored into the estimate of potential health risks from radiation exposure during transportation.

Comment (4563)
Regarding mitigation measures, the WM PEIS should consider new, more restrictive, worker protection and environmental standards, along with the use of robots to do work that would otherwise exceed the new worker-protection standards.

Response
DOE complies with all applicable laws and to protect human health and the environment in undertaking its waste management responsibilities. Moreover, DOE believes that existing standards adequately protect human health (both workers and the public) and the environment. Although worker protection and environmental laws and standards might change over time, DOE cannot predict such changes or their applicability to the mitigation measures discussed in the WM PEIS.

8. Technical Issues

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(No comments were received for this section)

8.1 Waste Types Analyzed, Volumes and Characteristics

Comment (27)
If the WM PEIS contains information different from the 1993 Integrated Data Base Report, the difference needs to be thoroughly explained.

Response
The Draft WM PEIS identified the sources of volume data for each type of waste. Those sources represented the best available data at the time of the analysis on how much waste there was, and where it was at the time DOE prepared the Draft WM PEIS. Many of those sources have since been updated. Therefore, the Final WM PEIS provides an update of all of the site-specific waste volumes for low-level waste, low-level mixed waste, and transuranic waste, and has performed a reanalysis of impacts at selected sites (see Volume IV, Appendix I). Appendix I discusses why these waste volumes have changed and how they qualitatively affect the WM PEIS impacts analysis.

Comment (164)
Waste volumes could shrink drastically if the criteria for classification, for example 100 nanocuries per gram for transuranic waste, were relaxed. This should apply to low-level waste and low-level mixed waste as well.

Response
As is DOE policy, the WM PEIS applies current waste classification criteria, which is consistent with existing statutory definitions of waste types, to the existing and projected waste volumes. Current waste classification criteria would not be relaxed unless the statutory definitions were amended.

While it is true that relaxing the criteria for transuranic waste would reduce the amount of that waste type, it would increase the amount of low-level waste and low-level mixed waste. The definitions of low-level waste and low-level mixed waste do not set radioactivity thresholds below which the waste is not considered to be radioactive.

Comment (195)
A commentor believes that DOE should be dealing with low-level mixed, low-level, transuranic, and high-level wastes in similar ways.

Response
Similarities between waste types were considered in the WM PEIS; however, each waste type has unique physical and regulatory requirements and must be managed separately. See WM PEIS Volume I, Section 1.5.

Comment (476)
The WM PEIS needs to clarify whether wastewater volumes are included in waste totals, and where the wastewater from the sludges goes.

Response
The Draft WM PEIS included wastewaters in the volume totals for low-level mixed waste, low-level waste, and transuranic waste. DOE would continue to manage this wastewater at each site. Other wastewaters that are the subject of the WM PEIS analysis do not constitute large volumes and DOE is likely to recycle them to minimize treatment requirements; however, the waste volume totals do include wastewaters.

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Since the Draft WM PEIS was published, DOE has released updated waste-volume data (see Appendix I in Volume IV of the Final PEIS). These data include wastewater in the volumes for low-level mixed waste and transuranic waste, but not in the volumes for low-level waste. DOE used the revised data to reanalyze impacts of selected sites that might be significantly affected by the new data.

The WM PEIS high-level waste analysis addressed only the impacts of the storage and transportation of vitrified high-level waste in canisters. The hazardous waste analysis did not include wastewater in the total volume of hazardous waste because of the DOE policy to manage existing wastewater on the generator sites due to the difficulty and expense of transporting it.

The total sludge volume includes the water in sludge wastes. The wastewater that is derived from sludge processing is not included in the primary waste streams because it is already included in the sludge volume.

Comment (1087)
DOE should explain why the waste volumes in the Draft WM PEIS for Fernald Environmental Management Project (FEMP), including those in Table 4-2, are so much lower than the actual waste volumes at FEMP. The numbers are confusing and should be revised in the Final PEIS to include the actual waste volumes at FEMP. DOE should explain the source of the waste-volume data used in the PEIS for FEMP, especially for low-level waste.

Response
The Draft WM PEIS identified the sources of volume data for each type of waste. Those sources represented the best available information at the time of the analysis on how much waste there was, and where it was at the time DOE prepared the Draft PEIS.

Sites continually characterize their wastes, and implement pollution prevention practices; these activities can change estimates of waste volumes. DOE has released updated waste-volume data, which is incorporated in the Final WM PEIS analysis (see Appendix I in Volume IV). The sources for these updated data are provided, along with a discussion of how the new data affected the WM PEIS analysis.

DOE considers FEMP low-level waste to be environmental restoration waste, not waste management waste. The 1995 Integrated Data Base (the source of new low-level waste data) reported no waste management wastes generated or stored at FEMP, and projected no waste management waste generation for the future. The WM PEIS Low-Level Waste Inventory Technical Report provides details on the amounts and characteristics of low-level waste that would be treated at FEMP under some alternatives. This technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The WM PEIS does not evaluate environmental restoration alternatives and, therefore, does not quantitatively evaluate environmental restoration wastes at FEMP or other sites. The impacts of environmental restoration activities at FEMP are evaluated in site-specific CERCLA documents including:

- *Feasibility Study/Proposed Plan for Operable Unit 1, Final, Fernald Environmental Management Project* (DOE/EA-0938);

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- *Feasibility Study Report for Operable Unit 4, Final, Fernald Environmental Management Project* (DOE/EIS-0195);
- *Feasibility Study Report/Environmental Assessment for Operable Unit 2, Final, Fernald Environmental Management Project* (DOE/EA-0953);
- *Feasibility Study Report for Operable Unit 5, Final, Fernald Environmental Management Project*; and
- *Operable Unit 3 Final Remedial Investigation/Feasibility Study Report, Final, Fernald Environmental Management Project.*

Comment (1105)
DOE should provide more information about the amounts and types of wastes potentially coming to FEMP for treatment.

Response
In relation to the treatment of waste from other sites, DOE considered FEMP as a potential treatment site for low-level mixed waste and low-level waste. Under Regionalized Alternative 1 for low-level mixed waste, FEMP would receive low-level mixed waste for treatment from Argonne National Laboratory-East (ANL-E,) Ames Laboratory, and the Mound Plant, which would increase FEMP treatment volume requirements such that 76% of its total treatment volumes would come from other sites. (See Volume I, Table 6.3-3.) Under Regionalized Alternative 2, FEMP would receive low-level waste for treatment from ANL-E, Ames, Mound, and Fermi National Accelerator Laboratory. Since all FEMP onsite low-level waste is categorized as environmental restoration waste, 100% of FEMP's treatment volume would come from other sites (see Table 7.3-4). No other low-level mixed waste or low-level waste management alternatives would require FEMP to treat wastes from other sites. Table 6.1-1 lists the estimated total volume of low-level mixed waste from waste management activities at each of the 37 low-level mixed wastes sites. Table 7.1-1 lists the total estimated low-level waste volumes at those sites.

Details on the amounts and characteristics of low-level mixed waste and low-level waste that would come to FEMP from these sites are provided in the Low-Level Mixed Waste Technical Report prepared for the WM PEIS (ANL/EAD/TM-32, Draft-April 1995) and the Low-Level Waste Technical Report prepared for the WM PEIS (ANL/EAD/TM-20, Draft-April 1995). These reports are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (1530)
WM PEIS authors must not have read the Baseline Environmental Management Report (BEMR), because there are vast discrepancies between the waste numbers in the PEIS and the waste.

Response
The 1996 BEMR identifies all activities and projects in the DOE Environmental Management Program. The WM PEIS focuses only on the waste management portion of that program. Furthermore, the WM PEIS considers only current waste management waste inventories plus 20 years of generation, while BEMR considers wastes in inventory plus generation over each site's life cycle, which might extend over 75 years. Section 1.8.2 describes BEMR and its relationship to the PEIS.

8.1 Waste Types Analyzed, Volumes and Characteristics

The PEIS uses BEMR as a source only for estimates of environmental restoration waste volumes. Volume I, Chapters 6 through 10 of the PEIS, identify other sources of PEIS waste volumes. The Final PEIS considers the 1996 BEMR environmental restoration waste volumes (see Appendix B in Volume III and Chapters 6, 7, and 8 in Volume I).

Comment (1584)
Given the existing problems with plutonium at the Rocky Flats Environmental Technology Site (RFETS), the Hanford Site, and the Savannah River Site (SRS), the WM PEIS ignores the dangers associated with plutonium, which will still be undecayed after 10,000 years and, contrary to some DOE statements, can move through the soil.

Response
Depending on the isotopes and level of radioactivity, there can be plutonium in four of the waste types (transuranic, high-level, low-level mixed, or low-level) considered in the WM PEIS. Moreover, the different plutonium isotopes have different half-lives; some decay faster than others. DOE analyzed the waste streams that contain plutonium isotopes for potential environmental impacts.

As described in the WM PEIS, DOE proposes to dispose of transuranic waste, including that containing plutonium, at WIPP. DOE is addressing the potential impacts of transuranic waste disposal at WIPP in the WIPP SEIS-II. The WM PEIS evaluates the impacts of disposing of low-level and low-level mixed wastes at several facilities. It assumes breaches at disposal facilities and provides models of wastes containing plutonium moving through the environment. It estimates little or no plutonium in groundwater (see Site Data Tables, Volume II). The WM PEIS also describes impacts to workers and offsite populations from exposure to plutonium. DOE is in the process of stabilizing and repackaging weapons-usable fissile materials such as plutonium and placing them in safe, secure storage. For plutonium, these corrective actions were developed in response to DOE's *Plutonium Vulnerability Management Plan* (DOE/EM-0199), the assessment by DOE's *Plutonium Working Group Report* (DOE/EH-0415), and recommendations made by the Defense Nuclear Facilities Safety Board to improve the remediation of the sites where plutonium is currently stored.

A number of NEPA documents are currently available that address plutonium at RFETS, the Hanford Site, and SRS. The Storage and Disposition of Weapons-Usable Fissile Materials PEIS considers surplus plutonium materials Department-wide. The stabilization, concentration, and storage of plutonium residues, as well as non-weapons-usable waste, is covered in the RFETS Environmental Assessment on Solid Residues Treatment, Repackaging, and Storage, the SRS F-Canyon Plutonium Solutions EIS, and the Hanford Plutonium Finishing Plant Complex EIS. These documents are available to the public. Additional NEPA documents (such as the Rocky Flats Plutonium Residues and Scrub Alloy EIS) will be prepared to further address plutonium within the DOE complex.

The 1995 Baseline Environmental Management Report provides information on possible plutonium problems at DOE sites. At RFETS, soil contamination is highest east and southeast of the temporary storage area (903 Pad) where DOE used steel drums to store plutonium-contaminated industrial oils from 1958 to 1968. DOE used TRX facilities at SRS for experimental work and the development and demonstration of new processes. The old TRX seepage basin was the main contributor to SRS groundwater contamination, with concentrations of plutonium exceeding the primary drinking water standard. There are also concentrations of plutonium in soil or groundwater above established limits at the Hanford Site.

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Most plutonium compounds are only slightly soluble in water and, therefore, have a low-mobility in most soils. DOE recently completed the *Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste* (DOE/ID-10521/2). This report classifies the mobility of plutonium as high, medium, or low. Of the 15 sites considered in the report, only the Oak Ridge Reservation (ORR) was in the medium mobility class.

Comment (1652)
Commentors suggested that DOE change the classifications and definitions of waste because they either lack sufficient waste characterization or are classified by production source or management risks rather than by health risks.

Response
The commentors correctly point out that the definition of wastes have different bases--some are defined by source, some by physical characteristics, and some by exception. Although a waste type may be broadly defined to encompass wastes that potentially pose a wide range of health risks, DOE's management in effect classifies the waste according to health risk. One example is waste acceptance criteria for disposal of low-level waste. These waste acceptance criteria require that wastes that would pose higher risks to groundwater because of physical, chemical, or radiological characteristics be stabilized.

In the WM PEIS, low-level waste and low-level mixed waste are divided into "alpha" and "non-alpha." Low-level waste, low-level mixed waste, and transuranic waste are divided into "contact-handled" and "remote-handled." These divisions are made in recognition of what is required to protect the health of waste management workers. Thus, it is not necessary to change the definitions of waste types for DOE to manage waste according to the health risks they pose.

Comment (1830)
Commentors expressed concerns that the projected waste volumes used for the WM PEIS analysis are based on 1994 and earlier data. The designation of ANL-E as a major site and the WM PEIS impact analysis for ANL-E are based on inflated radioactive waste projections and alternatives that do not fit. For low-level mixed waste, a projected volume of 8,410 cubic meters was listed in the data tables. The PEIS acknowledges that this figure is 60 times higher than is currently estimated by ANL-E. The document cites similarly inflated estimates for BNL. It is ominous that DOE should consider a factor of 60 applied in this circumstance to be realistically conservative. This approach renders the evaluation of alternatives meaningless. Based on the approach taken for these two sites, the credibility of any of the data in the report is questionable. DOE should work with the DOE Operations Offices to obtain correct data, recalculate the numbers, and conduct a more accurate, meaningful analysis.

Response
The Draft WM PEIS used low-level mixed waste information from DOE's 1994 Mixed Waste Inventory Report. The Final WM PEIS contains mixed waste information for ANL-E from the 1995 Mixed Waste Inventory Report which estimates the volume of mixed waste (inventory plus 20 years of generation) at ANL-E to be 159 cubic meters. DOE did not reanalyze waste management at BNL using new waste-volume data. The previous analysis, although likely to be conservative, was considered sufficiently accurate for programmatic decisions. See Section 3.7 in Volume I for DOE's preferred alternatives, and the reasons they are preferred, for all waste types, including low-level mixed waste.

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Appendix I in Volume IV provides detailed information on 1995 data for low-level waste, low-level mixed waste, and transuranic waste. DOE examined these data for each site to determine whether a reevaluation of impacts was required. The criteria applied and sites chosen for reanalysis are also identified in Appendix I.

Identification as a "major site" does not mean the site will be selected as a site for waste management activities. The major site concept, which is explained in Section 1.6.1 in Volume I of the WM PEIS, is intended to facilitate the analysis in terms of alternatives considered and to allow for meaningful comparison of programmatic waste management options. ANL-E fits the WM PEIS definition of a major site.

Comment (2079)
In Volume I, Chapter 1, the box titled, "Types of Radioactivity" states that dense materials are the best shield for neutrons. This is incorrect; hydrogenous materials (water or wax) are the best shield.

Response
DOE corrected the Summary document and Chapter 1 in Volume I of the WM PEIS to indicate that hydrogenous materials, like water, are more effective than dense materials for shielding neutrons.

Comment (2140)
DOE should explain what type and quantity of waste will be generated by the particle accelerator scheduled to be at BNL in 1999.

Response
The Relativistic Heavy Ion Collider (RHIC) is currently scheduled to be completed in 1999. DOE prepared an environmental assessment in 1991 to evaluate potential environmental impacts associated with the construction and operation of RHIC. Based on 1989 waste generation data for BNL, it was estimated that RHIC would increase BNL's generation of solid waste by 5%, hazardous non-radioactive waste by 2%, and low-level radioactive waste by 4%. The radioactive low-level waste would be mainly in the form of activated target material. Based on the most recent data, less than 1% of the low-level radioactive waste generated in the DOE complex is generated at BNL.

The Final WM PEIS uses more recent waste-volume data that were not available when the Draft WM PEIS was prepared. A discussion of the new waste volumes is provided in Volume IV, Appendix I, of the Final PEIS.

Comment (2142)
DOE should explain what wastes would be produced from transmuting and partitioning wastes at BNL.

Response
DOE assumes that this comment refers to using nuclear reactions to transmute long-lived radionuclides to short-lived or stable nuclides. Such transmutation could take place in accelerators or nuclear reactors. One transmutation reaction that has been considered concerns technetium-99, a troublesome radionuclide with a half-life of 225,000 years. In this process, technetium-99 would be bombarded with neutrons to form technetium-100, which decays quickly (16-second half-life) to ruthenium-100, which is stable. Transmutation also applies to waste containing fissionable fertile nuclides (nuclides will be transmuted to fissionable nuclides upon neutron absorption), such as those in uranium, thorium,

and transuranic waste. The effect would be to convert long-lived fertile radionuclides into shorter-lived fission products through the fission process. These fission products would be disposed of as low-level radioactive waste. Also, useful heat would be produced.

The following caveats apply to transmutation: (1) demonstration of the process has not been applied to transuranic waste and (2) it is a technology that has not yet been proven acceptable for production-size facilities.

The low-level waste data used in the Draft WM PEIS were taken from the 1992 Integrated Data Base. For the Final PEIS, the waste estimates have been updated using the 1995 Integrated Data Base. Approximately 1% of the curie content of the low-level mixed waste at BNL is either technetium-99 or a fissionable fertile nuclide and potentially suitable for transmutation.

Comment (2154)
Commentors asked whether classified waste is considered in the WM PEIS, and stated that DOE should declassify all waste volumes at all sites. The public cannot decide what to do until all the wastes have been openly identified.

Response
A classified waste, which requires protection against unauthorized information or material disclosure for reasons of national security, is a special-case waste when there is no management plan for it. Such waste would be managed as a special-case. As further discussed in Volume I, Section 1.5.6, of the Final WM PEIS, special-case waste is not considered in the WM PEIS. Special-case wastes account for less than 4% of low-level waste, low-level mixed waste, and transuranic waste inventories.

Comment (2155)
Does DOE classify platinum as a waste? There is platinum onsite at Portsmouth.

Response
DOE waste could contain traces of platinum and, therefore, could be considered waste. For the WM PEIS analysis, DOE used standard radiological profiles for each site and made assumptions about the concentration of each waste type in each treatability group based on available data on the origins of the waste. None of these profiles contained platinum. Most of the radioactive isotopes of platinum have short half-lives (days or hours) and it is a fairly inert metal.

Comment (2172)
Ninety-nine percent of all wastes are liquids, but were left out of the WM PEIS. DOE admits that under a number of alternatives, Hanford exceeds its total wastewater treatment capacity. Hanford exceeds it even under current proposals without sending more waste here to be treated.

Response
Contaminated wastewater generated at a DOE site is treated at that site. The process residues from this treatment are included in the waste volumes considered in the WM PEIS, as were the volumes of low-level waste, low-level mixed waste, and transuranic waste wastewater as available from the data sources identified in the Draft PEIS. The Final WM PEIS does not evaluate low-level waste wastewater.

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At the Hanford Site, a large volume of secondary low-level mixed waste and low-level waste wastewater is projected from management of high-level waste. (More detail could be obtained from the Tank Waste Remediation System EIS.) This wastewater is also excluded from WM PEIS evaluations of low-level mixed waste and low-level waste. It is considered to be part of high-level waste treatment, which is not within the scope of the WM PEIS.

Under no alternative in the PEIS is there liquid waste that will be shipped to Hanford for treatment at a wastewater treatment facility. However, some alternatives evaluated in the WM PEIS could require additional wastewater treatment capacity at the Hanford Site. This is shown in Tables 11.6-1 and 11.6-2 in Volume I, which displays the range of combined waste management alternative impacts and the range of cumulative impacts respectively at the Hanford Site.

Comment (2269)
A review of the 200 Area West Study shows that the plutonium numbers are invalid for that area. The data show all the same isotopic mix, which was done for reasons of national security. For this reason, DOE should be careful about using the Hanford Environmental Information System database numbers in the PEIS.

Response
Special nuclear materials are not usually classified as wastes and, therefore, are outside the scope of the WM PEIS. The storage and disposition of weapons-usable fissile materials is analyzed in a separate PEIS.

The Draft WM PEIS identified the sources of the waste-volume data used. These sources represented the best available data at the time of the analysis on how much waste there was, and where it was at the time the Draft WM PEIS was prepared. Appendix I in Volume IV of the Final WM PEIS uses the most recent databases to update the site-specific waste volumes.

Some nuclides of plutonium are fissile. Therefore, plutonium can be used to sustain a nuclear chain reaction in a nuclear reactor or a weapon. Plutonium in a material of sufficient purity could be used in weapons. Management of such material is addressed in the Storage and Disposition of Weapons-Usable Fissile Materials PEIS.

Waste generated in the DOE complex that is contaminated with plutonium would be either low-level waste, low-level mixed waste, or transuranic waste. The WM PEIS does not use the Hanford Environmental Information System database. The data bases that are used for these waste types are referenced in Chapters 6 through 8 in Volume I and in Appendix I in Volume IV.

Comment (2329)
It is not clear what categories and volumes of wastes are to be treated by the Toxic Substances Control Act (TSCA) incinerator, the Scientific Ecology Group (SEG) unit, and other planned installations at Oak Ridge National Laboratory (ORNL).

Response
The WM PEIS analyzes siting options for treatment, storage, and disposal of waste on a programmatic scale. The categories and volumes of waste to be treated at the Oak Ridge Reservation (ORR) depend on waste type and siting option, or alternative. For each waste type, the PEIS shows the treatment

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sequence by physical and chemical characteristics. For example, Figure 7.2-1 in Volume I shows that combustibles and organic liquids would undergo thermal treatment, such as incineration.

The TSCA incinerator, located at the K-25 Site, is a facility for destroying mixed waste, hazardous waste, and certain chemical substances covered by the TSCA. The 1994 low-level mixed waste incineration capacity for ORR was 13,500 cubic meters per year.

SEG is a private company that provides low-level waste processing services. According to a recent NRC report (NUREG/CR-6147), there is an SEG supercompactor near ORR that handled more than 1 million cubic feet of low-level waste during 1989. The WM PEIS considered supercompaction as a technology for treating compactible low-level waste. SEG also operates an incinerator at the ORR.

The WM PEIS does not provide determinations of which facilities to use at a site, although it provides credit for existing capacities in the evaluation of impacts. Thus, the existing treatment capacity at the TSCA facility is considered and construction impacts are not listed for wastes that could be treated in the TSCA facility. The WM PEIS also does not make determinations of whether to treat waste onsite or use a commercial facility such as SEG. These determinations will be made after site-level evaluations.

The technical reports available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS contain more information on categories and volumes of waste.

Comment (2332)
It is not clear what becomes of the solid residue and what weight is given to issues related to transportation of contaminated feeds and residues at ORR.

Response
The WM PEIS evaluated the impacts of routing wastes requiring treatment and or disposal through a series of facilities, referred to as a treatment train. This analysis accounted for 100% of the entering material (feeds) and exiting material (residues) as they were routed from each facility to the next appropriate facility for treatment. At the conclusion of treatment, residues were routed to disposal. Any waste shipped offsite was appropriately packaged and certified before shipment. Figure 6.2-1 in Volume I, as an example, shows the PEIS flow diagram for low-level mixed waste.

DOE analyzed transportation impacts associated with each waste management alternative as wastes were routed to other sites for treatment and/or disposal. Both truck and rail transportation were considered using computerized routing models following the general principle of minimizing distance and transportation time. Transportation routes were selected to be consistent with DOE's current routing practices and all applicable U.S. Department of Transportation regulations. Sections 6.2.4, 7.2.4, 8.2.4, and 9.2.4 in Volume I and Appendix E in Volume IV contain more detail on transportation.

Therefore, contaminated feeds and residues are included in wastes routed to disposal following treatment, and are considered in the evaluation of transportation and disposal impacts.

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Comment (2336)
The WM PEIS deals in only a cursory fashion with liquid wastes, although the possibility of expensive and embarrassing events from this category seem more likely than from many on which the WM PEIS focused.

Response
While the WM PEIS covers five waste types, those wastes are not homogenous and are derived from thousands of different waste streams. Therefore, the wastes were combined into treatment groups for purposes of developing treatment system designs (see Volume I, Section 5.2.1). Each treatment group is identified with one of the five waste types considered in the WM PEIS and a treatment method, where appropriate, that EPA recognizes as meeting the requirements of RCRA. For the WM PEIS analysis, the physical structure of the waste was used for the initial sort for treatment grouping.

At the most basic level of analysis, all waste can be grouped into six physical categories using common engineering criteria design parameters, which also served as the initial set of treatment categories. Wastes could be subjected to more than one treatment process before being suitable for disposal. These physical categories considered in the WM PEIS include aqueous liquids and organic liquids. Aqueous liquids are primarily water with organic content less than 1% (such as wastewater) and organic liquids are liquids and slurries with organic content greater than 1% (such as solvents).

Liquids are included in the generic treatment plan for the different physical waste forms. For example, Figure 6.2-1 in Volume I shows the WM PEIS flow diagram for low-level mixed waste.

Comment (2392)
Volume I, Table 1.6-2, gives volumes and percent of wastes at major sites. The WM PEIS should present species by volumes and curies for all wastes. By describing relative size in volumes rather than providing the information in curies, the reader can readily be misled. For example, the graph would lead one to believe that both Hanford and INEL have more transuranic waste issues to address than does SRS and LANL, whereas if one were to look at curies (what one cares about when it comes to exposure) the SRS transuranic waste issues are by far the largest of any of the DOE sites. In addition, presenting transuranic wastes by only physical volume favors sites with plutonium-239 versus sites with mostly plutonium-238, which could place SRS and LANL at a funding disadvantage relative to Hanford and INEL. The use of volumes as the measure of waste obscures rather than clarifies the nature and extent of waste management problems elsewhere as well, and places some sites at a funding disadvantage.

Response
Both volumes and curies are important for the evaluation of impacts for each alternative. Waste volume is a primary criterion for identifying sites as potential locations for waste management activities under the various alternatives. Waste volume is a readily understandable measure of wastes at each site, and is presented in Volume I. Information on total radioactivity cannot be accurately presented without detailed information on the radiological profiles--as noted in the comment. However, the radiological profile data are voluminous. Consequently, this information is contained in the technical reports referenced in Volume I, Section 15.2, and available in the DOE public reading rooms listed in Section 1.9 in Volume I.

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Broad radioactive categories (contact- versus remote-handled, alpha versus non-alpha) are also important in the development of alternatives. They are also important in estimating costs and impacts associated with resource use. The source terms for risk contain detailed radiological profiles for each site and are presented in the technical reports. However, risk is one of the major impact categories analyzed for all alternatives. The results of the risk analyses are summarized in Volume I.

As discussed in the technical reports, the source terms were developed by assigning profiles to waste streams groupings, then by routing those waste steams through the treatment trains--keeping an account of the radiologic content of each part of the waste flow. For transuranic wastes, for example, the curies of plutonium-238 versus plutonium-239 are tracked throughout the streams and specific radionuclides such as plutonium-238 and americium-241 drive the risks. Appendix D identifies for each waste type those radionuclides that are risk drivers.

The WM PEIS is not intended to be a mechanism for controlling funding at various DOE sites. However, DOE believes that the WM PEIS accurately portrays the importance of the radiological characteristics, as well as the volumes of wastes to decisionmakers who allocate resources.

Comment (2431)
Data presented in Volume I, Table 4-2, for INEL list values that are inconsistent with other DOE documents, including the sources listed in Section 5.2.1. The listed inventories for mixed waste are less than inventories listed in the INEL Site Treatment Plan. Programmatic decisions (i.e., assumptions made during the analysis of risk, impacts, and costs) based on this data are a concern that should be addressed.

Response
As stated in Volume I, Section 5.2.1, DOE revises the databases used for the WM PEIS as new data become available. The Draft WM PEIS used the latest data available for low-level mixed waste, which was the 1994 Mixed Waste Inventory Report. Changes in waste inventories at INEL or at other sites could affect the size of proposed facilities, but are not likely to affect basic conclusions based on the PEIS. Appendix I in Volume IV of the Final PEIS addresses how more recent waste-volume data, including data from the 1995 Mixed Waste Inventory Report, could affect the analysis of WM PEIS alternatives.

Comment (2434)
It would be helpful if the tables defining the alternatives showed amounts of offsite waste (of each type) to be treated or disposed of at each site under each alternative and/or the percentage of total DOE complex waste (of each type) to be treated or disposed of at each site under each alternative (not just the percentage of waste to be treated or disposed of at each site that came from offsite).

Response
The amount of waste that would be treated and disposed of at treatment and disposal sites under each alternative is in the supporting technical reports for waste types. The technical reports are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. The amount of offsite waste each site would treat and dispose of can be determined using the volumes identified in the technical reports and the percentages identified in Volume I of the PEIS.

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Comment (2439)
In Volume I, Table 7.1-1, the total for INEL is wrong. It should be 104,000.

Response
The inventory of 3,500 cubic meters and 20-year projected generation of 101,000 cubic meters has been rounded up to 105,000 cubic meters in Table 7.1-1 in Volume I.

Comment (2807)
Volume I, Section 1.5.6, of the Draft WM PEIS refers to some low-level waste (LLW) that, "because of its high radioactivity levels, cannot currently be disposed of at existing DOE LLW disposal facilities..." If some LLW is so radioactive, it is a misnomer to characterize it with the term "low-level." This misleads the public into thinking that all of this waste is relatively innocuous. Therefore, LLW of this nature should be given a new and distinct term and should be handled separately and with greater care than LLW that fits the implied definition of the term.

Response
Section 1.5.6 in Volume I of the WM PEIS describes wastes that are not considered in this document. Such wastes include special-case waste and commercial greater-than-Class-C (GTCC) LLW. Special-case waste is defined as radioactive waste owned or generated by DOE that does not fit into typical management plans developed for the major radioactive waste types such as high-level waste, low-level waste, and transuranic waste. Examples of special-case waste are (1) LLW that, because of its high radioactivity levels, cannot currently be disposed of at existing DOE LLW disposal facilities without exceeding their performance standards and (2) transuranic waste that cannot meet geologic disposal acceptance criteria.

Under the Low-Level Radioactive Waste Policy Amendments Act of 1985 (42 USC 2021), DOE is also responsible for commercially generated GTCC LLW. GTCC exceeds NRC concentration limits for Class C LLW specified in 10 CFR 61 and, thus, exceeds limits for shallow land burial. Commercial GTCC LLW includes activated metals, process wastes, other contaminated solids generated from the operation of commercial nuclear power plants, and radioactive materials that are used in minerals exploration and as part of medical treatments. Because of their high radioactivity levels and long half-lives, special-case wastes and GTCC LLW must be isolated for hundreds or, in many cases, thousands of years. Unlike transuranic waste and high-level waste, however, neither of these waste types is authorized under the Nuclear Waste Policy Act (42 USC 10101-10270) for disposal in a geologic repository. Further, both special-case wastes and GTCC LLW vary considerably in their nature. DOE is currently developing strategies for both GTCC LLW and special-case waste that include disposal. On March 13, 1995, DOE published a notice in the *Federal Register* inviting interested parties to provide input into the development of strategies. Subsequently, two workshops were held to discuss preliminary strategies. Based on the input received, alternative strategies will be evaluated in a NEPA review once a proposal is developed.

Comment (2823)
In Volume I, Section 1.1, provide a reference, citation, or basis for classifying test specimens as low-level waste.

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Response
DOE revised Section 1.1 to indicate that DOE Order 5820.2A is the source for the statement about the classification of test specimens.

Comment (2905)
The WM PEIS does not characterize the waste streams at the sites well enough to enable the public to make constructive suggestions regarding the proposals. Additional information that would be useful for each waste classification at each site includes:

- Weight and volume of each waste stream;
- Level of radioactivity for each waste stream;
- Volume of waste by radioactivity level ranges and half-lives;
- Post-treatment volume for permanent disposal;
- Nature of non-hazardous substrate(s): State, carbonaceous, mineral, metal, etc.;
- Nature of contaminants: organic/inorganic, species, amount, concentration, half-life, if applicable;
- Potentially applicable processing and storage technologies, including required means of handling, e.g., contact or remote;
- Feasibility of transporting waste across sites for treatment and permanent disposal; mode of transportation available at each site, e.g., truck, rail;
- Suitability of treatment methods (e.g., compaction, combustion, vitrification, etc.);
- Relative cost of treatment;
- Future manpower availability and requirements at each site;
- Permanent disposal requirements and existing suitable site disposal facilities.

Response
The WM PEIS analyzes the potential impacts of managing wastes containing hazardous chemicals and radioactive isotopes. The chemicals/isotopes represented in DOE waste are numerous and diverse and reflect the spectrum of activities that DOE conducts. DOE manages these chemicals and isotopes according to broad waste types: high-level waste, low-level waste, low-level mixed waste, transuranic waste, and hazardous waste. The WM PEIS is organized according to these waste types. It is important to note, however, that risk analyses were based on individual chemicals and radionuclides.

A detailed discussion of waste characterization data used for the analysis of impacts in the WM PEIS is contained in the technical reports listed at the back of Volume I. These technical reports are available in the DOE public reading rooms listed in Section 1.9 in Volume I. For example, the reports authored by Argonne National Laboratory (ANL) show weight and mass of the waste stream groups (aggregates of the more than 2,000 streams in DOE) analyzed at each site, radioactivity levels and radiological profile (curies by radionuclide and percentage in the waste stream of each of the waste stream groups), disposal volumes, chemical-physical structure of the waste stream groups, and concentrations of contaminants in the waste groups. The ANL reports also give technical specifications for the technologies assumed for the analysis and the assumed existing facilities at each site. Other reports authored by the Idaho National Engineering Laboratory (INEL) detail costs and resources.

A more general discussion of these elements of the analytic methods employed by the WM PEIS is contained in Volume I, Chapter 5, and in Appendices C and D in Volume III. The WM PEIS does not contain a discussion of onsite transportation capabilities. The PEIS analysis assumed adequate

transportation onsite and conducted a representative assessment of impacts using one site as its model. More detailed analyses of onsite transportation options will be included in site-level analyses, as appropriate.

The WM PEIS is not intended to provide the detail necessary to make all waste management decisions. Rather, it provides a broad, programmatic analysis of waste management across the DOE complex upon which strategic and programmatic decisions can be based. To address the issue of safe and efficient management of such wastes, DOE first needed to develop an overall picture. For purposes of this programmatic analysis, DOE made broad assumptions about waste characteristics and management practices. Before implementing Department-wide waste management strategies, additional NEPA reviews will likely be necessary to identify the precise location, capacity, and design of facilities at the individual DOE sites. Implications of specific waste characteristics would also be addressed in such reviews.

Comment (2910)
The wastes are generally characterized by volume. The Final WM PEIS should explain whether these are before or after treatment.

Response
The WM PEIS analyzes waste volumes for hazardous waste, low-level waste, low-level mixed waste, and transuranic waste before treatment (with the exception of certain wastes in storage that might have been treated, and evaporated wastewater) and high-level waste volumes after treatment. The PEIS analyzes the treatment activity and makes assumptions on final waste forms (volumes) to evaluate disposal alternatives. The PEIS limits its evaluation of high-level waste to alternatives for storing waste that has been treated. DOE considers the treatment of high-level waste a site-specific activity, since this waste will not be shipped for treatment and is, therefore, beyond the scope of the WM PEIS.

Comment (2937)
It should be made clear whether wastes generated from weapons dismantlement and processing surplus enriched uranium are included.

Response
The WM PEIS does not specifically address wastes from the processing of surplus highly enriched uranium (HEU). When DOE estimated volumes of low-level waste and low-level mixed waste volumes for the PEIS analysis, it did not consider the disposition of surplus highly enriched uranium. DOE will estimate volumes of waste from processing surplus HEU in the Disposition of Surplus Highly Enriched Uranium EIS and nuclear weapons assembly/disassembly in the Stockpile Stewardship and Management PEIS. The waste volume estimates in the WM PEIS are conservative and would cover the minor volumes of wastes DOE expects to generate from processing surplus HEU and weapons dismantlement. Appendix I in Volume IV of the Final PEIS provides the latest available information on waste inventories.

Comment (3032)
DOE should use current data in Table 1.6-2 and state if the data are limited to waste management waste.

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Response
Tables 1.6-2 and 1.6-3 in Volume I of the WM PEIS presents the waste management waste volumes used in the document. The sources for these waste-volume data are described in Section 5.2.1 in Volume I of the PEIS.

Since environmental restoration wastes are outside the scope of the WM PEIS, DOE has changed the title of Table 1.6-3 in the Final PEIS to indicate that the data are for waste management wastes only.

Comment (3079)
Table 7.3-2 and others show the percentage of offsite waste compared to locally generated wastes. However, this method of delineating the effect of adding offsite wastes is biased against large sites, such as Hanford, that have large quantities of locally generated waste.

Response
In choosing sites for the alternatives, DOE considered waste volumes, transportation requirements, character of waste, specialized treatment requirements, and existing facilities (see Section 3.5 in Volume I). Table 7.3-2 in Volume I was generated after sites had already been selected using the above set of criteria, and was therefore, not used to choose sites for analyses. The objective of this table and others showing the alternatives is to provide more information on the alternatives.

DOE believes the waste volume and shipping tables, such as Table 7.3-2, contained in each waste-type chapter for each alternative provide valuable information to the public regarding the relative effect of adding offsite waste that would be shipped to their site under each alternative. Although these tables do not compare the size of waste volumes at the sites, the percentages given help the reader understand the potential increase in the volume of waste each site would be required to manage, and gives some indication of the potential impact at the site.

Comment (3262)
Throughout the WM PEIS, various amounts of waste are cited as being the subject of the WM PEIS. The figures listed are not consistent. For instance:

- Table 6.1-1 lists a 20-year projected inventory of low-level mixed waste of 22,000 cubic meters for RFETS;

- Table 6.15-1 predicts low-level mixed waste from environmental restoration at RFETS to be 116,000 cubic feet;

- The RFETS contractor has estimated that 194,000 cubic meters of low-level mixed waste will be generated, as well as 12,300 cubic meters of low-level waste (Rocky Flats Accelerated Site Action Project - October 9, 1995). These numbers add significantly to the 20-year projection in the WM PEIS.

Response
The 21,000 cubic meters of low-level mixed waste in Volume I, Table 6.1-1, represents waste management inventory at RFETS, plus the anticipated 20-year generation. The environmental restoration waste volumes have been updated for the Final WM PEIS, based on the 1996 Environmental Restoration Core Database. The total volume of environmental restoration low-level

waste, low-level mixed waste, and transuranic waste at RFETS is now estimated to be 96,000, 380,000, and 4,900 cubic meters, respectively. Since 1992, the mission of RFETS has been decontamination and decommissioning and cleanup, as well as special nuclear material stabilization and storage.

Comment (3328)
The classification of the five types of waste in this document is an incredible piece of mathematical genius meant to convince us all of something. The WM PEIS Summary document states that DOE developed and applied specific assumptions to evaluate the potential environmental impacts of the alternatives, and that DOE first identified the type, characteristics, quantity, and special requirements (e.g., handling requirements) of each waste type to frame the analysis within reasonable bounds and to make the analytical process more manageable. Wouldn't the application of specific facts produce a better evaluation?

Response
The classification of the five waste types in the WM PEIS was not made based on DOE policy, but rather, was based on the existing definitions of those waste types set forth in Federal statutes passed by Congress. These statutes also specify many requirements, such as handling requirements, for these wastes, with which DOE must comply.

The WM PEIS is a programmatic document that evaluates the potential environmental consequences of implementing various forms of an entire DOE program. Such documents typically consider impacts that will occur in the future under conditions that often are not precisely set. The WM PEIS evaluation is based on facts to the extent that they are available. For example, waste volumes and characteristics were obtained from the latest data available. However, various waste forms would be transported along routes that have yet to be specified, and much of the waste would be treated and disposed of in facilities that have not been built. Therefore, it was necessary to make reasonable assumptions about routes, facilities, and other issues in order to estimate and evaluate the potential consequences of the various alternatives.

Comment (3342)
The categorization of waste into a handful of types may be convenient, but there is much contamination below the low-level criteria which, in time, will be proven hazardous, and should not be excluded.

Response
The categorization of wastes into waste types is based on statutory definitions. Therefore, DOE is required to apply these definitions in its management of waste. Radioactive waste that does not meet the definition of high-level waste, spent nuclear fuel, or transuranic waste is low-level waste. If low-level waste is also contaminated with constituents that are hazardous under RCRA, then it is low-level mixed waste. There is no statutory lower limit on the amount of radioactivity in low-level waste and low-level mixed waste. However, in practice, any radioactivity above background levels would result in a waste being classified as either low-level waste or low-level mixed waste.

Comment (3424)
Plutonium residues and scraps at Hanford should be declared waste (rather than special nuclear material exempt from regulation) and its disposal considered in the WM PEIS.

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Response
Plutonium scraps (materials discarded from manufacturing processes) and residues currently stored in the Plutonium Finishing Plant at Hanford have been declared excess to defense program needs. Plans for treatment of such plutonium-bearing material to render it more stable are discussed in the Plutonium Finishing Plant Stabilization EIS. The Record of Decision for that EIS, published in the *Federal Register* on July 10, 1996, selected the alternative to stabilize the material and then place it in interim storage on the Hanford Site. However, these scraps and residues have not yet been declared waste. Before the designation of "special nuclear material" can be removed and the material declared to be waste, certain processing must take place so that safeguards and security requirements are met.

Comment (3528)
The WM PEIS should provide more details about the types of waste categorized as special-case waste [e.g., explain whether classified transuranic waste (see Implementation Plan for NTS - DOE/NV-390, Rev. 0) is a special-case waste]. The WM PEIS should further identify wastes excluded from the PEIS based on the laws/regulations providing for such exclusions (as, for example, materials emitted as a result of nuclear explosions are considered a "Federally permitted release" not reported to EPA).

Response
As described in Volume I, Section 1.5.6 of the WM PEIS, at some sites there are kinds of low-level waste or transuranic waste that are designated as "special-case" wastes by the generating site. Although it may be categorized as low-level waste or transuranic waste, such waste would be managed as a special-case. DOE did not undertake a detailed waste-stream and site-specific analysis in the WM PEIS to develop options for each of these exceptions. As detailed analyses are conducted, management plans for each waste stream will be established.

DOE is currently developing strategies for special-case wastes that include disposal. On March 13, 1995, DOE published a notice in the *Federal Register* inviting interested parties to provide input into the development of strategies. Subsequently, two workshops were held to discuss preliminary strategies. Based on the input received, alternative strategies will be evaluated in a NEPA review.

Classified waste is addressed in the NTS Sitewide EIS. It is defined as weapons components and assemblies designated by the U.S. Government, pursuant to Executive Order, statute, or regulation, that require protection against unauthorized information or material disclosure for reasons of national security. Additional security and safeguards management activities are required in the handling of these materials. These classified wastes can be, but are not necessarily special-case waste. The databases from which waste volume information was obtained do not include classified waste.

The WM PEIS addresses five waste types (i.e., low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste) that have resulted from DOE's past energy and weapons research and production. If a waste resulting from a nuclear weapons testing activity falls into one of the five categories and is not classified waste, it is addressed in the WM PEIS. Note that contaminated media such as soils and groundwater are being addressed by DOE's Environmental Restoration Program and, therefore, are outside the scope of the WM PEIS.

Comment (3530)
The waste volumes at NTS (i.e., 0.3 cubic meters of low-level mixed waste and 610 cubic meters of transuranic waste) are seriously under-reported. For example, there are about a dozen sites with

kilogram quantities of plutonium-239 disposed over hundreds of acres, and at Area 13, approximately 600,000 cubic yards of surface soil were removed and hauled to a desert crater at the Nevada Test Site (NTS).

Response
The Draft WM PEIS identified the sources of waste-volume data. Those sources represented the best data available at the time the Draft PEIS was developed. Since then, new information from updated databases has become available for low-level mixed waste, low-level waste, and transuranic waste. The updated data are discussed in Volume IV, Appendix I, of the Final PEIS to determine if the update waste-volume data affect any of the impacts described in the PEIS.

While the 1994 Mixed Waste Inventory Report reported a current inventory of 0.3 cubic meters of low-level mixed waste at NTS, the 1995 Mixed Waste Inventory Report shows 300. For transuranic waste, the newer data show 620 cubic meters in inventory at NTS, compared to 610 cubic meters reported in the earlier sources. Environmental restoration waste volumes are presented for each site in Volume III, Appendix B, of the WM PEIS. However, environmental restoration alternatives are not addressed in the WM PEIS analysis. The wastes referred to in the comment are primarily soils contaminated with plutonium. These wastes have been removed, packaged, and disposed of at NTS. Therefore, no further action is contemplated, and consequently, these volumes are not included in the Waste Management Program inventory for NTS.

Comment (3685)
The WM PEIS does not incorporate historical data for waste volumes for the five waste types. Why? We never have had a U.S. Nuclear Policy Management Plan inclusive of addressing the waste.

Response
The waste volumes considered in the WM PEIS have two components: (1) an inventory of waste that was generated in the past and is now in storage awaiting treatment and disposal and (2) projections of wastes to be generated in the 20-year period of analysis. The inventory waste is based on historical data. The databases that contain these historical data are referenced in the respective waste-type chapters in Volume I of the PEIS. The waste volumes do not include waste that has already been disposed of or wastes that will remain within the Environmental Restoration Program. As explained in Volume I, Section 1.7.1, environmental restoration wastes were originally within the scope of the WM PEIS. After completion of the Implementation Plan, it became clear that it would not be appropriate to make programmatic decisions regarding cleanup strategies that would be applicable to all of DOE's sites. DOE announced its proposal to shift the focus of the WM PEIS on January 24, 1995 (60 FR 4606).

Comment (3740)
The public needs to have questions answered (1) What are the isotopes of the materials? (2) What are the half-lives of the isotopes? (3) Is plutonium involved in the material to be disposed of at ANL-E? (4) Will the waste be in a fixed or liquid state?

Response
While the WM PEIS covers five waste types, those wastes are not homogenous and are derived from thousands of different waste streams that contain a wide variety of isotopes. Details of the radiological composition assumed for each waste type are found in the technical reports published for the waste

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types (see Volume I, Section 15.2). For example, low-level waste is divided into six categories, each of which contains an assumed mix of isotopes. Each of these isotopes has a unique half-life, which could range from a few years to thousands of years.

Plutonium is listed in the ANL-E low-level waste management feedstock radiological profiles for fission products. It accounts for less than 1% of the total activity of ANL-E's low-level waste. (See the WM PEIS Low-Level Waste Technical Report, which is available in the DOE reading rooms listed in Volume I, Section 1.9, of the Final PEIS.)

Comment (3746)
The WM PEIS fails to disclose quantities and plans for the very hottest "low-level" radioactive waste, e.g., greater-than-Class-C (GTCC) waste and special-case waste.

Response
Low-level radioactive waste (LLW) includes all radioactive waste that is not classified as high-level waste (HLW), spent nuclear fuel, transuranic waste (TRUW), or uranium and thorium mill tailings or waste from processed ore. As described in Section 1.5.6 in Volume I of the WM PEIS, under the Low-Level Radioactive Waste Policy Amendments Act of 1985, DOE is responsible for managing commercially generated GTCC LLW. GTCC exceeds NRC concentration limits for Class C LLW specified in 10 CFR Part 61, and is, therefore, generally not suitable for near-surface disposal. However, unlike TRUW and HLW, this waste is not included for disposal in a geological repository authorized by the Nuclear Waste Policy Act. DOE has identified certain waste as special-case waste that does not fit into typical management plans. Special-case LLW includes highly radioactive LLW that cannot comply with the waste acceptance criteria of near-surface disposal facilities.

DOE is currently developing strategies for managing GTCC and special-case LLW that include disposal. On March 13, 1995, DOE published a notice in the *Federal Register* inviting interested parties to provide input into the development of strategies. Subsequently, two workshops were held to discuss preliminary strategies. Based on the input received, alternative strategies will be evaluated in a NEPA review once a proposal is developed.

Comment (3934)
The volumes and types of wastes considered in the WM PEIS omit major predictable, known categories and sources within the current DOE inventory, as well as categories and sources that DOE can reasonably expect to be created within the next 20 years.

Response
The volumes and types of wastes included in the Draft WM PEIS were based on the best information available at the time the Draft PEIS was prepared. The Final PEIS includes updated data (see Appendix I in Volume IV). The databases containing waste volumes and types are available to the public.

The WM PEIS includes only categories of waste that are appropriate for a programmatic decision. Volume I, Chapter 1, of the WM PEIS includes a discussion on which wastes were included and excluded, with supporting rationale.

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Comment (4015)
DOE should update the BNL portion of Table 4-2 in Volume I because (1) for low-level mixed waste, the table reports 85 cubic meters in inventory and 110 cubic meters to be generated over 20 years, while Chapter 11 shows 10 cubic meters and 20 cubic meters, respectively; and (2) the table does not list any low-level waste quantity for BNL, while Chapter 11 indicates that there are 400 cubic meters in inventory and 4,000 cubic meters to be generated over 20 years.

Response
The analysis in the Draft WM PEIS was based on inventory and projected waste volumes for each generating site as listed in the databases identified in the Draft. The sources of WM PEIS waste volumes are identified at the beginning of Chapters 6 through 10 and reflect a "snapshot in time." This snapshot is considered sufficient for the broad programmatic decisions to be made based on the WM PEIS.

Since the Draft WM PEIS was published, new information from updated databases has become available. Appendix I in Volume IV of the Final WM PEIS discusses updated waste-volume information and whether the new information affects any of the impacts described in the WM PEIS. Where the newer data were likely to cause significant increases in the impacts predicted based on the older data, sites are reevaluated. Where the new data showed decreases, however, the older analyses were retained to assure a conservative approach that captured the greater possible impacts. For BNL, the new data predicted low-level mixed waste decreases and low-level waste increases. Thus, low-level waste at BNL was reevaluated, while the existing low-level mixed waste evaluation was retained. Table 1.6-2 indicates the waste volumes used in the final analysis, which is 190 cubic meters of low-level mixed waste for inventory plus 20-year projected generation at BNL, based on the old data (see Appendix I, Table I.2-1). For low-level waste at BNL, the new data reports 5,640 cubic meters for inventory plus 20-year generation, as indicated in the revised Table 1.6-2 and in Appendix I. DOE has revised Volume I, Section 11.2, to be consistent with Table 1.6-2 and Appendix I.

Comment (4038)
Please note that there is controversy over whether the numbers for accumulated radioactive and hazardous waste from past nuclear weapons research and production on which the Draft WM PEIS is based are accurate. If the PEIS substantially understates the amount of environmental restoration waste, the balance between cleanup and ongoing weapons program waste management activities could be altered. This does not, however, change the fact that DOE is proposing new weapons research and production capabilities at a time when it has barely begun to address the problems caused by past activities.

Response
As described in WM PEIS Appendix B (Volume III) and Sections 6.15, 7.15 and 8.15 (Volume I), environmental restoration waste volumes were updated for the Final WM PEIS based on the database used for the 1996 Baseline Environmental Management Report, which was the best information available when the Final WM PEIS was prepared. The environmental restoration waste volumes at certain sites have substantially increased, based on the updated data. The WM PEIS contains a qualitative discussion on the potential effects of transferring some environmental restoration wastes to the Waste Management Program. Much of the environmental restoration waste is likely to be managed in place or in environmental restoration facilities. Appendix B provides details on environmental

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restoration wastes. Environmental restoration waste management decisions will be made on a site-by-site basis.

The waste-volume data used in the Draft WM PEIS were obtained from the best available sources of information at the time of the analysis about how much waste there was, and where it was at the time DOE prepared the Draft PEIS. Many of the more recent DOE documents have used waste-volume data from more recent databases on this subject, resulting in inconsistencies between the various DOE documents. Appendix I in Volume IV of the Final WM PEIS provides an update of all of the site-specific waste-volume data for low-level waste, low-level mixed waste, and transuranic waste. A partial reanalysis using these updated volumes has been accomplished by determining the chemical and radioactive emissions for particular low-level waste, low-level mixed waste, and transuranic waste alternatives. Appendix I in Volume IV discusses why these waste volumes have changed and how the new data might affect the impacts estimated by the WM PEIS analysis. Also, where large changes in impacts were likely, DOE reevaluated the impacts with the more recent data and revised the WM PEIS.

The WM PEIS analyzes the potential environmental impacts of managing the existing inventory and 20 years of projected waste inventory. Proposed new weapons research and production capabilities are outside the scope of the WM PEIS and, thus, are not addressed in the WM PEIS.

Comment (4044)
No two documents generated by DOE appear to agree on total volumes of particular categories of radioactive waste. For example, there are extremely wide variations in waste volumes between the 1995 WM PEIS, 1995 Baseline Environmental Management Report, and 1992 Integrated Data Base (particularly low-level and mixed wastes). This casts significant doubt on the statistical precision attempted in the risk assessment tables of the Draft WM PEIS, and on DOE's determinations of the extent of new facilities and transportation required to manage the large volumes of radioactive waste.

Response
The Draft WM PEIS identified the sources of waste volumes. Those sources represented the best available data at the time of the analysis on how much waste there was and where it was at the time DOE prepared the Draft WM PEIS.

Sites are constantly updating their data on inventory waste, performing additional analysis of their waste, and implementing pollution prevention practices, all of which result in different waste volumes. The WM PEIS used the official databases rather than individual site estimates to achieve a degree of consistency in the assumptions on existing inventories and projected waste generation. Generally, the waste volumes analyzed in the WM PEIS are higher and, therefore, provide a more conservative impact analysis. Updated inventory data for the individual sites are still within the range of the WM PEIS analysis (see Appendix I in Volume IV in the Final PEIS). DOE revised the applicable WM PEIS technical reports to include the updated waste volumes data.

Comment (4046)
The WM PEIS should not assume that the existing regulatory scheme for radioactive waste characterization will remain in effect for the indefinite future. The PEIS should also address the potential regulatory and financial consequences of the adoption of an alternative waste classification regime, especially since the administrative categories of low-level waste, high-level waste, and

transuranic waste have been criticized as not being based on human health risk, radioactivity, or half-life, but instead as rules of administrative convenience.

Response
The evaluation of the effects of a different waste classification system based on hazard rather than existing regulatory standards would be speculative and, therefore, impossible to meaningfully analyze.

The waste categories used by DOE to describe its wastes are established by statutes that define waste categories (e.g., the Nuclear Waste Policy Act). Regulations of EPA and NRC also use waste categories that incorporate the statutory scheme. Thus, changing to a risk- or hazard-based nomenclature system would require statutory changes by Congress.

While the present system of categorizing wastes might be imperfect, it does divide radioactive wastes into hazard categories that are useful as a first, "rough cut" approximation. In general, transuranic wastes do not need to be remotely handled, yet the plutonium and other transuranic radioisotopes have long half-lives and require permanent isolation from the human environment. High-level waste contains high concentrations of gamma-emitting radionuclides, as well as long-lived radioisotopes, and must be remotely handled. Low-level waste, *in general,* presents less of an external radiation exposure hazard than high-level waste, and contains lower concentrations of long-lived, alpha-emitting radionuclides than does transuranic waste.

Because the present nomenclature is not fully descriptive of the hazards of the wastes, DOE also considers the specific hazards of each waste stream when making waste management decisions. Different radionuclides emit different kinds (alpha, beta, and gamma) and strengths (measured in electron volt, eV, units) of radiation. For example, as described in Volume I, Section 1.5 of the WM PEIS, low-level mixed waste and low-level waste are further divided into the categories of contact-handled and remote-handled and alpha and non-alpha waste. Transuranic waste is divided into contact-handled and remote-handled categories. This depends on the specific radionuclides that are present in the waste, and their concentrations.

Thus, the WM PEIS analysis does take the major characteristics of the waste, within each waste type, into consideration in determining risks and other impacts from treatment, storage, and disposal.

Comment (4065)
Unless the Final WM PEIS includes an analysis of options for "legacy" waste *without* the addition of stockpile stewardship and management wastes and related research and development generated waste, it will continue to be grossly incomplete. Distinctions can and must be made between existing wastes currently in storage and programmatic wastes not yet generated, over which we can exercise a much greater degree of choice and, therefore, control.

Response
The WM PEIS was intended to provide an analysis upon which to make programmatic decisions and includes existing inventories and projected wastes from the Stockpile Stewardship and Management Program and related research and development. It was, therefore, necessary to include both inventory wastes, which are included in inventory volumes, and newly generated wastes in its WM PEIS analysis so that impacts would not be underestimated. Impacts of managing inventory wastes would be within the range of impacts described in the PEIS. However, because DOE must manage both inventory and

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newly generated wastes and would use the same facilities and technologies for both categories of waste, alternatives that handled them separately would not be considered reasonable and would likely be considered improper segmentation of the waste management actions under NEPA.

Appendix G in Volume IV of the WM PEIS does consider the distinction between inventory wastes and projected waste generation; however, by assuming potential waste minimization reductions to projected wastes and discussing how these reductions might affect impacts.

Comment (4457)
No evidence was presented in Section 6.1 of the Draft PEIS Summary document to support the assignment of radiological profiles uniformly to each transuranic waste (TRUW) stream at DOE sites, nor was the significance of nonuniformity assessed sufficiently to establish that the modeling used is adequate for DOE decisionmaking.

Response
DOE revised the information on nonuniformity, which is now presented in the Final WM PEIS in Volume I, Section 8.2.1.2, to clarify the derivation of TRUW radiological profiles. DOE also revised the Summary document.

Radionuclide concentrations for the 10 largest generators of TRUW were obtained from process knowledge, supplemented by limited sampling and analysis of stored TRUW. Smaller generators were assumed to have the same concentrations as LANL. Derivation of radiological profiles at each site was based on estimated radionuclide concentrations in the TRUW at the site. These profiles identify the radionuclides likely to be encountered, which influences risk and other impacts.

These methods were based on the best available data at the time the Draft WM PEIS analysis was performed. DOE, through its management and operations contractors, continues to develop better ways to determine radiological profiles as part of its ongoing site monitoring efforts.

Comment (4515)
The categories of waste in the Draft WM PEIS are oversimplified and inadequate to support the WM PEIS and associated analyses. The chemical and physical characteristics of waste (beyond their overall physical structure) need to be divided into many subcategories to determine the appropriate physical and chemical waste treatment processes needed to properly treat the waste and prepare it for disposal, and to estimate the associated environmental impacts.

Many of the radioactive waste categories need to be subdivided into wastes that pose a significant hazard over very long time periods those that would not pose such a hazard if stored for a few decades, etc.

Response
DOE performed its analysis of waste treatment by developing treatment categories based on the chemical and physical characteristics of the waste. The waste in each category would follow a unique set of treatment technologies, called a "treatment train," to achieve a prescribed level of decontamination. Dividing the waste into a number of different treatment trains would become very expensive because the economies of scale would be lost in the resultant small-throughput volumes of waste at each treatment facility. Too few treatment trains would be very inefficient, because efficient

destruction of the wide range of chemical contaminants that could be present in a particular treatment train would not be likely.

DOE carefully chose the categories of waste described in the WM PEIS analysis to avoid the problems discussed above. For example, the low-level mixed waste analysis in the PEIS used 23 different treatment categories for each of five handling categories (contact-handled non-alpha; contact-handled alpha; remote-handled non-alpha; remote-handled alpha; and polychlorinated biphenyls). DOE believes that this level of detail is appropriate for a programmatic analysis. More information on treatment categories is presented in the technical reports that support each of the waste-type chapters. The technical reports are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final PEIS.

To some extent, the current waste classification system addresses the half-lives of radionuclides. The distinguishing characteristic of transuranic waste is that it contains relatively high concentrations of radionuclides with long half-lives that must be isolated for long periods. The waste acceptance criteria for some DOE disposal facilities have classification criteria that require stabilization of waste with relatively high concentrations of certain long-lived radionuclides.

8.1.1 Low-Level Mixed Waste

Comment (1688)
Table 1.6-2 lists ORR with 26% of DOE's low-level mixed waste inventory. Explain what current or proposed ORR operations (excluding environmental restoration) are or will be responsible for generating over 25% of the low-level mixed waste in DOE's total inventory.

Response
The Draft WM PEIS estimates of low-level mixed waste current inventory and 20-year projected generation volumes were obtained from the 1992 Mixed Waste Inventory Report. This was the best source of low-level mixed waste data at the time DOE prepared the Draft PEIS. More recent mixed waste data are provided in the 1995 Mixed Waste Inventory Report, and DOE used the revised data in selected new analyses for the Final WM PEIS. Appendix I in Volume IV of the Final PEIS presents this updated waste-volume data. Table I.2-1 indicates a decrease in the estimated inventory plus 20-years generation of low-level mixed waste at ORR from 59,000 cubic meters to 50,000 cubic meters, based on the 1995 Mixed Waste Inventory Report. DOE has revised Table 1.6-2 to indicate that this more up-to-date information on waste volumes is located in Appendix I.

Activities that are responsible for the generation of low-level mixed waste at ORR include routine laboratory research, physical-plant activities and laboratory cleanout at ORNL, manufacturing and development engineering at the Y-12 Plant, and waste management at the K-25 Site.

A described in the 1995 Mixed Waste Inventory Report, the three largest sources of low-level mixed waste at ORR, and the type of waste generated, are sludge from the Y-12 Central Pollution Control Facility, ash from the K-25 TSCA incinerator, and sludge from the K-25 Central Neutralization Facility.

Comment (2002)
The WM PEIS discusses the radioactive portion of mixed waste; it should discuss the total concentrations of all constituents in the waste.

Response
For low-level mixed waste, the impact analyses, including health risks and ecological resource impacts, considered the impacts of releases of both radionuclides and hazardous constituents from waste management facilities.

Volume I, Section 6.2.1.1, of the WM PEIS describes the constituent chemical profiles that DOE assigned to identify the composition and concentration of RCRA hazardous chemical constituents that are expected to be present in low-level mixed waste. Sixteen hazardous chemical constituents (six toxic metals, three inorganic chemicals, and seven classes of organic chemicals) were evaluated, based on their presence in 32 mixed waste streams.

Concentrations of chemical constituents in most low-level mixed waste streams are not well known. DOE has performed chemical analyses of the RCRA hazardous constituents on only a limited number of low-level mixed waste streams. For most low-level mixed waste streams, information concerning the chemical constituents comes from what is known about the history of the site that generated the waste. The composition and concentration of hazardous chemical constituents for the low-level mixed waste streams were developed by (1) compiling chemical composition data presented in DOE's May 1994 edition of the Mixed Waste Inventory Report and (2) performing an engineering assessment of the industrial processes that generated the respective low-level mixed waste streams. Low-level mixed

waste chemical profiles were assumed to be independent of the site that generated the waste and dependent only on the waste treatment code, based on information about historical DOE site operations and industrial processes, and Mixed Waste Inventory Report data.

Comment (2003)
Section 6.1.2 states that "waste volumes were extrapolated." List factors and assumptions made for low-level mixed waste extrapolations or cite references in this paragraph.

Response
Volume I, Section 6.1.2, describes how estimates of the current low-level mixed waste inventories and amounts DOE expects to generate were developed for each of the 37 low-level mixed waste sites. The 1994 Mixed Waste Inventory Report was the source of the mixed waste-volume data used for the WM PEIS analysis. This source of data was chosen to ensure consistency with quantities of wastes considered in the Site Treatment Plans required by the Federal Facility Compliance Act. The Mixed Waste Inventory Report lists (as of 1994) inventories of mixed waste and projected generation volumes of mixed waste for only 5 years. For the WM PEIS analysis, DOE needed waste projections for the next 20-year period of analysis. DOE used several techniques to obtain the 20-year projection. The data survey conducted to support Mixed Waste Inventory Report provided 20-year estimates for many individual waste streams. DOE used the 20-year estimates where available, and extrapolated the last year out to 20 years where the estimate was for less than 20 years. When the survey indicated that generation of a waste stream would end before 20 years, DOE also ended the projection, as indicated in the survey. A description of how these projections were developed is in the technical report, *Mixed-Waste Treatment Model: Basis and Analysis,* which is cited in WM PEIS.

Updated waste volume inventories are presented in Volume IV, Appendix I, of the Final WM PEIS.

Comment (2074)
Do the low-level mixed waste waste volumes listed in the WM PEIS include blend-down of highly enriched uranium with depleted uranium?

Response
As discussed in Section 1.8.2 of the WM PEIS, DOE issued the Disposition of Surplus Highly Enriched Uranium EIS in 1996. That EIS addresses the disposition of a nominal 200 metric tons of surplus highly enriched uranium (175 metric tons has been declared surplus to defense needs to date) to make the material non-weapons-usable and to recover its economic value where possible. The preferred alternative is to blend as much of the material as possible (up to 85%) for use as fuel in commercial nuclear power reactors and to blend the remainder for disposal as waste. The Record of Decision for that EIS, published in the *Federal Register* on August 6, 1996, opts for this preferred alternative. The blended waste is not included in the waste volumes in the WM PEIS although the cumulative impacts are included in Chapter 11 in Volume I. However, blended waste volumes from the disposition of highly enriched uranium would be small compared to the waste volume projections in the WM PEIS.

Comment (2421)
Volume I, Section 1.5.3, states that after characterization, some waste currently managed as transuranic waste might be reclassified as low-level mixed waste. DOE needs to distinguish between this alpha low-level mixed waste and other low-level mixed waste because current thinking, at least at

8.1.1 Low-Level Mixed Waste

INEL, is that alpha low-level mixed waste will be treated along with transuranic waste and both codisposed at WIPP.

Response
DOE recognizes that the sentence cited in the comment might have been confusing and deleted it from the PEIS.

The WM PEIS separates non-alpha low-level mixed waste from alpha low-level mixed waste, which DOE would manage at facilities designed for alpha waste. As stated in Volume I, Section 1.6.2. of the PEIS, variations in waste volumes, classification, and management are uncertainties that DOE does not expect will affect programmatic decisions. This discussion is elaborated in Appendix I (Volume IV). Sitewide or project-level NEPA reviews would consider site-specific data about the wastes.

The WIPP SEIS-II provides a detailed analysis of transuranic waste disposal.

Comment (2500)
In Volume I, Section 5.2.1, what is the third site for which DOE adjusted the low-level mixed waste analysis to correct waste inventories?

Response
DOE has revised the text in Section 5.2.1 to clarify which of the sites where corrections to waste inventories or projections were made. These sites are Colonie, RFETS and ETEC, ANL-E, and NTS.

Comment (2953)
Does the volume of low-level mixed waste for ORR in the Summary document include Portsmouth and PGDP, and wastes currently stored on the sites for treatment?

Response
The waste volumes presented in the Summary document and the body of the WM PEIS reflect current waste inventories and projections of future waste at ORR, the Portsmouth Plant, and PGDP as separate entities. However, wastes currently at ORR that originated at the Portsmouth Plant or PGDP are included in totals for ORR. The PEIS considers waste currently stored at a particular site part of the existing inventory at that site, regardless of its origin.

Comment (3189)
The total volume of PGDP low-level mixed waste reported in the WM PEIS is 600 cubic meters based on 1994 data. The PGDP Site Treatment Plan addresses a total volume of 1,032 cubic meters based on 1994 data. Please explain this discrepancy.

Response
The total volume of low-level mixed waste reported in the Draft WM PEIS was based on data from the 1994 Mixed Waste Inventory Report, which was the best available source of low-level mixed waste data at the time DOE prepared the Draft PEIS. The Final WM PEIS includes data from the 1995 Mixed Waste Inventory Report (see Appendix I), which lists 1,000 cubic meters of low-level mixed waste at PGDP.

8.1.1 Low-Level Mixed Waste

Comment (3761)
DOE needs to explain which waste volumes will be used in making the final decisions regarding ANL-E; the current waste volume of 8,000 cubic meters, or the projected waste volume of 140 cubic meters?

Response
The analysis of low-level mixed waste in the Draft WM PEIS was performed using waste data derived from the 1994 Mixed Waste Inventory Report. Since that analysis, the Mixed Waste Inventory Report has been updated using 1995 data. The changes in waste volumes at each DOE site as reported in the latest Mixed Waste Inventory Report are addressed in Appendix I. For ANL-E, the estimated inventory plus 20 years generation was revised downward from 8,400 cubic meters to 160 cubic meters. Those revised inventories were used to estimate impacts in the Final WM PEIS, and will be used to compare alternatives and support decisionmaking.

Comment (3987)
DOE has projected that the Portsmouth Plant will generate 25,000 cubic meters of low-level mixed waste (LLMW) within the next 20 years. Inventory is projected to be 33,000 cubic meters of LLMW. Did DOE use USEC operations to arrive at this projected volume of LLMW?

Response
LLMW volumes for the Portsmouth Plant include waste generated by USEC operations. The waste volumes given in Chapter 6 of the Draft WM PEIS were based on information from DOE's 1994 Mixed Waste Inventory Report. Updated data from DOE's 1995 Mixed Waste Inventory Report are contained in Appendix I in Volume IV of the Final PEIS. The updated data show a decrease in inventory plus 20 years of generation from 33,000 cubic meters to 15,500 cubic meters at the Portsmouth Plant.

Comment (3988)
It is extremely difficult to believe that DOE has not already made some assumptions about what treatments and processes will be used and where in order to arrive at the predictions listed in Table 6.1-1.

Response
Table 6.1-1 in Volume I lists quantities of low-level mixed waste that have been generated and are awaiting treatment, storage, and disposal at waste management facilities, or that are predicted to be generated over the next 20 years. These wastes will be generated by other organizations within DOE, such as Defense Programs, and will be transferred to waste management facilities. Sizing and siting of low-level mixed waste facilities addressed in this document will be based on what is needed to manage the waste volumes given in Table 6.1-1.

Waste volumes in Table 6.1-1 of the Draft WM PEIS were based on information in the 1994 Mixed Waste Inventory Report. Updated waste-volume data from the 1995 Mixed Waste Inventory Report are contained in Appendix I, Volume IV, of the Final WM PEIS. Table 6.1.1 has been changed in the Final WM PEIS as a result of the discussion presented in Appendix I.

8.1.1 Low-Level Mixed Waste

Comment (3989)
Table 6.1-2 indicates that the Portsmouth Plant capable of treating 7,781,620 cubic meters per year and planned capacity of an additional 84,528 cubic meters. What aqueous treatment facility is currently being planned for Portsmouth? Portsmouth current capacity for aqueous treatment already exceeds all other listed major sites, according to this chart.

Response
The WM PEIS Affected Environment Technical Report describes the Portsmouth Plant current aqueous waste treatment capacity as a 7,400,000 cubic-meters-per-year liquid effluent control facility, three groundwater treatment facilities with a total capacity of 267,516 cubic meters per year, and a small filtration and neutralization facility. Section 2.11.0 of that technical report lists a planned capacity of 169,098 cubic meters per year for two groundwater treatment facilities under construction. The technical report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

8.1.2 Low-Level Waste

Comment (495)
"The definition of LLW [low-level waste] is < 100 nCi/g." Not enough attention has been given to this definition and the possibility that LLW might be redefined. There needs to be a lower end to the definition for LLW, such as how much above background. The definition for LLW needs to be definitized. DOE needs to tell the public what would happen to the risks if the nanocurie level defined for LLW changed upwards.

Response
The WM PEIS uses standard and approved definitions for each of the five waste types. LLW is defined in Section 11(e)(2) of the Atomic Energy Act of 1954 (42 USC 2011 *et seq.*) as waste containing radioactivity that is not classified as high-level waste, transuranic waste (TRUW), or spent nuclear fuel, and is not byproduct tailings containing uranium or thorium from processed ore. LLW can also be test specimens of fissionable material irradiated for research and development if the concentration of transuranics is less than 100 nanocuries per gram of waste. It is both beyond the scope of the WM PEIS and inappropriate to change the definitions of waste types. It is assumed that the reference in the comment to concentrations less than 100 nanocuries per gram refers to the boundary between LLW and TRUW. This boundary pertains only to waste containing alpha-emitting transuranic radionuclides with half-lives greater than 20 years. There is no limit on the concentration of radionuclides otherwise.

Comment (1089)
DOE should address wastes with very low levels of radioactivity, including the large quantity of very low-level waste at FEMP.

Response
Low-level waste is one of the five waste types analyzed in the WM PEIS, and is addressed in detail in Volume I, Chapter 7, of the WM PEIS. DOE assumes the commentor is referring to environmental restoration low-level waste, because FEMP has no low-level waste for which the Waste Management Program is responsible. Some of FEMP's low-level waste is only slightly radioactive.

Comment (1358)
The WM PEIS identifies a total current inventory plus 20-year projected volume of 220 cubic meters of low-level waste at the Princeton Plasma Physics Laboratory (PPPL). This amount appears to be low when compared to the projections made in the Environmental Assessment for the Tokamak Fusion Test Reactor Decontamination and Decommissioning Project and the Tokamak Physics Experiment.

Response
DOE obtained the low-level waste volume data used in the WM PEIS from the 1992 Integrated Data Base and the 1994 Waste Management Information System Database. These sources provided the best available data on waste inventories and generation at the time DOE prepared the Draft WM PEIS. The information in the *Tokamak Fusion Test Reactor (TFTR) Decontamination and Decommissioning Project and the Tokamak Physics Experiment Environmental Assessment* is newer than the information used in the Draft WM PEIS. In addition, that environmental assessment includes wastes from decontamination and decommissioning that were not included in the WM PEIS waste volumes. However, even if DOE considered the 1,450 cubic meters of low-level waste reported in the Tokamak environmental assessment in the WM PEIS, PPPL would still be a small generator and not a "major"

8.1.2 Low-Level Waste

site. Therefore, the WM PEIS alternatives would not change, and PPPL would continue to ship wastes to other sites under all WM PEIS alternatives.

The Final WM PEIS includes updated waste-volume data and an evaluation of how the new data on low-level waste, low-level mixed waste, and transuranic waste could affect the analyses of alternatives in the PEIS (see Volume IV, Appendix I).

Comment (1498)
One commentor stated that low-level does not mean low hazard and that low-level wastes could be contaminated with a number of different radionuclides, up to and including plutonium.

Response
Low-level radioactive waste is defined by what it is not (spent nuclear fuel, high-level waste produced in reprocessing spent nuclear fuel, transuranic waste). Some low-level waste is slightly contaminated; other low-level waste might be highly radioactive. DOE low-level radioactive waste might contain small quantities of plutonium. However, since plutonium is a transuranic element (its atomic number is greater than that of uranium), the amount of plutonium in low-level waste is greatly limited. Waste that contains more than 100 nanocuries per gram of alpha-emitting transuranic radionuclides with half-lives greater than 20 years is transuranic waste.

Comment (1747)
The low-level waste volumes listed for ORR are not consistent with the solid low-level waste volumes data from the DOE ORNL Waste Management Remedial Action Division. If both liquid and solid waste volumes are considered in the WM PEIS, the volume of solid waste alone would seem to be the more pertinent number, since liquid low-level wastes will probably continue to be treated onsite, and only secondary waste streams from liquid waste treatment will be disposed of, with a much larger volume of the treated waste stream being discharged under NPDES or air pollution permits. Please clarify. Are Table 7.1-1 low-level waste volumes given prior to compaction of these materials?

Response
Table 7.1-1 of the WM PEIS provides estimates of the current inventory and 20-year projected generation volumes for solid low-level waste prior to compaction. It does not include wastewater volumes. These estimates were derived from the 1992 Integrated Data Base and are generally higher than the estimates contained in more recent reports (see Volume IV, Appendix I). Changes in low-level waste volumes as a result of compaction were taken into account in the PEIS analysis.

Comment (1929)
The figure for low-level radioactive waste at the Pantex Plant, which shows a value of 40,000 cubic meters for current inventory plus 20 years production, is about 85 times too large.

Response
Volume IV, Appendix I, of the Final WM PEIS presents updated waste volume inventories and projections, and indicates a much lower amount of low-level waste for the Pantex Plant than was listed in the Draft WM PEIS.

8.1.2 Low-Level Waste

Comment (1938)
How much low-level waste will be stored at ANL-E and what is its half-life? Will this waste be from Illinois only or shipped from elsewhere?

Response
Low-level mixed waste and low-level waste are described in Volume I, Sections 1.5.1 and 1.5.2, respectively, of the WM PEIS. Most low-level waste can be handled without additional shielding or remote-handling equipment. Low-level waste could contain isotopes with either long or short half-lives. For example, uranium-238 is a naturally occurring isotope that has a half-life of several billion years. Isotopes of other elements in low-level waste could have half-lives of less than 1 year. A full discussion of the quantities and radiological profiles of low-level waste and low-level mixed waste used in the WM PEIS can be found in the technical reports for those waste types, which are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

New waste data became available after DOE prepared the Draft WM PEIS. These data are presented in Volume IV, Appendix I, and were used in new analyses for the Final WM PEIS.

Under the Decentralized Alternatives for low-level mixed waste and low-level wastes, ANL-E would manage its own wastes and a small quantity of low-level mixed waste and low-level waste generated at Ames and Fermi. Under the Regionalized and Centralized Alternatives, all ANL-E wastes would be managed at other DOE sites.

Comment (2080)
The Draft WM PEIS Summary document says the highest risks to offsite populations would occur at FEMP, LLNL, and the Portsmouth Plant when thermal treatment of tritium-contaminated waste is assumed. Is the tritium onsite at Portsmouth, and will Portsmouth receive tritium from offsite in the future?

Response
The tritium that would present the highest risks to offsite populations near the Portsmouth Plant under low-level waste Regionalized Alternative 4 and Centralized Alternatives 3 and 4 would originate at other DOE sites.

The Portsmouth Plant does not have tritium-contaminated waste onsite. Any risk that occurs from thermal treatment of tritium-contaminated waste would come from waste being shipped to the Portsmouth Plant. Sites that have this type of waste and would ship to the Portsmouth Plant under various low-level waste or low-level mixed waste alternatives include ANL-E, Princeton Plasma Physics Laboratory, and the Mound Plant. Under some alternatives, ANL-E and the Mound Plant would ship tritium-contaminated waste to FEMP for thermal treatment. Lawrence Berkeley Laboratory would ship its tritium-contaminated waste to LLNL. LLNL would also treat its own tritium waste under the alternatives in which it conducts thermal treatment of wastes. The WM PEIS Low-Level Waste Technical Report identifies sites with tritium-contaminated low-level waste. DOE assumed that the low-level waste portion of low-level mixed waste at those sites would have the same characteristics. Chapters 6 and 7 of the WM PEIS identify where each site would ship low-level waste and low-level mixed waste for treatment.

8.1.2 Low-Level Waste

Comment (2200)
The PEIS failed to include as low-level waste the surplus facility reactor cores and the naval submarine cores.

Response
The management of spent nuclear fuel is analyzed in the SNF/INEL EIS and is included in the WM PEIS cumulative impacts analysis (see Chapter 11 in Volume I). The deactivated reactor vessels and their internals are decontamination and decommissioning wastes that are the responsibility of the Environmental Restoration Program (at least at Hanford). Environmental restoration waste is included in the WM PEIS only to the extent that it might affect the comparison among waste management alternatives (see Appendix B in Volume III).

Naval submarine reactor compartments are disposed of with the spent nuclear fuel removed. The defueled naval submarine reactor compartments are not included in the WM PEIS because their disposal is addressed in the SNF/INEL EIS.

The disposition of some defueled naval reactor plants is discussed in *Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Cruiser Ohio Class and Los Angeles Class Naval Reactor Plants*, issued by the Navy in April 1996. More than 40 defueled naval reactor plants have been shipped from the Puget Sound Naval Shipyard to the Hanford Site and disposed of in Trench 94 in the Hanford burial grounds. The reactor compartment packages currently in Trench 94 are regulated as a mixed waste because they contain activated metals, solid lead shielding regulated by Washington State, and polychlorinated biphenyls regulated under the Toxic Substances Control Act. The preferred alternative in the above-referenced EIS is to continue to ship this material to Hanford for disposal in Trench 94.

Naval reactor compartment packages already disposed of are not subject to additional waste management activity and, therefore, are not included in the waste volumes in the WM PEIS. WM PEIS Appendix I (Volume IV) lists 37,000 cubic meters of mixed waste to be shipped from Puget Sound to Hanford for disposal. Thus, disposal of surplus naval reactor cores is included in the WM PEIS to the extent that they are in the 1995 Mixed Waste Inventory Report.

Comment (2341)
In the activated bulk metal/equipment category, cobalt-60 is the only one being considered. I believe nickel-63 should also be considered in Table 7.2-1. I mention nickel because of absorption of this into the steel beams of old nuclear power plants. These power plants are to be dismantled and I assume will be included in your bulk activated items.

Response
Table 7.2-1 in Volume I of the WM PEIS identifies the radiological categories, but does not list all the nuclides in each category. The nuclides in each category, including nickel-63, are listed in the WM PEIS Low-Level Waste Technical Report. Nickel-63 is a component of the Induced Activity radiological category. DOE has modified the supporting text for Table 7.2-1 to reference the technical report for detail on the radiological categories.

8.1.2 Low-Level Waste

Comment (2440)
Where does the WM PEIS account for the alpha-contaminated low-level waste stored at INEL's Radioactive Waste Management Complex (RWMC)? Approximately 27,000 cubic meters of the 65,000 cubic meters of transuranic waste stored at the RWMC are of this type. Because the INEL alpha waste is to be treated and disposed of along with the INEL transuranic waste, DOE should include it in the transuranic waste chapter of the WM PEIS.

Response
DOE used standard definitions for each of the waste types analyzed in the WM PEIS that do not necessarily reflect site-specific definitions. In the PEIS, transuranic waste is defined as radioactive waste having concentrations greater than 100 nanocuries per gram of transuranic elements. Although at INEL all alpha low-level waste with greater than 10 nanocuries per gram is considered to be mixed and treated and disposed of as transuranic waste, this is not the case in the PEIS. Rather, the PEIS accounts for these wastes as alpha low-level mixed waste, and they are included in the low-level mixed waste chapter (Chapter 6).

Comment (2783)
Use of the 1992 Integrated Data Base is obviously inappropriate for BNL, as it shows BNL producing no low-level waste (LLW). Since there is no quantification of LLW produced at BNL, I assume that all LLW risk analyses are fatally flawed, even by DOE standards, because it is also assumed throughout that BNL does indeed produce LLW. This must be addressed.

Response
The 1992 Integrated Data Base, the source of LLW data for the Draft WM PEIS, did not provide LLW data for BNL. Thus, the evaluation in the Draft PEIS for BNL did not include impacts from management of LLW. However, Tables 1.6-2 and 7.1-1 in Volume I of the Final PEIS show that the projected LLW volume at BNL is 5,600 cubic meters. The updated data were obtained from the 1995 version of the Integrated Data Base. Consideration of updated LLW estimates for BNL are included in Appendix I in Volume IV of the Final PEIS. Appendix I addresses the issue of how updated waste projections affect WM PEIS alternatives. The updated data for BNL were used to estimate impacts in the Final WM PEIS.

The PEIS considers BNL a candidate site for disposal of its own LLW, but not a candidate for receipt of offsite LLW. Consideration of BNL as a site for disposal of onsite LLW does not mean that it will be selected as a disposal site.

Comment (3796)
The definition of low-level waste (LLW) is all-encompassing and exclusionary. The definition needs to be reviewed. Curie content and half-life should be considered in the definition.

Response
It is outside the scope of the WM PEIS to change the definition of LLW. LLW can be only slightly radioactive or highly radioactive and can contain radionuclides with a range of half-lives; therefore, DOE does not manage all of its LLW in the same way. As discussed in WM PEIS Volume I, Section 1.5.6, DOE manages two classifications of LLW that are not suitable for near-surface disposal. These are special-case LLW generated by DOE operations and LLW generated commercially that is more highly radioactive than Class C LLW according to the NRC rules in 10 CFR Part 61 (greater-

8.1.2 Low-Level Waste

than-Class-C LLW). DOE manages special-case and greater-than-Class-C LLW differently than other LLW.

DOE does not manage all LLW that is suitable for near-surface disposal the same. Disposal facilities impose waste acceptance criteria on the waste that they accept. For example, the waste acceptance criteria for the LLW disposal facility at Hanford categorize waste on the basis of the curie content of key radionuclides, including those with long half-lives. More highly radioactive or long-lived waste is required to be more highly stabilized and immobilized than other wastes.

Comment (3964)
Please clarify how FEMP can be listed as having no low-level waste (LLW) yet be listed for management of LLW and included in alternatives for disposal and treatment of LLW.

Response
When FEMP was identified as a candidate site for LLW treatment and disposal (disposal of onsite waste only), both environmental restoration and waste management wastes were to be evaluated in the WM PEIS. Because all LLW at FEMP is currently environmental restoration waste, which is no longer within the scope of the WM PEIS, only offsite waste is evaluated for treatment at FEMP. Disposal is not evaluated because FEMP disposal is limited to its own onsite waste in the definition of the alternatives. DOE revised WM PEIS Table 7.3-1 to make this distinction.

The PEIS does not evaluate environmental restoration alternatives and, therefore, does not quantitatively evaluate environmental restoration wastes at FEMP or other sites. The PEIS does evaluate how the comparison among waste management alternatives could be affected by the transfer of environmental restoration waste to the Waste Management Program. See Appendix B in Volume III. FEMP is currently included in the DOE Environmental Restoration Program. Wastes generated at FEMP will be the result of environmental restoration activities.

New data from the 1995 Integrated Data Base reported no waste management LLW generated or stored at FEMP, with no projected waste generation. Details on the amounts and characteristics of LLW that would come to FEMP are provided in the WM PEIS Low-Level Waste Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Appendix I in Volume IV of the PEIS provides a comparison of the latest waste volumes reported by DOE to the waste volumes used in the Draft PEIS.

Comment (4069)
All of DOE's buildings (e.g., LANL's Chemical and Metallurgical Research Facility) are solid, hazardous, low-level waste, and should be shut down, sealed in concrete, and monitored for migration of contaminants.

Response
DOE does not agree with this approach because of environmental, safety, regulatory, and health concerns.

8.1.3 Transuranic Waste

Comment (1748)
Much of the transuranic waste (TRUW) that was retrievably stored was buried in a variety of container types that have since degraded. It is very likely that transuranic waste stored in such a manner has already or will very soon be released to the environment. Discuss in greater detail the recoverability of transuranic waste that has been retrievably stored for the past 25 years.

Response
Waste volume source terms and radionuclide and hazardous chemical concentrations of retrievably stored TRUW are discussed in the WM PEIS Transuranic Waste Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. No significant emissions of radioactive or hazardous chemical constituents are expected during recovery of retrievably stored TRUW if storage containers remain intact. Corroded or damaged waste containers could result in releases during retrieval operations. Preliminary estimates indicate that about 72% of TRUW retrievably stored in drums has been stored for 10 or more years, and up to 30% of the drums might be badly deteriorated. Based on actual experience from waste container sampling programs at INEL, DOE assumes that 0.01% of the gaseous hazardous and radioactive constituents and 0.0001% of the hazardous and radioactive particulates would be released from breached containers and become airborne during retrieval operations. Retrieval operations, including repackaging, can be performed within enclosed structures maintained slightly below atmospheric pressure to minimize potential risk from emissions. High-efficiency particulate air filters can be used to reduce particulate emissions.

Comment (1758)
Are transuranic waste residues included in the WM PEIS analysis and would they go to WIPP? There has been conflicting information regarding disposal of plutonium residues at RFETS. We have been told that plutonium residues will go to WIPP. However, a DOE WIPP official told an audience at a meeting of the Rocky Flats Citizens Advisory Board on December 1, 1994, that WIPP does not have enough room for the RFETS plutonium residues. The WM PEIS does not clarify this issue.

Response
The WM PEIS analysis of transuranic waste at RFETS does include plutonium residues, as shown in Table 8.1-1. DOE plans to handle these residues like other types of transuranic wastes. Decisions concerning disposal of RFETS residues will be based on the analyses in the WIPP SEIS-II and other information. DOE is also preparing a separate EIS on treatment of the RFETS plutonium residues.

Comment (2071)
DOE needs to explain why transuranic waste was not included in the WM PEIS for the Portsmouth Plant. DOE needs to consider transuranic waste in the analysis because it is being mixed with low-level waste and oil contaminated with polychlorinated biphenyls.

Response
DOE obtained transuranic waste-volume data from the 1993 Mixed Waste Inventory Report and the 1992 Integrated Data Base, which were the most current sources at the time the Draft WM PEIS was prepared. Neither of these sources reported any inventory or projected generation of transuranic waste at the Portsmouth Plant. In preparing the Final PEIS, DOE considered newer sources of waste inventory data (see Appendix I in Volume IV). These sources also report no inventory or projected generation of transuranic waste at Portsmouth.

8.1.3 Transuranic Waste

As discussed in Section 1.6.2 in Volume I, the waste volumes analyzed in the WM PEIS represent a "snapshot in time," accurate to the extent existing inventories and future operations were understood when the databases were developed. Recognizing these uncertainties, DOE believes the waste volumes used for the WM PEIS analysis are sufficiently accurate for programmatic decisionmaking.

Comment (2343)
Considering transuranic waste as mixed waste creates the paradox of thermal treatment emitting radionuclides or having to abide by rules that require solvents and heavy metals be treated to land disposal restrictions criteria.

Response
As stated in Volume I, Section 8.1 of the WM PEIS, although approximately 60% of transuranic waste contains both radioactive and hazardous components, DOE assumes that all transuranic waste is mixed waste only for purposes of the WM PEIS analysis. The WM PEIS analysis includes alternatives under which TRUW would be treated to meet land disposal restrictions. Although the WIPP Land Withdrawal Act amendments contained in the 1997 Defense Authorization Act exempt waste to be disposed of at WIPP from RCRA's provisions regarding land disposal restrictions, land disposal restriction treatment alternatives are reasonable in that they allow DOE to evaluate the impacts of treating TRUW that might not be sent for disposal at WIPP. WM PEIS conclusions will support decisions for siting transuranic waste storage and treatment facilities. DOE will evaluate the level of treatment needed to support the safe disposal of transuranic waste at WIPP in the WIPP SEIS-II, and a decision will be announced in the WIPP SEIS-II Record of Decision.

Comment (2441)
Under Regionalized Alternative 3 for transuranic waste (Table 8.3-5), the 31% INEL would receive from offsite for treatment is more significant than it seems, as INEL has the largest volume of transuranic waste of all the DOE sites.

Response
The WM PEIS was designed to evaluate a range of treatment, storage, and disposal alternatives for the management of DOE's radioactive and hazardous wastes. In the case of transuranic waste, three treatment schemes (treatment to meet RCRA land disposal restrictions, treatment to reduce gas generation potential, and treatment to meet the WIPP waste acceptance criteria) are considered for Decentralized, Regionalized, and Centralized Alternatives. In moving from decentralized to regionalized treatment, transuranic waste is transferred to the sites having the most waste because the receiving sites have the greatest experience handling this waste and less untreated transuranic waste would have to be transported. As the site with the most transuranic waste, INEL is a reasonable candidate for a transuranic waste treatment facility.

Comment (2575)
What will happen to the transuranic waste that cannot be sent to WIPP either because it is pre-1970 (buried) transuranic waste or it would not meet waste acceptance criteria?

Response
As stated in Section 8.1.1 in Volume I of the WM PEIS, disposal of transuranic waste cannot begin until DOE meets a series of regulatory requirements imposed under the Waste Isolation Pilot Plant Land Withdrawal Act of 1992. Before it is shipped for disposal, all transuranic waste will be required

to meet the WIPP waste acceptance criteria being established by DOE in consultation with EPA and the State of New Mexico (DOE, 1991). These waste acceptance criteria are not yet final, but will be determined prior to operating WIPP as a disposal facility. For wastes that initially do not meet final waste acceptance criteria, further treatment might be necessary for it to be disposed of at WIPP. For purposes of analysis, DOE assumed that all transuranic waste will meet final WIPP waste acceptance criteria.

The WM PEIS analyzes retrievably stored defense transuranic waste, which has generally been stored since 1970. Before 1970, DOE buried transuranic waste. As it is considered environmental restoration waste, it will be managed in accordance with the CERCLA. While management of environmental restoration wastes are not within the scope of the WM PEIS, Section 8.15 in Volume I contains information regarding transuranic waste generated as a result of environmental restoration activities (including retrieval of buried transuranic waste) and the extent to which these waste volumes might influence WM PEIS alternatives.

DOE has prepared the WIPP SEIS-II to evaluate the potential impacts of disposal of transuranic waste, including pre-1970 buried waste, at WIPP. For further information on the WIPP SEIS-II and its relationship with the WM PEIS, see Section 1.8.1 in Volume I.

Comment (2576)
How was INEL's transuranic waste inventory calculated? There are currently 65,000 cubic meters of transuranic waste stored at INEL. Why does the inventory in the WM PEIS only show 39,000 cubic meters stored and generated over the next 20 years? Where is the remaining waste?

Response
The transuranic waste-volume data presented in Volume I, Chapter 8, of the Draft WM PEIS as current inventory were obtained from the 1993 Interim Mixed Waste Inventory Report and the 1992 Integrated Data Base and represent waste management wastes only. The data were extrapolated to estimate waste volume totals for the 20-year period of analysis. However, these waste inventories do not include wastes projected to be generated as a result of environmental restoration activities, nor do they include pre-1970 transuranic waste (also known as buried TRUW). Table B.5-3 in Volume III shows that DOE estimates environmental restoration transuranic waste to be 9,700 cubic meters at INEL based on updated information from the 1996 Baseline Environmental Management Report. Appendix I in Volume IV of the Final WM PEIS addresses how newer waste-volume data obtained from updated versions of the Mixed Waste Inventory Report and the Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report, Revision 2, might affect the analyses of alternatives in the WM PEIS.

Comment (2780)
Volume I, Section 1.5.3, states that, after characterization, some waste currently managed as transuranic waste may be reclassified as low-level mixed waste. This statement is of great concern as it implies that the more radioactive (and, therefore, more hazardous) transuranic waste could be reclassified as a less hazardous waste through a simple paper definition. The implication and meaning of this statement and policy must be fully revealed in the PEIS. Furthermore, it should be noted that BNL is completely inappropriate to receive this type of waste.

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Response
Radioactive wastes, including transuranic waste and low-level mixed waste, are classified in accordance with the waste type definitions provided in Volume I, Section 1.5, of the WM PEIS. The referenced statement in the Draft WM PEIS meant to acknowledge that some low-level mixed waste is currently managed with transuranic waste at some sites, as a result of previous management practices. As part of ongoing characterization efforts, this commingled low-level mixed waste may be segregated from the transuranic waste inventory and be managed separately.

DOE recognizes that the statement in Section 1.5.3 of the Draft WM PEIS was misleading and revised the section in the Final WM PEIS to state that low-level waste and low-level mixed waste could also contain transuranic isotopes, but with concentrations less than 100 nanocuries per gram of waste.

DOE does not consider BNL as a candidate site for receipt of any offsite waste analyzed in the WM PEIS.

Comment (2957)
Why is transuranic waste-volume data not more recent than 1991?

Response
The 1991 data were the most current data available at the time DOE began the WM PEIS. DOE used two primary sources to estimate transuranic waste inventory and annual generation rates for the WM PEIS. First, DOE relied on the 1993 Interim Mixed Waste Inventory Report and the 1992 Integrated Data Base. From these reports, waste volumes were extrapolated to provide waste totals for the 20-year analysis period. However, since the initial preparation of the PEIS, DOE has issued updated information on several types of waste. Appendix I in Volume IV of the Final PEIS addresses how updated data on low-level waste, low-level mixed waste, and transuranic waste could affect the analyses of WM PEIS alternatives. Also, where large changes in impacts were likely, DOE reevaluated the impacts with the more recent data and revised the WM PEIS.

Comment (3254)
The Final Supplemental EIS for WIPP estimates 969 shipments of transuranic waste from LLNL to WIPP (25-year period) in comparison to the WM PEIS estimate of 260 transuranic waste shipments. Although the time period for the estimate differs (20 versus 25 years), the WM PEIS should explain the large difference in projected shipments from LLNL.

Response
The number of transuranic waste shipments depend on transuranic waste volumes. The reason the shipment number for LLNL is much lower in the WM PEIS than in the 1990 WIPP Supplement EIS (SEIS-I) is that the estimated volume of transuranic waste at LLNL in the WM PEIS is much lower than that in the WIPP SEIS-I. The WIPP SEIS-I analysis was based on waste volumes presented in a 1987 database, whereas the WM PEIS analysis is based on more recent waste-volume data.

Comment (3597)
A footnote in Section 8.1.1 is shocking. DOE assumes to include non-defense transuranic waste (TRUW) with defense TRUW at WIPP, if all regulatory requirements are met. As you state, the WIPP Land Withdrawal Act of 1992 provides for disposal of defense TRUW. This is a blatant example of

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DOE's disregard for the agreements and public acts made with the States, Congress, and the American people. WIPP is a project for the potential permanent disposal of defense TRUW.

Response
In accordance with the WIPP Land Withdrawal Act, DOE proposes to dispose of only defense TRUW at WIPP as stated in Section 8.1.1 in Volume I of the WM PEIS. At the time the WM PEIS analysis was performed, a small amount of non-defense TRUW was included in the TRUW volumes available. For purposes of analysis, all of the TRUW evaluated in the WM PEIS was assumed to be defense TRUW. This additional small volume of waste provided for a slightly more conservative analysis as it overestimates the amount of TRUW that will be sent to WIPP. DOE has revised the referenced footnote to make this clearer.

Specific information pertaining to the volumes of non-defense TRUW can be found in WIPP SEIS-II.

Appendix B in Volume III of the WM PEIS addresses environmental restoration TRUW that might be generated at DOE sites and managed in waste management facilities. Again, for purposes of a conservative analysis, all environmental restoration TRUW considered in the WM PEIS was assumed to be defense TRUW.

Comment (3598)
What small percentage of non-defense transuranic waste (TRUW) is destined for WIPP under your assumption? Where did it come from? Is there non-defense TRUW in the environmental restoration waste?

Response
In accordance with the WIPP Land Withdrawal Act, DOE proposes to dispose of only defense TRUW at WIPP (see Section 8.1.1 in Volume I of the WM PEIS). For purposes of analysis only, the WM PEIS assumed all TRUW is defense TRUW that will be disposed of at WIPP, including environmental restoration TRUW.

DOE has added updated waste-volume data to the Final PEIS (see Volume IV, Appendix I). Section I.4.1 states that the updated data include volumes of the majority of TRUW that is currently planned for disposal at WIPP and quantities of TRUW that currently are not planned for WIPP disposal. Non-WIPP TRUW, which is about 0.5% by volume of the WIPP TRUW, consists of small quantities of non-defense TRUW resulting from several activities. Most of the non-WIPP commercial TRUW waste was generated by commercial nuclear fuel reprocessing activities conducted at WVDP, while smaller volumes are from nuclear powered pacemakers manufactured by ARCO Medical Products. Sealed TRUW radiation sources used in non-defense laboratory operations at ORNL, and TRUW generated by life sciences and other types of non-defense research conducted at Lawrence Berkeley National Laboratory are some of the other sources of the non-defense TRUW inventory.

Comment (3601)
Two-thirds of the volume of WIPP was for waste to be generated until 2010 *only* by the formerly named Rocky Flats Plant. Exactly what waste is going to occupy the two-thirds capacity no longer needed for waste coming from Rocky Flats production processes? Since WIPP can only accommodate a minute amount of the total *current* transuranic waste (TRUW), where will the rest of the TRUW go once WIPP is full?

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Response
The WM PEIS was not intended to address the proposed disposal of TRUW at WIPP. As described in Volume I, Section 1.8.1, the WIPP SEIS-II discusses the sources and volumes of TRUW planned for disposal at WIPP.

The 1990 WIPP Final Supplement EIS (SEIS-I) identified a little over 2 million cubic feet of newly generated TRUW at RFETS that might be disposed of at WIPP. This represented about one-third of the 6.2-million-cubic-foot capacity authorized by the WIPP Land Withdrawal Act. Current waste volume estimates for RFETS in the WM PEIS show about 6,200 cubic feet of TRUW, consisting of both existing waste and waste that will be generated over the next 20 years.

In accordance with the WIPP Land Withdrawal Act (Public Law 102-579), the total capacity of WIPP is limited to 6.2 million cubic feet (approximately 175,600 cubic meters) of defense transuranic waste. According to recent sources discussed in Appendix I of the Final WM PEIS, approximately 132,000 cubic meters of current and projected transuranic waste was identified, which is well within the capacity of WIPP.

It is true that during the 35-year planned operational life of WIPP, the amount of transuranic waste projected to be available for disposal during this period could exceed the statutory capacity of WIPP. DOE is in the early planning stages of evaluating options for disposal of this excess transuranic waste.

Comment (3602)
The definitions and explanations of contact-handled transuranic waste (CH-TRUW) and remote-handled transuranic waste (RH-TRUW) are insufficient and uninformative. Also, there seems to be no analysis of the long-term effects of CH-TRUW and RH-TRUW on humans or the environment, or why 200 millirems is the dividing line. As stated, the difference between CH and RH is 200 millirems per hour. Is this per worker? How many hours total out of a year will a worker be allowed to work under CH conditions and be exposed to the 200 millirems per hour threshold, and/or any exposure level below 200? Is there a kind of buffer zone around the 200 millirem CH threshold? According to our estimates, where the DOE maximum estimated exposure per worker per year is 5 rems, a worker can only be exposed to the 200 millirems per hour threshold a maximum of 25 hours per year. This is only one parameter/scenario that does not take into account consecutive hours of exposure or how many hours of this type of exposure will be necessary to manage TRUW. DOE should fully explain the CH and RH classifications and how CH and RH waste classifications will be applied to workers and ensuring their safety, as well as for estimating potential costs of handling TRUW at CH levels.

Response
The 200 millirems per hour limit on CH-TRUW is found in DOE Order 435.1. It is consistent with definitions at 10 CFR Part 61 and 40 CFR Part 191, and with the maximum allowable radiation at the surface of a container transporting spent nuclear fuel or high-level waste codified in 10 CFR Part 71. The limit was codified as part of the WIPP Land Withdrawal Act (Public Law 102-579). The 200 millirems per hour is the upper limit on CH-TRUW; most CH-TRUW containers emit much less radiation. According to the WIPP Safety Analysis Report, the average radiation dose per CH-TRUW container is 5 millirems per hour for waste packed in standard waste boxes and 14 millirems per hour for waste packed in standard waste drums. Since the rate of radiation emission is measured at the surface of the waste container, and since most CH-TRUW containers are handled by machinery because of their weight, the radiation dose to workers is further reduced by their distance from the

waste package. The radiation dose to workers is measured by dosimetry devices; it is not computed based on the time that they spend in waste-handling activities. While it is theoretically possible for a worker to receive the 5 rem per worker per year dose limit in 25 hours working with CH-TRUW, DOE regulations in 10 CFR 835 limit occupational dose to less than 1 rem per year. The average radiation dose to workers from handling CH-TRUW, based on the most recent WIPP Safety Analysis Report, is approximately 700 millirems per year.

Comment (3605)
The hazardous chemical constituents in transuranic waste based on RFETS data do not accurately reflect the hazardous chemical constituents in the transuranic waste from other sites because not all the sites did the type of concentrated plutonium work RFETS did. Other sites might have other, just as dangerous or more dangerous, hazardous chemical constituents that are not included in DOE estimates because they are based on RFETS data, and not on site-specific waste streams.

Response
There are limited data on hazardous constituents in transuranic waste, and most of the data come from RFETS and INEL. DOE used RFETS data because it was the most complete data available. The WM PEIS analysis assumes all transuranic waste is mixed waste, although only 60% is actually mixed. Therefore, the WM PEIS overestimates the expected impacts from hazardous constituents in transuranic waste. This assumption is believed to be sufficiently conservative to compensate for the lack of extensive knowledge about the hazardous constituents in DOE transuranic waste.

Comment (3606)
The radionuclide concentrations based on LLNL's transuranic waste do not accurately reflect the radionuclide concentrations for all generators. LLNL's work is more experimental in nature and not production oriented. LLNL is listed in Table 8.1-1 as one of the smallest generators of contact-handled transuranic waste.

Response
The primary radionuclide data used in the WM PEIS for transuranic waste were from the 10 largest generator sites, which together generate approximately 99% of DOE's transuranic waste. The LLNL data were used only to represent the smaller generator sites. Because LLNL waste contains relatively large amounts of americium and plutonium compared to the waste from the other small generator sites, the assumption that the waste from all small generator sites is similar to LLNL includes the radiological impacts.

Comment (3608)
In Volume I, Section 8.2.3, explain what is meant by: "After the designated work-off period, TRUW is assumed to be treated as it is generated on an annual basis; however, this was not analyzed in the WM PEIS." It is unclear what this means. Does this include TRUW currently in inventory? Annually generated waste during work-off period? Waste annually generated after work-off period? All of the above?

Response
Transuranic waste volumes in inventory (storage) and generated during the 20-year period of analysis (consisting of 10 years of construction and 10 years of operations during which transuranic waste will be generated) are analyzed in the WM PEIS. The 20-year period of analysis includes a full 20-year

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operations period (i.e., no construction) for the No Action Alternative. Transuranic waste generated after this 20-year period is assumed to be treated annually as it is generated; however, the impacts of transuranic waste generated after the 20-year period are not analyzed in the WM PEIS. The impacts of storage beyond 20 years are analyzed as part of the No Action Alternatives in the WIPP SEIS-II. DOE revised Volume I, Section 8.2.3, to explain that, although not analyzed, the waste generated each year after the work-off period is expected to be small and its impacts are expected to be included by those analyzed in this study.

Comment (3614)
In Volume I, Section 8.2.4, what does "not to exceed 3 millirem per hour" for contact-handled transuranic waste mean? What does "not to exceed 7 millirem per hour" for remote-handled transuranic waste mean?

Response
The text in Section 8.2.4 has been corrected. It now states that the average external package dose rates were assumed to be 3 millirem per hour for contact-handled transuranic waste and 7 millirem per hour for remote-handled transuranic waste shipments at 1 meter from the shipping container. Section 8.2.4 also explains that these values were derived from site-specific information contained in the WIPP Final Supplement EIS, and are less than the regulatory limit of 10 millirem per hour at 2 meters from the container.

Comment (3622)
No plans are specified for dealing with remote-handled transuranic waste under the No Action Alternative.

Response
Volume I, Section 8.3.1, describes the No Action Alternative for transuranic waste (TRUW). DOE would continue to characterize and package newly generated transuranic waste to meet current WIPP waste acceptance criteria for storage at sites where existing or planned facilities are available.

Although transuranic waste consists of contact-handled transuranic waste and remote-handled transuranic waste, no distinction was made in the text because both are managed the same way under the No Action Alternative. However, only 6 sites have remote-handled transuranic waste, while 11 sites have contact-handled transuranic waste, as indicated in Table 8.3.1.

Comment (3623)
Under the Decentralized Alternative, will the 6 sites with smaller amounts of contact-handled transuranic waste (CH-TRUW) that will be shipped to the nearest of 10 sites continue to generate CH-TRUW after the removal of their CH-TRUW? Under Regionalized Alternatives 1 and 2, will the 10 sites with smaller amounts of CH-TRUW that will be shipped to the nearest of 5 sites continue to generate CH-TRUW after the removal of their CH-TRUW? Will RFETS continue to generate RH-TRUW? Under Regionalized Alternatives 1, 2, and 3, will the 3 sites with smaller amounts of remote-handled transuranic waste (RH-TRUW) that will be shipped to the nearest of 2 sites continue to generate RH-TRUW after the removal of their RH-TRUW? Under Regionalized Alternative 3, will the 10 sites with smaller amounts of CH-TRUW that will be shipped to the nearest of 3 sites continue to generate CH-TRUW after the removal of their CH-TRUW?

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Response
Although it is likely that transuranic waste would continue to be generated after the 20-year period of analysis, projection of future waste generation is problematic. This is one of the reasons why the WM PEIS limits the analysis of impacts to 20-years. Continuation of the past 20-years activities that generate TRUW is uncertain at this time.

As discussed in Section I.1.5 in Volume IV, circumstances that may affect future TRUW generation includes:

- Changes in DOE's site missions that are not reasonably foreseeable at this time;
- Changes in regulations and statutes concerning the definitions of waste types;
- The success of pollution prevention efforts;
- Waste characterization techniques that may affect the waste type assigned to a given inventory. Some waste currently classified as TRUW, for instance, may not contain 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste and may require reclassification as LLMW or LLW. Conversely, some LLW could be reclassified as TRUW; and
- Volume reduction of LLMW and LLW during treatment may result in a residue with sufficient concentrations of transuranic elements to warrant reclassification of the residue as TRUW. Regardless of classification, DOE may choose to manage certain waste streams together, even though they are different waste types, because they have similar characteristics and pose similar risks, such as alpha LLW and TRUW.

Transuranic waste volumes in inventory (storage) and generated during the 20-year period of analysis (consisting of 10 years of construction and 10 years of operations during which transuranic waste would be generated) are analyzed in the WM PEIS. Transuranic waste generated after this 20-year period is assumed to be treated annually as it is generated; however, the impacts of transuranic waste generated after the 20-year period are not analyzed in the WM PEIS. DOE revised Volume I, Section 8.2.3, to explain that, although not analyzed, the waste generated each year after the work-off period is expected to be small and its impacts are expected to be bounded by those analyzed in this study.

In January 1992, the termination of nuclear weapons production changed the primary mission of the RFETS from nuclear weapons production to cleanup and restoration. Nuclear weapons activities at RFETS have ceased, and special nuclear materials and wastes are being stabilized and stored for safe final disposition. The 1996 Baseline Environmental Management Report (BEMR) assumes that all special nuclear material will be transferred offsite by FY 2020. With this material transferred offsite, additional waste management TRUW would not be generated. According to the 1996 BEMR, plans call for the treatment of all RFETS TRUW by 2028, and the shipment of all TRUW offsite for disposal in 2039.

Comment (3624)
There is no plan specified for managing remote-handled transuranic waste under the Decentralized Alternative.

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Response
Under the Decentralized Alternative described in Volume I, Section 8.3.2, DOE would process and package remote-handled transuranic waste at the six sites where it is currently located.

Comment (3625)
In Volume I, Figure 8.3-2, TRUW Decentralized Alternative, the "Treat (% Rec'd from Offsite)" row indicates (0) in all the columns. Is this correct?

Response
The figure is correct. Transuranic waste would be treated and packaged at the site of origin under the Decentralized Alternative. It would then be shipped to 10 sites, for storage only.

Comment (3632)
Is WIPP authorized for the treatment of contact-handled transuranic waste (CH-TRUW)? What containers will be used to transport waste to WIPP?

Response
WIPP currently has no facilities to treat CH-TRUW and is not pursuing licensing for any CH-TRUW treatment facilities. The WIPP Land Withdrawal Act (Public Law 102-579) requires use of containers certified by NRC for transporting TRUW to or from WIPP. The only currently available certified TRUW container is the TRUPACT-II, which DOE plans to use for shipping CH-TRUW. The RH-72B cask, which DOE plans to use for shipping remote-handled transuranic waste, is currently undergoing NRC certification. DOE is considering whether to develop and seek certification for other containers for transporting waste that currently cannot be shipped efficiently in existing containers because of its weight.

Comment (3808)
DOE needs to inform the public about the source and volume of transuranic waste onsite at ANL-E.

Response
Waste management transuranic waste at ANL-E is generated by the Chemical Technology Division, which conducts research on analysis of specimens of nuclear fuel elements. As provided in Table I.4-1 in Volume IV of the WM PEIS, new data suggest a waste management inventory of roughly 140 cubic meters of contact-handled transuranic waste at ANL-E (current inventory plus 20-year generation).

Comment (3923)
The public needs to understand the definition of transuranic waste.

Response
Transuranic waste is defined as radioactive waste having concentrations greater than 100 nanocuries per gram of alpha-emitting transuranic elements (elements that have atomic numbers greater than 92), with half-lives greater than 20 years, with certain exceptions. This definition, as well as a more detailed description of transuranic waste, how it is produced, and the nature of its effects are presented in Section 6.1 in the WM PEIS Summary document, and Sections 1.5.3 and 8.1.1 in Volume I.

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Comment (3941)
Has DOE projected the capacity of WIPP as sufficient to allow for disposal of existing transuranic waste and projected volumes to be produced for the next 20 years?

Response
The capacity of WIPP is limited by the WIPP Land Withdrawal Act (Public Law 102-579) and by the Consultation and Cooperation Agreement with the State of New Mexico. Under these limits, as analyzed in the WIPP SEIS-II, WIPP would not be able to accommodate all of DOE's defense remote-handled transuranic waste.

Comment (3995)
Please clarify the distinction between contact-handled (CH) and remote-handled (RH) transuranic waste (TRUW)? Why does DOE discuss the management of TRUW as a mixed waste with distinctions between TRUW and mixed LLW blurred, at least to me.

Response
As described in Section 8.1.2 in Volume I of the WM PEIS, TRUW is categorized as either CH or RH based on the level and type of radioactivity it emits. CH-TRUW consists primarily of alpha particles and low energy radionuclides with little penetrating power. CH-waste containers can be handled directly by humans. RH-TRUW typically contains a greater proportion of radionuclides that produce highly penetrating radiation (gamma radiation) and requires special shielding in treatment, storage, and disposal facilities.

Mixed waste includes both radioactive and hazardous constituents. Approximately 60% of TRUW is considered mixed waste because it contains both radioactive and hazardous components. However, mixed TRUW is different from mixed low-level waste in the content of the radioactive component. For purposes of the WM PEIS analysis, DOE analyzed all TRUW as if it were mixed TRUW. This is a more conservative analysis because it increases the hazardous components of the waste for the analysis.

Section 8.1.1 in Volume I states that because of its radioactive characteristics, TRUW falls under the jurisdiction of the Atomic Energy Act. In addition, mixed TRUW's hazardous constituents are regulated under RCRA (42 USC 6901 *et seq.*). The hazardous components, such as solvents and heavy metals, can be subject to RCRA land disposal restrictions (40 CFR 268) promulgated by EPA.

8.1.4 High-Level Waste

Comment (2198)
The WM PEIS discusses only selected radioactive isotopes contained in high-level waste, and ignores the longer-lived isotopes such as cesium-135, plutonium-242, and uranium-238.

Response
The WM PEIS high-level waste analysis does consider longer-lived isotopes such as cesium-135, plutonium-242, and uranium-238. Details on the amounts and characteristics of high-level waste are provided in the WM PEIS High-Level Waste Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2303)
Let the ultimate best forms of high-level waste drive the decisions, not the size, not the timing of the national repository.

Response
The WM PEIS addresses only the storage of treated high-level waste prior to its ultimate disposal in a geologic repository. The disposal of high-level waste is not within the scope of this PEIS. The environmental evaluation for geologic disposal will be presented in the DOE Yucca Mountain Repository EIS.

DOE is proceeding with plans to vitrify high-level waste to process it into a solid form. DOE believes that vitrification and encapsulation in stainless-steel canisters is the best final waste form for storing high-level waste.

Comment (2406)
The high-level waste section of the WM PEIS Summary document should include a section on the high-level waste vitrified product quality that will allow its acceptance at a geologic repository. This is an important issue for this PEIS. Analysis should consider what will happen to high-level waste that does not meet repository standards.

Response
The acceptability of vitrified high-level waste with respect to a geologic repository waste acceptance criteria is an issue related to high-level waste *treatment*, which is not within the scope of the WM PEIS. Section 9.1.2 in Volume I of the WM PEIS identifies references that provide information about high-level waste treatment at the Hanford Site, INEL, SRS, and WVDP. The Yucca Mountain Repository EIS will address issues related to acceptance of vitrified high-level waste at a geologic repository.

Comment (3145)
The WM PEIS does not include adequate consideration of most high-level waste (HLW) because (1) it fails to include HLW from commercial nuclear power plants and SRS, INEL, and Hanford; and (2) it focuses only on stored vitrified HLW as opposed to other storage, processing, and disposal issues.

Response
HLW is the highly radioactive waste material that results from the reprocessing of spent nuclear fuel and irradiated targets in nuclear defense, research, and production activities. Commercial nuclear power plants produce spent nuclear fuel, not HLW.

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The WM PEIS does not consider the storage or disposal of spent nuclear fuel. In addition, the scope of the WM PEIS is limited to analysis of the impacts of storing vitrified HLW. The decision to vitrify HLW is explained in Volume I, Section 9.1. HLW would be treated and packaged for disposal in a licensed geologic repository. HLW is currently stored at the Hanford Site, INEL, SRS, and WVDP.

The impacts of disposing of HLW in a repository are not within the scope of this PEIS, but will be analyzed in a DOE NEPA document relating to a geologic repository. Because the Yucca Mountain site is the only candidate repository site being studied at present, DOE assumed the existence of a geologic repository there to analyze the impacts of transporting the HLW to a potential disposal facility.

Impacts related to HLW treatment, where known, have been added to the revised cumulative impacts analysis sections of Chapter 11 for the Hanford Site, INEL, SRS, and WVDP. These estimates of potential risks from recent sitewide or project-level NEPA analyses (e.g., Hanford Tank Waste Remediation System and WVDP Completion and Closure EISs) are based on additional detailed site-specific information.

Comment (3537)
The WM PEIS considers management of vitrified high-level waste only, although this is a tiny percentage of the high-level waste that will eventually require storage. Thus, the WM PEIS minimizes the potential future problems with managing high-level waste.

Response
Storage of vitrified high-level waste (HLW) is evaluated in the WM PEIS. Storage of liquid or calcined HLW, treatment (vitrification) of HLW, and remediation of liquid HLW storage tanks is outside the scope of the WM PEIS.

Information about the storage and treatment of liquid and calcine HLW is available in other DOE reports. For example, information on Hanford HLW is available in the Safe Retrieval, Transfer, and Interim Storage of Hanford Tank Wastes EIS, and the Hanford Tank Waste Remediation System EIS. Information on INEL HLW is given in the SNF/INEL PEIS, for SRS it is given in the Defense Waste Processing Facility SEIS, and for WVDP it is given in the Completion and Closure EIS. Impacts related to liquid HLW storage and treatment, where known, have been added to the revised cumulative impacts analysis sections of Chapter 11 for the Hanford Site, INEL, SRS, and WVDP.

The WM PEIS considers storage of virtually all of the vitrified HLW that DOE expects to produce. Some confusion may have resulted because Section 9.1.2 in Volume I provides liquid HLW volumes that are much larger than the volume of HLW canisters that would be stored. This is because the HLW in its present form contains a mixture of radioactive and nonradioactive materials. DOE plans to separate the highly radioactive components of this mixture, a small portion of the material currently in the tanks, and convert it into a vitrified form. The nonradioactive portion of HLW consists of water and chemicals that were added during reprocessing and subsequent treatments. This material could be contaminated with some radioactive material and is considered to be low-level waste or low-level mixed waste, depending on whether it contains some hazardous materials such as solvents or heavy metals. This material will be immobilized and may be managed as low-level waste or low-level mixed waste.

8.1.4 High-Level Waste

Comment (3692)
Volume I, Table 9.2-1, shows a 2-year canister production period at WVDP under the high-level waste No Action Alternative, and 26 years for all other alternatives. Is this true?

Response
DOE revised Table 9.2-1 to show that, for WVDP, under No Action and all other Alternatives, the time between anticipated start of production and anticipated end of production is 3 years.

Comment (3929)
The WM PEIS should include an evaluation of high-level waste treatment and the corresponding direct and indirect impacts on human health and the environment.

Response
The decision to vitrify high-level waste is explained in Volume I, Section 9.1, of the WM PEIS. Currently, four sites store and manage high-level waste: the Hanford Site, INEL, SRS, and WVDP. DOE is proceeding with plans to treat high-level waste by processing it into a solid form that would not be readily dispersible into air or leachable into groundwater or surface water. This process is referred to as vitrification. Vitrification of high-level waste is addressed in other NEPA reviews. Thus, the WM PEIS only analyzes the impacts of the stored vitrified high-level waste. However, impacts related to high-level waste treatment, where known, have been added to the cumulative impacts analysis sections of Chapter 11 for Hanford, INEL, SRS, and WVDP. These estimates of potential risks from recent project-level and sitewide NEPA analyses (e.g., Hanford Tank Waste Remediation System and WVDP Completion and Closure EISs) are based on additional detailed site-specific information.

Comment (4304)
When will the current high-level waste at Hanford be permanently and safely stored?

Response
Approximately 213,000 cubic meters (56.3 million gallons) of high-level waste is currently stored at the Hanford Site in 177 belowground storage tanks built between 1943 and 1986. The proposed alternatives for vitrified high-level waste storage at the Hanford Site are discussed, along with potential impacts associated with each alternative, in Volume I, Chapter 9, of the WM PEIS.

The WM PEIS assumes, for purposes of analysis, that the Hanford Site high-level waste would be vitrified and packaged in canisters, with canister production beginning in 2009 and completed by 2028. DOE's preferred alternative is to store these canisters at the Hanford Site while they await disposal in a licensed geologic repository.

Comment (4423)
The WM PEIS should include alternatives to evaluate impacts, and associated mitigating measures, from high-level waste (HLW) treatment, because of the high potential for adverse effects. DOE should explain why treating HLW at sites other than where it was generated was not considered a viable alternative. DOE should further recognize that the measures (other than cost) that determined that these alternatives are inappropriate could be pertinent to continued storage of untreated waste and onsite transportation for treatment. Also, since the HLW No Action Alternative evaluates calcine and liquid HLW storage at INEL, impacts of pretreatment and vitrification should be addressed.

8.1.4 High-Level Waste

Response
The treatment of HLW is not within the scope of the WM PEIS, as explained in Volume I, Section 9.1.1. However, impacts related to HLW treatment, where known, have been added to the cumulative impacts analysis sections of Chapter 11 for the Hanford Site, INEL, SRS, and WVDP. These estimates of potential risks from recent NEPA analyses (e.g., Hanford Tank Waste Remediation System and WVDP Completion and Closure EISs) are based on additional detailed site-specific information. The treatment of HLW at sites other than where it was generated was not considered a viable alternative because of the risks associated with shipping untreated high-level waste.

To the extent known, the impacts of current storage of liquid and calcine HLW, and their subsequent treatment into an immobilized form for geologic disposal, are included in the cumulative impacts analysis for INEL, presented in Chapter 11 in Volume I of the WM PEIS.

Comment (4465)
What alternatives for the containment of the unvitrified high-level waste (HLW) at Hanford were considered under the No Action Alternative, and what mitigating measures? If none, what impacts from the non-vitrified waste could occur, including accidents, deliberate bombing, etc. The same issues apply to the calcine and liquid waste at INEL.

Response
The WM PEIS analyzes only the storage of vitrified HLW; the containment of liquid or calcine HLW that has not been vitrified is not within the scope of this document. Information about the storage and treatment of liquid and calcine HLW is available in other DOE reports. For example, information on Hanford HLW is available in the Safe Retrieval, Transfer, and Interim Storage of Hanford Tank Wastes EIS, and the Hanford Tank Waste Remediation System EIS. Information on INEL HLW is given in the SNF/INEL PEIS, for SRS it is given in the Defense Waste Processing Facility SEIS, and for WVDP it is given in the Long-Term Management of Liquid High-Level Radioactive Wastes EIS and the Completion and Closure EIS. These documents are among those listed in Table 11.2-1 and considered in the cumulative impacts analyses discussed in Section 11.2 in Volume I of the WM PEIS. Impacts of HLW treatment, to the extent known, have been added to the cumulative impacts sections for these sites in Chapter 11.

Section 3.1.3 of WM PEIS HLW Technical Report describes measures being undertaken at the Hanford Site concerning enhanced containment of unvitrified (liquid) HLW, namely:

- Upgrade of three piping systems for radioactive waste transfer;
- Addition of a large mixer pump in Tank 101-SY to control buildup of gases;
- Interim stabilization of presumed leaking tanks by removing most of the drainable liquid.

Section 3.5.3 in that report addresses similar issues at INEL. The report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

8.1.5 Hazardous Waste

Comment (255)
The Molten Salt Oxidation Test Facility should not be expanded to full size until (1) there is further public comment; (2) a site-specific EIS is completed; and (3) the WM PEIS is completed. The PEIS should identify the proposed treatment technology for LLNL, molten salt oxidation, as a type of incineration.

Response
DOE used incineration as the representative thermal treatment process for low-level mixed waste because it is the best demonstrated available technology for organic destruction of hazardous wastes. The WM PEIS describes the molten salt oxidation process as an emerging treatment technology for mixed waste (see Volume IV, Section H.3.3). There are a number of process uncertainties for the molten salt oxidation process that must be resolved, including the effect of ash and stable salt buildup on melt stability and spent salt processing; retention of particulates in the molten salt bed; and the process's tolerance to variations in operating conditions. Due to these technical concerns and the cancellation of the full-scale demonstration facility for molten salt oxidation at LLNL, DOE did not consider the molten salt oxidation process as the generic treatment technology in the WM PEIS. The WM PEIS analyzed the configuration of treatment and disposal sites, but will not support decisions regarding specific treatment technologies. Treatment technologies will be analyzed in site-specific NEPA reviews.

Comment (1749)
Provide updated data for Table 10.1-1, as this data fails to bring out current Toxic Substances Control Act incinerator totals.

Response
Table 10.1-1 in Volume I of the WM PEIS lists estimates of hazardous waste volumes at 11 large DOE generator sites. These estimates were derived from the 1991 EPA Information System biennial reports and DOE Site Inventory Reports. The data are considered sufficiently accurate for the purposes of the analysis, which requires a representative data set for a comparison of impacts for offsite commercial treatment versus onsite DOE treatment.

Comment (2038)
Referring to hazardous waste, EPA stated: "It was unclear where the numbers used to arrive at the 11% onsite treatment came from. The amount of waste to be treated does not match the amount of waste generated at the contributing DOE sites."

Response
DOE has revised Volume I, Table 10.3-5, which now indicates that a total of about 323 metric tons per year of hazardous waste would be treated by incineration and fuel burning at INEL, ORR, and SRS under the Decentralized Alternative. This waste is onsite waste; waste would not be received from offsite. Since the total volume of hazardous waste is 3,438.2 metric tons per year, this revised total volume is about 9% of the offsite commercial treatment hazardous waste totals presented in Table 10.3-5.

Comment (2118)
DOE should clarify why hazardous waste was not analyzed under four of the alternatives, even though hazardous waste is managed at BNL.

8.1.5 Hazardous Waste

Response
Chapter 10 in Volume I of the WM PEIS describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for hazardous waste. The alternatives were selected to provide representative results for the range of onsite options. Hazardous waste has been generated, or is projected to be generated, at about 45 DOE sites. Based on RCRA uniform hazardous waste shipping manifests, facility reports, and hazardous waste generation and disposal information dating back to 1984, DOE estimates that more than 90% of the total hazardous waste (wastewater and nonwastewater) in a given year is generated by 11 or fewer DOE sites, although they are not the same every year. In general, only nonwastewater hazardous waste from these 11 larger sites was analyzed in this PEIS. Because BNL is not one of those 11 largest generator sites, the PEIS does not specifically analyze hazardous waste at BNL. However, the PEIS analysis is representative of DOE sites in general. In addition, hazardous wastes generated by environmental restoration activities are not covered in the WM PEIS.

Table 10.1-1 lists the quantities of hazardous waste at the 11 DOE hazardous waste generators used for the evaluation of WM PEIS alternatives.

Comment (2352)
In the hazardous waste section, incineration (thermal destruction) is emphasized. By the very nature of incineration, secondary "new chemicals by fire" are created. I believe these secondary chemical compounds should be covered.

Response
DOE did evaluate the effects of incineration emissions from the treatment of hazardous waste, including combustion products. Section D.3.3.2 in Volume III of the WM PEIS describes special assumptions, including the source term for chlorinated organics and inorganics emitted in incinerator flue gases developed from a set of RCRA trial burn data from a commercial facility that currently processes similar DOE-generated hazardous waste.

Thermal destruction is the efficient burning of combustible solid and liquid wastes to destroy organic constituents and to reduce the volume of waste. The greater the destruction efficiency, the cleaner the air emissions. The thermal destruction technology assumed in the WM PEIS is incineration. Additional information on thermal treatment methods is provided in Section 6.2.2 in Volume I, which states that EPA considers incineration the best demonstrated available technology for treating organic waste. Properly designed and operated incinerators have been shown to be as or more effective than other proven treatment technologies, and DOE does not preclude their use at any site.

Comment (2404)
The WM PEIS Summary document states that 99% of DOE's hazardous waste is wastewater that will be treated by DOE, and 1% of the hazardous waste will be treated and disposed of at commercial facilities. The significance of these values and materials involved should be explained more clearly in the Summary document.

Response
The WM PEIS summary document presents only the highlights of the entire document. Details on the significance of these values and materials and the hazardous waste impact analysis are provided in Volume I, Chapter 10, of the WM PEIS.

8.1.5 Hazardous Waste

Comment (2587)
Where do the hazardous waste residues end up? Disposal seems to be left out of most of the alternatives. Is 1991 the most current data for hazardous waste treatment tonnage?

Response
Hazardous waste is stored onsite only for a limited time in order to accumulate sufficient quantities for treatment. All of the treatment residues of listed hazardous waste are sent to EPA-permitted commercial hazardous waste disposal sites. Since the environmental impacts and risks from the commercial treatment and disposal of hazardous waste are covered under RCRA Part B permits, these potential impacts are not specifically addressed in the WM PEIS.

At the time the WM PEIS alternatives for the management of hazardous waste were developed, 1991 data for onsite treatment and storage volumes and 1992 data for offsite shipment to commercial treatment were the latest available data, as described in Volume I, Section 10.1.2. The hazardous waste analysis requires representative data to evaluate the alternatives of onsite or commercial treatment; the 1991 and 1992 data are considered representative. DOE believes that although more recent hazardous waste volume information is now available, the data would not significantly change the results of the hazardous waste analysis, including identification of the preferred alternative. (See Volume I, Section 3.7). The hazardous waste analysis compared more onsite treatment of hazardous waste with continued reliance on offsite commercial vendors. For this analysis, DOE required only a representative set of sites and hazardous waste data. The 1991 and 1992 data are sufficiently accurate for this purpose.

Comment (2855)
The Summary document, Section 8.1, states that most DOE hazardous waste consists of wastewater that contains less than a 1% concentration of organic hazardous waste materials. This might mislead the reader into assuming that dilution lessens the hazards compared to hazardous waste in its pure form. Hazardous wastewater has the greatest impact to groundwater and surface water resources (e.g., a 1% aqueous solution of benzene would be 2,000 times greater in concentration than the allowable maximum contaminant level under the Safe Drinking Water Act). Please clarify.

Response
The statement referred to in this comment is a factual statement about a characteristic of the wastewater. No information about risk is stated or implied. The reference to 1% concentration of organic material in DOE wastewater refers to the concentration before it goes to wastewater treatment and not the concentration in the effluent stream. To avoid the impression that this is the diluted effluent concentration, DOE has revised Section 8.1 of the Summary document to read, "Most DOE-generated hazardous waste consists of wastewater which, by definition, contains less than a 1% concentration of organic hazardous waste materials." This section was also revised to clarify that DOE hazardous wastewater requires treatment before it can be safely discharged to the environment.

8.2 Waste Types Considered

Comment (1108)
Commentors prefer for the WM PEIS to include special-case waste and greater-than-Class-C waste, and asked whether special nuclear material is addressed. They also asked about the location and quantity of greater-than-Class-C and special-case wastes. If these are not to be included in the WM PEIS, justification is needed.

Response
The WM PEIS does not address management of greater-than-Class-C (GTCC) wastes and wastes that are frequently designated "special-case" wastes by the generating site. Therefore, locations and quantities of such wastes are not provided. Section 1.5.6 in Volume I of the WM PEIS describes why GTCC waste is not considered for analysis. Because of their high radioactivity levels and long half-lives, special-case wastes and greater-than-Class-C low-level wastes must be isolated from human exposure for periods in excess of hundreds or, in many cases, thousands of years. Unlike transuranic waste and high-level waste, however, neither of these waste types is authorized under the Nuclear Waste Policy Act (42 USC 10101-10270) for disposal in a geologic repository. Furthermore, both special-case wastes and greater-than-Class-C low-level wastes vary considerably in their nature. DOE is developing management strategies for both greater-than-Class-C low-level wastes and special-case wastes that include disposal. On March 13, 1995, DOE published a notice in the *Federal Register* inviting interested parties to provide input into the development of strategies. Subsequently, two workshops were held to discuss preliminary strategies. Based on the input received, alternative strategies will be evaluated under NEPA once a proposal is developed.

The impacts of storage and disposition of special nuclear materials is outside the scope of this PEIS except where these impacts could be cumulative with impacts from waste management activities. Impacts of the management of special nuclear materials are being or have been evaluated in the Storage and Disposition of Weapons-Usable Fissile Materials PEIS, the Disposition of Surplus Highly Enriched Uranium EIS, and certain sitewide NEPA reviews. The relationship between the WM PEIS and these other NEPA documents is described in Volume I, Section 1.8.1, of the WM PEIS. DOE has coordinated the preparation of its NEPA reviews in an attempt to provide consistent information to the public and account for all cumulative impacts.

Comment (2267)
There are concerns about the large amounts of spent nuclear fuel being stored at the K-West and K-East Basins at Hanford. DOE should calcine and/or vitrify those wastes. Wet storage is thermally unstable and will burn. Placing it in a number of different locations would be a better strategy.

Response
Management of spent nuclear fuel is outside the scope of the WM PEIS. The impacts of the management of DOE spent nuclear fuel were analyzed in the SNF/INEL PEIS. The Final EIS on the management of spent nuclear fuel currently stored in the K-Basins was issued in February 1996, and is described in Volume I, Section 1.8.1, of the WM PEIS. Cumulative impacts from both these EISs are analyzed for the Hanford Site in Volume I, Section 11.6, of the WM PEIS.

Comment (2422)
The storage, treatment, and disposal of hazardous wastewater, sanitary and industrial wastes, special-case waste, and commercial greater-than-Class-C low-level waste are not covered in this EIS. This is the first of several examples of segmentation. It might be reasonable to leave out sanitary and

8.2 Waste Types Considered

industrial wastes and maybe even commercial greater-than-Class-C low-level waste, but why leave out special-case waste at DOE facilities? Just because DOE hasn't figured out what to do with it doesn't mean it does not have an environmental impact.

Response
As indicated in Section 1.5.6 in Volume I, some wastes within the radioactive waste type categories, such as low-level waste, transuranic waste, and high-level waste, have characteristics that require special considerations and different management than most of the other waste within that category. These wastes are special-case wastes managed on a case-by-case basis and are not specifically evaluated under the WM PEIS alternatives, although the WM PEIS waste volumes largely account for them. Section 1.5.6 describes waste types not considered in the WM PEIS including non-hazardous and nonradioactive sanitary waste, non-hazardous solid waste, hazardous and low-level process wastewater, special-case waste, and commercial greater-than-Class-C low-level waste. DOE agrees with the commentor that it is reasonable to not consider these waste types. DOE also believes that it is reasonable to not consider special-case wastes.

Because of their high radioactivity levels and/or long half-lives, special-case wastes must be isolated from humans for periods in excess of hundreds or, in many cases, thousands of years. Unlike transuranic waste and high-level waste, however, special-case wastes are not authorized under the Nuclear Waste Policy Act (42 USC 10101-10270) for disposal in a geologic repository. Furthermore, special-case wastes vary considerably in their nature. DOE is currently developing management strategies for special-case waste that include disposal. On March 13, 1995, DOE published a notice in the *Federal Register* inviting interested parties to provide input to the development of strategies. Two workshops were held to discuss preliminary strategies. Based on the input received, alternative strategies will be evaluated in a NEPA review once a proposal is developed.

8.3 Waste Management Facilities and Technologies

Comment (185)
We need to develop ways to safely store and dispose of waste.

Response
DOE is committed to managing its wastes to protect human health and the environment, including the safe storage and disposal of waste. The WM PEIS describes accepted, readily available technologies for managing wastes. DOE would employ improved technologies as they become available. Volume IV, Appendix H, describes emerging technologies that could influence the WM PEIS alternatives or mitigate impacts.

Comment (227)
A commentor is concerned that DOE will choose the least expensive and controversial disposal methods and will not provide for development of appropriate technologies for efficient treatment, storage, and disposal of each waste type as it is generated.

Response
DOE is committed to managing its wastes to protect human health and the environment, including the safe storage and disposal of waste. The WM PEIS analysis was based on the uniform application of currently available treatment, storage, and disposal technologies. The specific technologies used at a site to implement an alternative would depend on a number of factors that would be further evaluated at the site and project levels. Appendix H in Volume IV of the PEIS describes DOE's ongoing program of technology development. The discussion outlines the approach taken by DOE's Office of Environmental Management through its Office of Technology Development. DOE will continue to develop alternative technologies and implement them as quickly as feasible.

Comment (1286)
A commentor asked DOE to include the following environmental technologies in the WM PEIS: pollution cleanup, remediation of groundwater, new cleanup technologies, environmental sensing, and monitoring.

Response
Appendix H in Volume IV of the WM PEIS addresses the development of waste management technologies, including baseline and emerging technologies. The DOE Office of Technology Development will continue its systematic approach to solving key problems in waste management, including the assessment of environmental technologies, pollution cleanup, remediation of groundwater, new cleanup technologies, and environmental sensing and monitoring.

Comment (1287)
The WM PEIS should consider green manufacturing processes, including the production of long-lasting, light-weight materials; recycling technologies; and toxic reduction and resource conservation.

Response
DOE is strongly committed to waste minimization. The Office of Waste Management is responsible for coordinating and consolidating DOE's Waste Reduction Policy based on Executive Order 12856, which requires DOE installations to engage in waste minimization and to have an established program for implementing this policy.

8.3 Waste Management Facilities and Technologies

DOE's waste minimization program applies to all DOE activities and all types of waste that these activities generate. Source reduction by waste generators in Defense Programs, Energy Research, and other DOE programs will reduce the amount and radioactivity level of waste coming into the waste management complex, the cost of constructing and operating these facilities, and the human health risks to the public and workers.

Individual DOE sites have site-specific waste minimization and pollution prevention programs and plans in place. Waste reduction is achieved through (1) source reduction (reducing the quantity of waste that is transferred to waste management facilities) and (2) recycling. Appendix G in Volume IV of the WM PEIS addresses pollution prevention on a programmatic rather than site-specific scale. Appendix H, also in Volume IV, addresses development of waste management technologies, including baseline and emerging technologies. The DOE Office of Technology Development will continue its systematic approach to solving key problems in recycling technologies, resource-use reduction, and waste management.

Comment (1450)
DOE should research even safer and more space-efficient storage in the established areas, as well as technologies such as fusion power generation, which have little or no waste.

Response
DOE is committed to managing its wastes to protect human health and the environment, including the safe storage and disposal of waste. For the WM PEIS analysis, DOE used accepted, readily available technologies for managing wastes. Improved technologies would be utilized as they become available. Appendix H in Volume IV describes emerging technologies that could influence the WM PEIS alternatives or mitigate impacts.

Issues of power-generation technologies are not within the scope of the WM PEIS, which is DOE's evaluation of alternatives for managing its radioactive and hazardous waste across the nation.

Comment (1725)
DOE should minimize airborne releases by using available temporary containment strategies.

Response
DOE assumes the commentor is referring to environmental restoration activities, for which appropriate containment strategies will be developed at the project level. DOE intends to undertake environmental restoration activities only after completion of appropriate risk analyses and rulemaking decisions. These environmental restoration actions will be conducted in accordance with standard safety practices to minimize potential releases of contamination and exposures to members of the offsite population and environmental restoration workers. DOE also intends to minimize airborne releases from waste management activities.

Comment (1743)
Given the funding, regulatory and legal delays in siting, construction, and operation of a waste disposal facility, is the 10-year period to have facilities operational realistic?

8.3 Waste Management Facilities and Technologies

Response
Volume I, Section 6.2.3, discusses the DOE assumptions about the treatment and disposal facilities used in the impacts analyses. DOE believes that the estimated 10-year construction period, which includes all permitting actions and additional NEPA documentation, is a realistic period in which to have waste management facilities operational.

Comment (1769)
What about the $150 million allotment for innovative technology development and what, if any, outcomes were there at RFETS from this money?

Response
The $150 million referred to by the commentor for funding proposed development of innovative technologies was not allocated in the current RFETS budget.

Comment (1774)
Technologies associated with safety and transportation are important issues that need public discussions.

Response
DOE welcomes any suggestions about the relative safety of various waste management and waste transportation technologies. The public hearings and comment period following publication of the Draft WM PEIS were part of ongoing efforts to involve the public in DOE's decisionmaking. Sitewide and project-level NEPA reviews would provide additional opportunities for public comment and dialogue on these issues.

For the WM PEIS analysis, DOE assumed the use of standard, currently available technologies for waste management and transportation. These are described in Chapters 6 through 10 in Volume I, Appendix D in Volume III, and Appendices E and F in Volume IV of the PEIS. Supporting technical reports provide additional information. In addition, DOE has an aggressive technical development program exploring alternative waste disposal technologies. Alternatives will be tested and deployed depending on their potential to safely and effectively treat and transport waste. Appendix H describes emerging technologies that could influence the WM PEIS alternatives or mitigate impacts.

Comment (1788)
There needs to be additional technology development for waste storage/treatment.

Response
DOE has an aggressive technical development program exploring alternative waste disposal technologies. Alternatives will be tested and deployed depending on their potential to safely and effectively treat and store waste. Appendix H in Volume IV of the WM PEIS describes emerging technologies that could influence the WM PEIS alternatives or mitigate impacts.

Comment (2274)
One commentor noted that Section 5.2.3 of the Draft WM PEIS states that DOE used a modular approach to determine treatment technology requirements, transportation facility requirements, storage needs, and disposal requirements. From these modules, generic facility designs were determined for each waste type. The commentor asserted the Draft WM PEIS did not provide a detailed description of how these modules were designed or what criteria were used to determine design needs, and that

8.3 Waste Management Facilities and Technologies

although generic facilities were used to estimate acreage requirements, no description of these facilities is provided. Therefore, the assumptions and design criteria used to arrive at a generic design cannot be independently verified to ensure estimated acreage requirements are reasonable and appropriate. Due to the generic nature of the designs used to produce estimates of pollutant discharges, some conservatism needs to be incorporated into these estimates. One commentor asked DOE to send him all the waste facility design information used in the WM PEIS. Another commentor asked DOE to be more specific about the facility designs.

Response
Section C.3.1.1.1 in Volume III of the WM PEIS contains a more detailed description of the methods used to calculate land requirements for treatment, storage, and disposal facilities. Sections C.2.2 and C.2.3 contain the assumptions and design criteria used to develop the generic facility designs. Additional information about generic designs is provided in the waste management facility cost information reports (5 INEL reports), which are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (2674)
There is no known technology to safely treat and store nuclear waste and it will pollute the environment for years to come.

Response
DOE is committed to managing its wastes to protect human health and the environment, including the safe storage and disposal of waste. The WM PEIS analysis uses accepted, readily available technologies for managing wastes. In addition, DOE has an aggressive technical development program to explore alternative waste disposal technologies. Technology alternatives will be tested and deployed depending on their potential to safely and effectively treat waste. Appendix H in Volume IV describes emerging technologies that could influence the WM PEIS alternatives or mitigate impacts.

Comment (2926)
Can DOE assess the capabilities of different technologies, e.g., mobile compaction, advanced thermal technologies, etc., and what waste streams might be appropriate for specific technologies?

Response
Since the WM PEIS compares impacts across sites, treatment, storage, and disposal technologies were, for the most part, held constant for the analysis. This enabled DOE to compare "apples to apples," allowing only site environmental factors to be discriminators. Volume I, Section 1.7.3, discusses various levels of NEPA documentation. Sitewide or project-level NEPA reviews would provide details on treatment, storage, and disposal technology alternatives. Sufficient comparative data would be provided in such studies.

DOE has developed a number of non-NEPA technical studies that can be used to compare various treatment, storage, and disposal technologies. These studies are available to the public through the DOE Office of Environmental Management, Office of Research and Development.

8.3 Waste Management Facilities and Technologies

Comment (3222)
The WM PEIS does not consider the effects of advances in waste management technology. DOE should begin a vigorous program for improved treatment and storage technology for radioactive wastes, including technology to make radioactive waste benign.

Response
DOE has an aggressive technical development program exploring alternative waste disposal technologies. Alternatives will be tested and deployed depending on their potential to safely and effectively treat and store waste. Appendix H in Volume IV of the WM PEIS describes emerging technologies that could influence the choice of technologies considered in sitewide or project-level NEPA reviews.

By "benign," DOE assumes that the commentor means, makes radioactive waste non-radioactive (stable). A technology that could accomplish this for selected radionuclides is nuclear transmutation, in which nuclear reactions are used to transmute one nuclide into another. It has been proposed that transmutation be used to change technetium-99, a semi-volatile, long-lived radionuclide, which can be extremely mobile in groundwater flow, into stable ruthenium-100. However, the feasibility of using transmutation on a production level has not been proven.

Comment (3270)
The WM PEIS does not consider potential advances in waste management technology, and the effects of such advances on waste management options. There are many public and private-sector efforts to develop new technologies. The WM PEIS should account for and consider advances in waste management technology.

Response
The WM PEIS analysis incorporates accepted, readily available, proven waste management technologies. DOE would use improved technologies as they become available.

Appendix H in Volume IV of the WM PEIS describes emerging technologies that could influence the PEIS alternatives or mitigate impacts. Many of these technologies are either not commercially available, have not been demonstrated for the waste types considered in the PEIS, or have not been shown to be economically or technically viable (i.e., have not achieved engineering breakthrough). Some of the technologies described in Appendix H might prove viable in the future and could warrant consideration as the technologies mature.

Comment (3423)
If reducing waste volume and treatment also reduces the possibility of waste leaching into the environment or groundwater at Hanford, then the cost is worthwhile.

Response
DOE is committed to managing its wastes to protect human health and the environment. Leaching of radioactive material into groundwater is of great concern for disposal. Certain treatments can reduce the amount of leaching. The primary means to reduce leaching is to stabilize the waste. The stabilization processes considered in the WM PEIS are grouting, polymerization, and vitrification.

8.3 Waste Management Facilities and Technologies

Volume reduction on its own does not necessarily reduce leaching. In fact, volume reduction may concentrate the radionuclides and hazardous constituents in such a fashion that leaching would produce a more toxic leachate. For example, although incineration effectively reduces the volume of the waste and destroys organic constituents, radionuclides and metals tend to be concentrated in the residual ash. Therefore, it may be necessary to combine a volume reduction technology with a stabilization process to reduce leaching.

The disposal container as well as the disposal waste form is a barrier to leaching. A disposal container with too high a void content is subject to distortion and loss of structural integrity. Compacting waste, a volume reduction technique, increase the stability of disposal containers by reducing void space and, thus, through physical means reduces the possibility of leaching.

In Volume I, Sections 6.2.2, 7.2.2, 8.2.2, 9.2.2, and 10.2.2, present the technologies and treatment processes evaluated in the WM PEIS. Decisions regarding treatment technologies will not be made as a result of the PEIS. The specific technologies used at a site to implement an alternative will depend on a number of factors that will be further evaluated at the site and project level.

Tables 6.14-2, 7.14-2, and 8.14-2 contain the cost, by alternative, of managing low-level mixed waste, low-level waste, and transuranic waste, respectively. For low-level mixed waste, the level of treatment is mandated by the need to meet RCRA land disposal restrictions. For low-level waste, volume-reduction treatment is approximately twice as expensive as minimum treatment; however, the higher treatment costs are offset in part by reduced disposal costs. Overall, low-level waste alternatives that include treatment to reduce waste volumes are estimated to cost 20 to 25% more than corresponding alternatives that include minimum treatment. For transuranic waste, treatment to meet RCRA land disposal restrictions is estimated to be approximately 30% more expensive than meeting the WIPP waste acceptance criteria. The decisionmakers will consider costs when selecting the future configuration of the waste management complex.

Comment (4481)
The Draft WM PEIS should document the reasonably anticipatable impacts of routine process upsets, poor equipment design, inadequate maintenance and operation, and human error in the estimates of expected impacts of the alternatives.

Response
Because of the programmatic nature of the WM PEIS and the large number of sites involved, generic facilities were used to evaluate impacts associated with various waste management alternatives. The same parameters were used to characterize particular types of treatment, storage, and disposal facilities regardless of where a facility would be constructed. The sources for facility characterization data are referenced in the waste-type-specific technical reports supporting the WM PEIS and included various design reports and documentation, the Mixed Waste Treatment Project Functional and Operational Requirements Report, and RCRA trial burn test results from permitted facilities. The parameters that define the substances and amounts released to the environment during facility operations reflect the available data; DOE conducted the WM PEIS analyses to ensure that no artificial biases were introduced. Releases resulting from anticipated occurrences during normal operations are accounted for in the normal operation releases, to the extent that the original source of data included such releases. Releases occurring under conditions that would be more severe than the anticipated occurrences are considered in the WM PEIS accident analyses (see Appendix F in Volume IV for

details). Summary information on potential health risks resulting from facility accidents is presented in Sections 6.4.3, 7.4.3, 8.4.3, 9.4.3, and 10.4.3 in Volume I.

The focus of the WM PEIS analyses was on programmatic issues and differences that would inform DOE and the public in making reasonable choices among the alternatives, as required by NEPA. Because the facilities were generic and the analyses were done at a programmatic level, it was neither possible nor appropriate to consider site- and design-specific issues such as monitoring, maintenance, equipment design, etc. However, uncertainties associated with these issues are included in the conservative approach used and described in the accident analyses in Appendix F (in particular, Section F.2.9). In addition, site- and design-specific issues will be considered in greater detail in site-specific NEPA operational reviews. Site operations also require that safety analysis reports, readiness reviews, and other necessary start-up activities occur prior to the start of facility operations. These reviews occur to verify proper equipment design and to ensure that adequate maintenance and operational procedures are in place in order to minimize or eliminate potential routine process upsets and minimize human error during operations.

In addition, DOE provides guidance and direction in the form of Safety Guides, Orders, and Rules that relate to these issues in conjunction with the management of these activities. These are discussed in a general way in Volume I, Chapter 12.

8.3.1 Treatment

Comment (7)
What is the volume of a canister of high-level waste after vitrification?

Response
The WM PEIS assumes that the stainless-steel canisters would hold between about 0.62 and 1.17 cubic meters of high-level waste. This information has been included in Volume I, Section 9.1.2.

Comment (8)
If the waste will not leach or disperse into air or soil after vitrification, why are containers (especially metal canisters) necessary?

Response
The Defense Waste Processing Facility EIS and its supplement contain full descriptions of vitrified waste form characteristics. The vitrified waste comes from the melter in the form of a very hot liquid, which is poured into stainless-steel canisters that serve as molds (or forms) for the glass. The hot liquid cools and hardens inside the steel canister. While the vitrified waste is highly resistant to leaching, the cooled glass is very brittle and susceptible to chipping and cracking. The canisters provide the physical integrity for handling the waste through disposal.

Comment (10)
What are the costs of canisters?

Response
DOE assumes that this comment refers to assumptions used for the storage and transportation costs of high-level waste canisters. The costs of storing and transporting high-level waste canisters are provided in Section 9.14 (Volume I) and are expected to remain stable at approximately $3.0 billion, for all high-level waste alternatives except the No Action Alternative. This would result in a unit cost of approximately $143,000 per canister based on a total of 21,600 canisters. Of this total, the cost of the actual canister is about $10,000.

Comment (11)
What is the additional weight and volume of canisters to be transported and stored after vitrification?

Response
Canisters are 2 feet in diameter and 10 feet long. The weight and volume of high-level waste in a canister varies with the fill level. A typical filled canister weighs 1.7 metric tons (3,700 pounds) and contains approximately 0.62 cubic meter of borosilicate glass that incorporates the waste solids.

See Volume I, Table 9.1-2, of the WM PEIS for more information about the characteristics of canisters.

Comment (33)
Is vitrification possible and economical for treatment of large volumes of materials?

Response
Vitrification is the process of converting materials into a glass, glassy substance, or slag, typically through a thermal process at temperatures in the range of 1,000 to 1,600°C. An example of a high-level waste

vitrification facility is the SRS Defense Waste Processing Facility, which was designed to vitrify 132.5 million liters (35 million gallons) of high-level waste over a 24-year period into a glass material encased in stainless steel cylinders that would be suitable for disposal in a geologic repository. The Defense Waste Processing Facility began operations in March 1996, and is expected to operate until 2018.

Evaluation of various high-level waste treatment technologies resulted in the selection of vitrification as the treatment technology best suited to the majority of DOE's high-level waste, based in part on the performance of the product glass because (1) of its long-term stability; (2) it is strong enough to resist stresses of disposal in a repository; (3) it withstands leaching under conditions that could potentially exist in a repository; and (4) it is suitable for large-scale, remote operations with highly radioactive waste.

Vitrification is an alternative to incineration for combustible mixed, transuranic, and low-level wastes, as well as a stabilization technology for incinerator secondary waste. However, capital equipment such as the melter, energy required for melting, and off-gas treatment requirements appear to be more expensive for vitrification in comparison with incineration. In addition, incineration is a proven technology, while vitrification of wastes other than high-level wastes has yet to be proven on a large scale.

Further information concerning vitrification is provided in Section H.3.3.5 in Volume IV of the WM PEIS.

Comment (35)
Has vitrification been done on more than small volume tests?

Response
Yes. DOE recently began full-scale vitrification at the Defense Waste Processing Facility at SRS and at the West Valley Demonstration Project, as identified in Volume I, Section 9.1.

Comment (176)
There should be no thermal treatment of nuclear waste at LLNL because (1) the technology is unproven and (2) there are large population centers nearby.

Response
The WM PEIS analysis used thermal treatment as a generic technology to enable a relative comparison of potential impacts across sites. DOE will select treatment technologies for sites after considering site-specific information in sitewide or project-level NEPA reviews.

The WM PEIS analyses were based on the uniform application of currently available treatment, at storage, and disposal technologies at each of the 17 major waste sites. The technologies used at a specific site to implement an alternative would depend on a number of factors that DOE will evaluate further at the site and project level. Such evaluations would explore alternative technologies more fully tailored to site-specific considerations.

Properly designed and operated incinerators are as or more effective than other *proven* treatment technologies, and DOE will not preclude their use at any site. DOE compared impacts from incineration to those from non-thermal treatment technologies and identified little or no difference in treatment risks to human health. In addition, DOE has an aggressive technical development program to explore alternatives

8.3.1 Treatment

to incineration. Alternatives will be tested and deployed depending on their potential to safely and effectively treat wastes.

Comment (186)
DOE needs to clarify whether low-level waste will be incinerated at the SRS.

Response
The WM PEIS is a programmatic document that evaluates treatment operations in a conceptual fashion, applying generic treatment capabilities across all sites as needed to reach the treatment levels specified in the alternatives. If the capability to treat a waste type is already present at a site or, as is the case for the Consolidated Incineration Facility at SRS, it will become available during the period of analysis, the site received credit for this capability, thereby eliminating the need for new construction and any impacts associated with such construction.

Incineration at SRS is evaluated in the PEIS, with credit given for the Consolidated Incineration Facility, under the following alternatives:

- Low-Level Waste: No Action; Regionalized 2, 4, and 5; and Centralized 3 and 4 Alternatives
- Low-Level Mixed Waste: No Action, Decentralized, and Regionalized 1, 2, 3, and 4 Alternatives

DOE also evaluated low-level waste incineration in the SRS Waste Management EIS. The Record of Decision for that EIS includes the incineration of low-level waste in the Consolidated Incineration Facility.

Comment (202)
DOE needs to consider the consequences of transuranic waste not meeting WIPP waste acceptance criteria.

Response
The WM PEIS analysis assumed that all transuranic waste transported to WIPP for disposal would have to meet WIPP waste acceptance criteria, which are being developed by DOE in consultation with EPA and the State of New Mexico. Although these criteria have not yet been finalized, they will be at least the minimum standards for safe shipment and delivery of transuranic waste. The WM PEIS considers the impacts of more stringent (above the minimum) waste acceptance criteria, such as reduced gas generation and treatment to meet land disposal restrictions. DOE assumes that it would treat all transuranic waste to meet the imposed criteria before shipping the waste for final disposal.

Comment (467)
Appendix H discusses technology development and its potential for future treatments; DOE should outline the potential for plasma hearth and transmutation technologies.

Response
Section H.3.3.3 in Volume IV contains a description of the plasma hearth process, including schedule for availability, cost, and technical limitations.

DOE assumes that by "transmutation technologies," the commentor is referring to the use of nuclear reactions to transmute long-lived radionuclides to short-lived or stable nuclides. Such transmutation

could take place in accelerators or nuclear reactors. One transmutation reaction has concerned technetium-99, a troublesome radionuclide with a half-life of 225,000 years. In this process, technetium-99 would be bombarded with neutrons to form technetium-100, which decays quickly (16-second half-life) to ruthenium-100, which is stable. Transmutation also could be used on waste containing fissionable fertile nuclides (nuclides will be transmuted to fissionable nuclides upon neutron absorption) such as those in transuranic waste. The effect would be to convert long-lived fertile radionuclides in shorter-lived fission products through the fission process. These fission products would be disposed of as low-level radioactive waste.

However, the demonstration of the transmutation process has not been applied to transuranic waste, and has not yet been proven acceptable for production-size facilities. Because the feasibility of using transmutation technology for treating large volumes of waste is still speculative, it is not discussed in the WM PEIS.

Comment (507)
Advanced waste forms, e.g., vitrification and metals matrix, should be evaluated.

Response
DOE is committed to managing its wastes to protect human health and the environment, including the safe storage and disposal of waste. The WM PEIS analysis is based on the uniform application of generic, currently available treatment, storage, and disposal technologies. The specific technologies used at a site to implement an alternative will depend on a number of factors. Advanced technologies would be considered in sitewide or project-level NEPA reviews. DOE changed the PEIS to explain why advanced technologies were not used in the analysis (see Volume I, Section 5.2.2).

Appendix H in Volume IV describes DOE's ongoing program of technology development, which will continue to develop alternative technologies that will be deployed as quickly as feasible.

Comment (514)
Concerning the transuranic waste Centralized Alternative and waste treatment at WIPP, DOE should consider advanced treatment technologies, such as in a closed system.

Response
The WM PEIS transuranic waste analysis considered the possibility of treatment to three levels: (1) to meet current WIPP waste acceptance criteria, (2) to reduce gas generation, and (3) to meet RCRA land disposal restrictions. Each treatment process assumed currently available technologies that could be applied broadly across the system and compared between sites. However, DOE recognizes the importance of replacing these technologies as new, safer, and more cost-effective technologies become available.

The WM PEIS will support programmatic decisions on selecting sites to host transuranic waste storage and treatment facilities. Decisions on the minimum level of transuranic waste treatment needed to meet WIPP waste acceptance criteria will be based on the WIPP SEIS-II. DOE will consider all treatment technologies that can treat transuranic waste to meet this criteria.

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Comment (525)
DOE needs to clarify the relationship of waste incineration activities at LANL and those activities at INEL, and whether, based on waste quantities produced, these are contradictory to current practices.

Response
DOE clarified the WM PEIS to reflect that the hazardous waste Decentralized Alternative does not call for the construction of new incinerators (Volume I, Section 10.3.2). Due to the relatively low projected waste volumes to be processed at LANL, DOE canceled plans for an incineration facility there because operating such a facility would not be cost-effective. The Final WM PEIS indicates that under the Decentralized Alternative, DOE would incinerate hazardous waste at INEL.

Thermal treatment was used as a generic technology in the WM PEIS analysis to allow a relative comparison of potential impacts across sites. Site-specific treatment technologies would be selected after consideration of information in any sitewide or project-level NEPA reviews.

Comment (1117)
DOE should clarify the meaning of thermal destruction.

Response
Thermal destruction, or thermal treatment, is the efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. The greater the destruction efficiency, the cleaner the air emissions. The thermal treatment technologies analyzed in the WM PEIS are incineration and desorption, which are described in Volume I, Section 6.2.2, of the WM PEIS.

The definition for thermal treatment is included in the Glossary in Volume I of the WM PEIS.

Comment (1523)
Have the treatment technologies identified in the WM PEIS been decided? Are they already in place? The WM PEIS needs more discussion about the treatment technologies and their impacts on cost and potential emissions. This discussion is key to decisions, but is not available in the PEIS.

Response
The WM PEIS does not select specific treatment technologies for specific sites. The 17 major sites identified in the WM PEIS have been evaluated as potential treatment, storage, and disposal facilities for comparative purposes. The PEIS is a national study and, therefore, management facilities and technologies are assumed to have a generic design, which allows DOE to make comparisons across sites. Thermal treatment, for example, was used as a generic technology. However, treatment technologies for sites would be selected after considering site-specific information in any sitewide or project-level NEPA review. Such analyses would explore alternative technologies more fully tailored to site-specific considerations.

DOE would use existing units to the extent feasible. Chapters 6 through 10 in Volume I identify existing capacity. However, existing capacity would not be sufficient to meet all of DOE's treatment needs; therefore, additional generic facilities were hypothetically placed where needed to address the difference between existing capacity and capacity needed to meet the requirements of a given alternative.

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Comment (1694)
Thermal beds are not as safe as DOE thinks.

Response
DOE assumes that the reference to the safety of thermal beds is to the safety of fluidized-bed incinerators. In a fluidized-bed incinerator, waste is fed to a hot bed of inert granular material for combustion, where the high thermal mass and turbulent mixing action of the bed rapidly transfers heat to the waste. This technology has high applicability to resins and combustible dry heterogeneous solids. RFETS has studied this technology.

The WM PEIS analysis assumes the use of currently available generic treatment technologies; for example, the PEIS considers the rotary kiln incinerator. Therefore, incinerator accidents addressed in the WM PEIS were appropriate for rotary kiln incinerators, not fluidized-bed incinerators. Specific technologies used at a site to implement an alternative would depend on a number of factors that DOE would evaluate further in sitewide or project-level NEPA reviews.

Comment (1721)
DOE should give more attention to the use of innovative technologies for treating transuranic waste (e.g., LLTD microwave).

Response
DOE assumes the commentor is referring to one of two technologies being developed by DOE, low temperature thermal desorption, or microwave melting. The DOE Office of Technology Development has an active program to develop improved technologies for the treatment, storage, and disposal of DOE radioactive and hazardous wastes.

The low-temperature thermal desorption process under development at RFETS uses heat at temperatures below the point at which organic materials decompose to evaporate organic materials such as solvents from wastes. The organic materials would then be collected and treated and/or disposed of as appropriate. The residue would then be stabilized and disposed of as appropriate. The residues would be disposed of at WIPP. Several methods have been investigated as the best source for this process, but apparently not microwave heating.

Microwave treatment of mixed waste, which has been investigated for the in-container solidification and stabilization of nonorganic wastes such as incinerator ash, sludges, or soils, is in the demonstration stage. Dry waste material is vitrified inside a metal disposal container in either a batch or continuous feed mode. Melt temperatures range from 1,800 to 2,600°F and the resulting product is a glassy monolith that would meet radioactive waste disposal criteria for liquid and particulate content and RCRA land disposal restrictions for leaching of toxic hazardous constituents.

The WM PEIS will support programmatic decisions on selecting sites to host transuranic waste storage and treatment facilities. Decisions on the minimum level of transuranic waste treatment needed to meet WIPP waste acceptance criteria will be based on the WIPP SEIS-II. DOE will consider all treatment technologies that can treat transuranic waste to meet this criteria.

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Comment (1798)
One commentor stated that if low-level wastes can be safely biodegraded, he would favor biodegradation as a treatment method.

Response
The radionuclide constituents of low-level waste cannot be biodegraded. It might be possible to successfully biodegrade the organic fractions of low-level waste. However, because of the programmatic nature of the WM PEIS study, DOE chose generic treatment technologies, which included thermal treatment, compaction/supercompaction, solidification, size reduction, and evaporation/concentration.

Comment (2011)
Figure 6.2-1 does not include solidification and stabilization, the primary treatment options. Solidification and stabilization are being used for treatment of low-level mixed waste at a few sites, and should probably be included in this figure.

Response
Figure 6.2-1 in Volume I of the WM PEIS illustrates the "generic" treatment train used to evaluate treatment of low-level mixed waste. The diagram includes secondary treatment modules for grout and polymerization. Grouting and polymerization are solidification and stabilization treatment methods. The modules listed for pretreatment, primary treatment, and secondary treatment contain the basic technologies to treat low-level mixed waste to meet land disposal restrictions. Waste is routed to modules based on treatment requirements, and both polymerization and grout modules receive some waste directly from pretreatment, as well as some after other types of "primary treatment" are accomplished. Thus, solidification and stabilization, represented by processes contained in both the polymerization and grout modules, are evaluated in the WM PEIS. Greater detail about these technologies is in the WM PEIS Low-Level Waste Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Although the WM PEIS is not intended to select technologies and, thus, uses only a generic system for its evaluation, DOE is considering other means of solidification and stabilization for its low-level mixed waste. Vitrification, various cement matrices, and ceramics are also being investigated. DOE intends to treat all low-level mixed waste in accordance with the requirements of land disposal restrictions and all other applicable requirements.

Comment (2014)
Volume I, Section 6.2.2, states that an approved method recognized by EPA was selected to process each treatability group. Specify the approved treatment method and provide a list of treatment technologies that would be recognized by EPA.

Response
Treatment technologies were taken from recommendations of the *Mixed Waste Treatment Project: Functional and Operational Requirements for an Integrated Facility*, Los Alamos National Laboratory, 8/30/92. The Mixed-Waste Treatment Project was established to provide treatment technology and processing options for treating low-level mixed waste. These technology options were selected based on the technology-based standards identified in 40 CFR 268 and the treatment standards for hazardous debris identified in 40 CFR 268.45.

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The WM PEIS Low-Level Mixed Waste Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9 of the Final PEIS, provides additional details about the treatment technologies that DOE evaluated for the WM PEIS. These waste treatment technologies are presented in terms of treatment modules for waste preparation, pretreatment, primary and secondary treatment, and preparation of treated waste for final disposal. This sequential linking of treatment modules constitutes a "treatment train." Each waste treatment form has a unique treatment train, as shown in Volume I, Figure 6.2-1, of the WM PEIS.

Comment (2016)
Volume I, Table 6.2-2, uses the term "Nonflame Technologies." DOE should use the term "Other Technologies," since "nonflame" is not a standard term used by EPA or States.

Response
DOE changed "Nonflame Technologies" to "Alternative Organic Treatment Technologies" in response to this comment.

Comment (2026)
The WM PEIS should include a complete environmental analysis of any new proposed disposal methods for mixed waste, especially with regard to the molten salt oxidation process.

Response
The WM PEIS does not propose specific treatment technologies for the candidate waste management sites. Because the PEIS is a national study, DOE assumed generic designs for management facilities and technologies, which allows comparisons across sites. Therefore, DOE used incineration as a generic thermal treatment technology in the PEIS analysis. DOE will select treatment technologies for sites after considering site-specific information in sitewide or project-level NEPA reviews.

DOE has an aggressive technical development program to explore alternatives to incineration. DOE will test and deploy incineration technologies depending on their potential to treat wastes safely and effectively.

Comment (2110)
I am in full support of waste treatment activities, including incineration.

Response
Thank you for your comment.

Comment (2117)
The concept of incineration and how it relates to the accelerator at BNL should be clarified.

Response
Incineration is a waste treatment activity that provides for the efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. An accelerator generally accelerates atomic or subatomic particles and causes them to collide with a target, which enables scientists to study the structure of matter. Thus, there is little relationship between incinerators and accelerators.

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Comment (2175)
Commentors oppose Vortec or glass encapsulation of radioactive waste. The glass frit produced during the Vortec process does not seem to be of high quality and there is a potential for leakage. DOE needs to pay attention to quality control when treatment technologies such as vitrification are being carried out.

Response
The Vortec process is an oxidation and vitrification process for the remediation of soils, sediments, and sludges that are contaminated with organics and heavy metals. A 20-ton-per-day pilot-scale facility at an EPA-funded site has operated successfully since 1988, producing a vitrified product that passes toxicity characterization leaching procedure standards. Large pilot plants are available for testing and large field demonstrations are underway. Transport systems are being designed for the treatment of DOE mixed wastes.

Due to its programmatic nature, the WM PEIS does not propose specific waste treatment technologies; rather, it includes environmental impacts from treating waste with existing and generic treatment facilities. DOE used representative technologies to estimate waste management impacts, but will not use the PEIS to select specific technologies (such as the Vortec process) for waste management.

With regard to the quality of the glass frit from the Vortec process, the following statement is from DOE Order 5700.6C, *Quality Assurance*: "It is DOE policy to establish quality assurance requirements to ensure that risks and environmental impacts are minimized..." One of the DOE quality assurance criteria is that "inspection and assurance testing of specified products and processes shall be conducted using established acceptance and performance criteria." This quality assurance requirement applies to the Vortec process, as it would apply to any treatment process.

Comment (2272)
At Hanford, DOE must pay particular attention to cultural impacts, especially to religious and cultural sites that are not on the National Register of Historic Places. The use of basalt from Gable Mountain for riprap could have cultural impacts; all areas along the river, as well as Gable Mountain and Gable Butte, are high risk for native remains.

Response
Section 4.4.4 in Volume I of the WM PEIS, which describes the affected environment at the Hanford Site, states that the Hanford Site contains numerous recorded archaeological and might contain additional cultural properties important to Native American groups. The Hanford Site contains no designated National Historic Landmarks. However, several industrial properties, including the B Reactor, are listed on the National Register of Historic Places.

Cultural resources, including historic and Native American resources, could be affected at sites where waste management facilities are ultimately built. However, the impacts of the construction of waste management facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends on their specific location at a site. These impacts will be examined in sitewide or project-level reviews.

8.3.1 Treatment

Comment (2333)
It would be helpful to point out the fraction of treated mixed wastes in which the radioactive or non-radioactive contaminants are essentially negligible, approaching natural background at ORR.

Response
The analytic methodology used in the WM PEIS does not segregate the wastes following treatment. Thus, the waste that is analyzed for disposal has uniform concentrations of radioactive elements and chemicals that should not be characterized as negligible.

Low-level mixed waste is treated to provide for safe disposal of the constituent radioactive components and for disposal of the nonradioactive, hazardous components in conformity with RCRA land disposal restrictions. Treatment of low-level mixed waste does not remove radioactivity; only time can remove radioactivity, through decay. However, treatment does stabilize radioactive waste so that it can be disposed of. The impact to air quality of treating hazardous constituents depends on the nature of the constituents. RCRA requires that hazardous organic compounds be destroyed. On the other hand, RCRA requires that toxic metals be stabilized so that they not leach appreciably from disposal facilities. A technical report that is available in the DOE public reading rooms listed in Section 1.9 in Volume I contains further information about the radiological profiles and treatment categories of low-level mixed waste. Sitewide or project-level NEPA reviews would contain more detailed information about the waste to be treated at ORNL.

Comment (2340)
According to Figure 7.2-1 in Volume I, only bulk equipment is to be reduced. Is shredding and compacting for bulk items?

Response
The materials to be shredded are identified as "bulk metals/equipment." These materials are individual pieces of metal and equipment that are amenable to size reduction. They are referred to as "bulk" because the volume is of the item itself, including void spaces, not of the individual components.

Shredding is practical for lighter gauge materials. The more broadly defined shredding (i.e., size reduction [to include shearing, sawing, cutting torches, impact tools]) is practical for mechanical disassembly of equipment, structural pieces, and hoods. This is often a pretreatment step for packaging or compaction, where applicable. This is why DOE used the term size reduction instead of the more narrowly defined shredding.

Comment (2446)
Volume I, Section 10.3.2, mentions that the INEL incinerator will be placed in standby. This is not so. It will be used for low-level waste and low-level mixed waste treatment until the advanced Mixed Waste Treatment Facility comes on line and possibly after.

Response
The commentor is correct that the Waste Experimental Recovery Facility incinerator at INEL will not be placed in standby. The incinerator is currently treating and will continue to treat for some time low-level waste and low-level mixed waste.

8.3.1 Treatment

DOE revised Section 10.3.2 to identify INEL as one of the sites that would perform thermal treatment of hazardous waste under the Decentralized Alternative.

Comment (2552)
In Volume II, Table II-6.5.7, what is the source of vinyl chloride under the Regionalized Alternative?

Response
Table II-6.5-7 shows vinyl chloride emissions from hazardous waste treatment at 1% of the standard under Regionalized Alternative 2, but not in other alternatives. The vinyl chloride treated at INEL under Regionalized Alternative 2 would be shipped from the Hanford Site. Under Regionalized Alternative 1, this vinyl chloride (approximately 500 kilograms) would be treated onsite at Hanford, as shown in Table II-5.5-7. There are also small amounts of vinyl chloride waste generated at INEL and ANL-E.

Comment (2555)
Volume III, Table C.4-2. Is vitrification the only technological option for treating high-level waste? For other options, there is a potential for releases of radionuclides from high-level waste treatment.

Response
The analysis of high-level waste treatment alternatives is not within the scope of the WM PEIS. Section 1.5.4 in Volume I states that the WM PEIS addresses only alternatives for storage of vitrified high-level waste prior to its ultimate disposal in a geologic repository. The impacts of vitrification of high-level waste are included in the cumulative impacts in Chapter 11 (Volume I).

Comment (2570)
Summary document, Table 1.3-2, and Volume I, Table 1.5-1, Chapter 3, and Section 5.2. In these tables, why isn't there a row for "how to treat" and in text, why isn't there some consideration of treatment methodology options as well as locations? In other words, why were generic treatment facility designs assumed? Is "where to treat" a programmatic decision and "how to treat" a site-specific decision? For example, some treatment methods are not suited to some sites, and capital-intensive treatment methods would benefit most by centralization.

Response
The WM PEIS is a programmatic document that presents options for where to treat, store, and dispose of DOE's radioactive and hazardous waste. Due to its programmatic nature, the PEIS does not attempt to select actual locations for waste management facilities on sites or select specific treatment technologies for sites. Rather, the PEIS assumes a generic waste treatment technology to enable comparisons of siting alternatives. The technologies analyzed were chosen for analytical purposes only. DOE revised Sections 1.7.3 and 5.1.2 in Volume I to include this explanation. The comment is basically correct, in that evaluating alternatives for "how to treat" is more appropriate at the sitewide or project level.

DOE will consider factors such as cost and technology development when selecting sites for waste management operations.

Comment (2581)
DOE does not address the uncertainty related to the treatment technologies for high-level waste (i.e., the treatment technologies are not yet proven).

8.3.1 Treatment

Response
The WM PEIS is a programmatic study that does not select technologies; rather, for purposes of analysis, it assumes a generic waste treatment train to enable decisionmakers to compare alternatives at a Department-wide level. However, Appendix H in Volume IV of the WM PEIS discusses selected examples of emerging technologies that could influence waste management alternatives or mitigate the impacts of waste management activities.

Issues related to treatment facilities and selection of treatment technologies will be addressed in the course of sitewide or project-level NEPA reviews.

Comment (2589)
The WM PEIS states that under the Decentralized Alternative for hazardous waste, DOE would implement its current plan to start incineration at LANL, ORR, and SRS, and to place the incinerator at INEL in a standby status. Does this statement really reflect current DOE plans? Our understanding is that there are no plans to restart the incinerator at LANL, and the incinerator at INEL is currently operating, with plans for continuing operation. Also, why is this alternative not discussed in Appendix D?

Response
DOE has modified the hazardous waste Decentralized Alternative by replacing LANL with INEL as an incineration site in Section 10.3.2. The incinerator at INEL is currently operating and will continue to operate.

The Decentralized Alternative is not discussed in Volume III, Appendix D. As can be seen by comparing the waste-volume estimates presented in Tables 10.3-4, 10.3-5, and 10.3-6 in Volume I, the Decentralized Alternative is a composite of the No Action Alternative (for INEL and ORR) and Regionalized Alternative 1 (for SRS). The health risk estimates for the Decentralized Alternative presented in Section 10.4 were compiled by using the estimates presented in Appendix D for the No Action Alternative for INEL and ORR and for Regionalized Alternative 1 for SRS.

Comment (2605)
Volume I, Section 7.4.3, states that thermal treatment technologies are the most effective in destroying the combustible hazardous constituents contained in low-level waste. Please clarify; this sounds more like hazardous or mixed-waste treatment.

Response
DOE has revised Section 7.4.3 to state that although there are many processes used for treating low-level waste, to date, thermal treatment technologies have been the most effective in destroying and reducing the volume of combustible materials contained in low-level waste.

Comment (2606)
In Volume I, Section 8.4.1.2, "thermal destruction of plutonium-238" should be changed to "thermal treatment or incineration of material containing plutonium-238," since plutonium cannot be destroyed thermally.

8.3.1 Treatment

Response
DOE revised Section 8.4.1.2 to indicate that this reflects thermal destruction of combustible material containing plutonium-238.

Comment (2651)
Commentors oppose incineration of radioactive and hazardous waste because of atmospheric inversions, production of potentially "lethal" airborne pollutants such as dioxins and furans to nearby population centers, and because the technology is unproven. Commentors suggest DOE wait until there is a safe alternative.

Response
DOE is committed to managing its wastes to protect human health and the environment, including the safe storage, transportation, and disposal of waste. The specific technologies used at a site to prepare waste for transportation to implement an alternative will depend on a number of factors that DOE will evaluate further at the site and project level. The WM PEIS does not select treatment technologies for specific sites.

The PEIS analyses were based on the uniform application of currently available treatment, storage, and disposal technologies. DOE used thermal treatment as a generic technology in the PEIS analysis to enable a relative comparison of potential impacts across sites. DOE will select a treatment technology at a site after considering site-specific information in sitewide or project-level NEPA analysis. Such analyses will explore alternative technologies more fully tailored to site-specific considerations.

Properly designed and operated incinerators are as or more effective than other treatment technologies, and DOE does not preclude their use at any site. EPA's combustion strategy states, "If properly designed and operated in compliance with regulatory standards, combustion is a technology that provides sound management of hazardous waste." Fact sheets on radioactive and mixed waste incineration published jointly by EPA and DOE (EPA 402-F-95-004 through 007, January 1996) recognize the effectiveness of incineration as part of the DOE Waste Management Program and that alternatives are not entirely comparable. Optimal operation of incinerators in conjunction with existing pollution control technologies, can minimize generation of dioxins and furans and radiation releases.

DOE compared impacts from incineration to those from non-thermal treatment technologies and identified little or no difference in treatment risk to human health. The Alternative Organic Treatment Technology Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS, evaluates the environmental impacts and costs of incineration versus a non-thermal treatment technology.

DOE has an aggressive Technical Development Program to explore alternatives to incineration. Alternatives will be tested and deployed depending on their potential to treat waste safely and effectively. The Technology Development Program is an integral part of the Office of Environmental Management's mission.

Comment (2848)
Cancer estimates in Volume I, Table 6.4-8, are based on conceptual thermal treatment with particulate radionuclide controls. DOE should clarify and specify what efficiencies were assumed for the high-efficiency particulate air filtration controls.

Response
High-efficiency particulate air filters are capable of trapping and retaining at least 99.97% of all monodispersed particles 0.3 micrometers in diameter or larger. To be conservative, the 99.97% efficiency was used in the WM PEIS analyses. DOE revised Section 4.3.1 in Volume I of the WM PEIS to include this specification. Supporting technical reports contain additional technology performance information. These reports are listed in Volume I, Section 15.2, and are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3133)
Referring to Section H.3.2, a commentor stated that it might be difficult to evaluate incineration (as the "national" baseline technology for organic destruction) for Hanford. Hanford costs have not been confirmed and perhaps are not calculable because Hanford has not used incineration due to political, public acceptability, or technical reasons.

Response
For the WM PEIS analysis, DOE assumed the use of standard, currently available technologies for waste management and transportation. These are described in Chapters 6 through 10 (Volume I) and Appendices D (Volume III), E, and F (Volume IV) of the WM PEIS. Supporting technical reports provide additional information. In addition, DOE has an aggressive technical development program to explore alternative waste disposal technologies. Alternatives will be tested and deployed depending on their potential to safely and effectively treat and transport waste. Appendix H in Volume IV describes emerging technologies that could influence the WM PEIS alternatives or mitigate impacts.

The WM PEIS does not select specific treatment technologies for specific sites. The 17 major waste sites identified in the WM PEIS have been evaluated as potential treatment, storage, and disposal facilities for comparative purposes. The PEIS is a national study and, therefore, management facilities/technologies are assumed to have a generic design, which allows DOE to make comparisons across sites.

DOE will use existing waste management units to the extent feasible. Chapters 6 through 10 identify existing capacity. However, existing capacity will not be sufficient to meet all of DOE's treatment needs; therefore, additional (generic) facilities were assumed where needed to address the difference between existing capacity and capacity needed to meet the requirements of a given alternative.

Comment (3134)
Section H.4.3.1 of the WM PEIS suggests using a cone penetrometer for dense, nonaqueous-phase liquids investigations. However, at Hanford, it might not be suitable to use a cone penetrometer for such investigations due to the depth of the groundwater and aquifer thickness.

Response
DOE revised Section H.4.3.1 in Volume IV of the WM PEIS to indicate that the cone penetrometer is generally used for shallow subsurface investigations.

Comment (3135)
Section H.4.3.1 of the WM PEIS states that ground-penetrating radar shows the most promise for detecting shallow pockets of dense, nonaqueous-phase liquids (DNAPLs). However, at Hanford, this technique would have limited capacities for delineation of DNAPLs, due to their expected depth.

8.3.1 Treatment

Response
Current developments are focused on improving the sensitivity at greater depth of detection technologies (seismic, passive and active magnetic, ground-penetrating radar, and inducted resistivity/polarization) that could be expected to detect shallow pockets of DNAPLs. Ground-penetrating radar shows the most promise. At present, none of these technologies is sensitive enough to be used alone or on all sites for DNAPL characterization, but when used in combination with other techniques such as the cone penetrometer, they can result in excellent delineation of DNAPLs.

Comment (3136)
The applicability of the heated steam technology for inorganics or organics is not confirmed for Hanford, where many of these contaminants are located at depths greater than 200 feet.

Response
Inclusion of technologies in WM PEIS Appendix H is not meant to imply that these technologies would be useful at all sites under all conditions. Technologies are described that could be applied given the appropriate environmental conditions.

Comment (3137)
The attachment to Appendix H of the WM PEIS notes that new methods need to be developed for removal of technetium-99 from groundwater. At Hanford, technetium-99 removal was successful, to non-detect levels, in the 200-BP-5 and -UP-1 Operable Units using ion-exchange resins.

Response
The attachment to Appendix H cited in the comment is a portion of the Office of Technology Development's fiscal year 1996 Budget Request Work Packages for Focus Areas and Crosscutting Programs. Among the many initiatives contained in the document is the development of new methods for removal of technetium-99 from groundwater. The existence of this initiative in the Office of Technology Development's fiscal year 1996 Budget Request Packages in no way implies that DOE believes that current technetium-99 removal methods are necessarily inadequate, nor does it imply that Hanford has not successfully removed technetium-99.

Comment (3149)
The WM PEIS does not provide a basis for treatment decisions since it fails to consider (1) treatment needed for waste characterization requirements, to reduce volumes and void spaces in drums, and to meet the EPA waste disposal assurance requirements, and (2) non-incinerator treatment.

Response
The WM PEIS is a national study on siting options for managing radioactive and hazardous waste safely and efficiently. For purposes of analysis, the PEIS uses generic treatment technologies to compare siting options. The PEIS will not be used to select actual treatment technologies. Therefore, there is no need to compare two technologies that have the same objective, such as incineration and another form of thermal treatment. However, the generic technologies considered in the document were chosen to meet regulatory requirements. For example, the generic technologies for low-level mixed waste and hazardous waste would meet the RCRA land disposal restrictions promulgated by EPA. Decisions related to the level of treatment needed for transuranic waste disposal at WIPP are addressed in the WIPP SEIS-II. Additional studies will be required before DOE selects actual treatment technologies for specific sites.

8.3.1 Treatment

Appendix H in Volume IV of the WM PEIS contains a description of technology development in general. In addition, several technical reports referenced in the PEIS provide technology-related information in different contexts. These reports are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3294)
It is unclear how various treatments affect the volumes requiring disposal. Would additional treatment significantly reduce the curies disposed, and if so, by how much?

Response
The degree of volume reduction achieved through treatment depends on the technology used. The WM PEIS technical reports for low-level waste and low-level mixed waste, which are available in the DOE public reading rooms listed in Section 1.9 in Volume I, contain volume reduction factors for the technologies represented in the WM PEIS. For solid combustible waste, incineration achieves the highest volume reductions. Overall volume reductions for alternatives can be obtained from the tables in Appendix I in Volume IV. Comparison of feedstock volumes and disposal volumes yields the effect of treatment.

Treating waste can change its physical and chemical characteristics and its volume, but does not affect the radioactive characteristics. Therefore, the curie content of the disposed waste is not reduced by treatment.

Comment (3330)
Nuclear energy wants to radiate and it will keep going until it is stopped by the exact science of nuclear waste management. Common sense dictates that the more one tries to move things around and change them, the more trouble in the end result. Use the actual scientific properties of nuclear waste to fully expend the radiation levels left. This will enable consolidation of future waste and the reclamation of current waste. The probability of cancer effects, genetic effects, and overall fatalities will drop.

Response
DOE is committed to the safe and efficient management of radioactive waste and waste that is defined as hazardous under RCRA. Treatment of this waste will put it in a more stable form, reduce its volume, and allow its permanent disposal. The physical, chemical, and radioactive properties of the waste are used to determine appropriate groups of treatment. For example, Figure 6.2-1 in Volume I illustrates how the treatment of low-level mixed waste depends on whether the waste is aqueous waste, organic liquids, solid process residues, soils, or debris.

Comment (3611)
See Volume I, Figure 8.2-2. What is the nongassing package for WIPP?

Response
The WM PEIS analysis of intermediate levels of treatment of transuranic waste considered technologies that could reduce hydrogen gas generation in the WIPP repository, in accordance with WIPP waste acceptance criteria. The technologies for reduced gas generation considered in the WM PEIS included shredding and grout stabilization, and packaging in a disposal overpack made from materials less likely to contribute to the generation of hydrogen gas. Figure 8.2-2 refers to this "nongassing package."

8.3.1 Treatment

Comment (3640)
Why is it necessary to incinerate plutonium-238?! And, what are the impacts of thermal destruction of plutonium? Thermal destruction, in essence, will increase risk to exposure of plutonium by humans and wildlife/fish.

Response
The interaction of radiation from plutonium-238 with organic materials can generate hydrogen gas. Transportation regulations limit the amount of this gas that is permitted in transportation containers. Incineration destroys the organic components in the waste, thereby eliminating the source of hydrogen. The incinerator ash, which would include the residual plutonium-238, would be stabilized in a grout or vitrified form prior to shipment for disposal.

The WM PEIS used currently available thermal technologies for the analysis of organic destruction; incineration was employed for the most intensive treatment of transuranic waste. High-efficiency particulate air filters were used for the off-gas systems. However, the WM PEIS was not intended to select technologies and the generic currently available systems provided a conservative analysis of impacts. For treatment of organics in plutonium wastes, DOE would consider proven alternative technologies when conventional thermal technologies such as incineration pose unacceptable risks. Site-specific designs would incorporate the best technologies for each waste treatment requirement and site.

Comment (3738)
DOE treats the land and habitat around Hanford as a free resource to sacrifice for burial of wastes without attempting to reduce volumes or treat the wastes before burial.

Response
Waste disposed of at the Hanford Site would be required to meet that disposal facility's waste acceptance criteria. The waste acceptance criteria for the Hanford low-level waste disposal facility require that all waste with greater than threshold quantities of key radionuclides be treated so that they be in a stable, immobilized form when disposed of. The wastes considered for disposal at Hanford in the WM PEIS are low-level waste and low-level mixed waste. The maximum amount of land potentially needed for low-level waste and low-level mixed waste disposal at Hanford is 137 acres, which is less than 3% of the recommended land area for future waste management activities. Both waste types would be treated to render them less hazardous, or to stabilize them before disposal. These processes also reduce volumes (i.e., for aqueous and organic wastes). The WM PEIS also specifically evaluated low-level waste alternatives that involved maximum possible volume reduction through thermal treatment, size reduction technologies, and super compaction prior to disposal, including disposal at the Hanford Site.

DOE is concerned about the future use of land at and surrounding its sites and facilities. Recommendations for future use of the Hanford Site are being developed by the Hanford Future Site Uses Working Group, which includes representations of Federal, Tribal, State, and local entities. Local entities include Benton County, Franklin County, and the City of Richland. For further information on DOE's efforts regarding future land uses, see DOE's 1996 publication, *Charting the Course: The Future Use Report,* which is available in the DOE public reading rooms listed in Volume I, Section 1.9.

8.3.1 Treatment

Comment (3745)
Hanford does not treat all liquid waste before disposing of it directly to the soil.

Response
It is the policy of DOE that use of soil columns to treat and retain radionuclides and nonradioactive materials in liquid waste streams be discontinued at the earliest practicable time in favor of wastewater treatment and minimization. To date, all of the wastewater streams at Hanford have been addressed in some manner with the cognizant State of Washington agency. These liquid effluent streams were evaluated to determine the best treatment and disposal options available. In cases where it was determined that the best available management option for the wastewater stream was treatment, the streams are being treated. For some of the streams it has been determined that the best available options are source control, minimization or administrative controls, or that no additional treatment is required.

At Hanford, except for the wastewater stream containing tritium, there are currently no liquid wastewater streams disposed to the ground that exceed the Safe Drinking Water Act maximum contaminant levels for radionuclides. Washington State Department of Ecology has agreed with DOE in the *Determination of Significance and Adoption of Existing Environmental Document*, published October 6, 1993, that there are presently no reasonable treatment technologies to remove tritium from the effluent. The Washington State Department of Ecology found the discharge option DOE selected to adequately protect human health and the environment.

There are some nonradioactive, non-hazardous liquid discharges at Hanford discharged to the soil for which the best treatment and disposal option has been determined, with concurrence from the State of Washington, to be source controls, minimization, or administrative controls. Examples of these liquid wastewaters are steam condensate and heating, ventilation, and air conditioning cooling water.

Comment (3773)
DOE needs to explain the water treatment technologies it will use, including evaporation, and how that water will be disposed of.

Response
Because of the programmatic nature of the document, the WM PEIS assumes generic treatment technologies. Generic treatment technologies for aqueous waste (wastewater) are shown in Figure 6.2-1 for low-level mixed waste, Figure 7.2-1 for low-level waste, and in Figures 8.2-1 through 8.2-3 for transuranic waste. More information on these technologies is given in the technical reports for these waste types available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Evaporation is a typical wastewater treatment technique; it is used to concentrate a liquid effluent by using heat to drive off relatively volatile components. It is used to concentrate aqueous wastes. Evaporation is conducted by vaporizing a portion of a solvent (typically water) to produce a concentrated solution or thick liquor of radioactive material (often called evaporator bottoms). The evaporated solvent, usually water, can be condensed and reused in process applications or can be discharged. Filters and adsorbents such as activated carbon are used to trap any hazardous materials in the vapors.

8.3.1 Treatment

Comment (3775)
The public is concerned about the amount of incineration and dumping taking place at ANL-E.

Response
DOE does not incinerate or "dump" radioactive or hazardous waste at ANL-E. Both radioactive wastes and hazardous wastes are sent offsite for disposal. There is no incineration of such wastes at ANL-E.

Comment (3912)
DOE needs to inform the public about the treatment technologies associated with the waste types and when or if incineration could be an option at ANL-E. The public is opposed to incineration in this area. DOE needs to explain when and where incineration will be used as a treatment technology.

Response
Because of its programmatic nature, the WM PEIS does not select treatment technologies. For purposes of analysis and comparison of siting alternatives, it assumes generic treatment modules such as thermal treatment. Sitewide or project-level NEPA reviews would address questions of technology selection.

The only alternative where thermal treatment at ANL-E is indicated is the Decentralized Alternative for low-level mixed waste. ANL-E has a small volume of solid process residues (15 cubic meters to be treated over 10 years), for which thermal treatment is indicated. However, it would not be very economical to use incineration to treat such small volumes. Therefore, DOE would probably consider a different thermal or non-thermal treatment suitable for treating small volumes.

Comment (3954)
Volume I, Tables 3.6-1 and 3.6-2 indicate volume reduction of low-level waste as a possible alternative. What methods of volume reduction are DOE considering other than incineration and disposal in sewerage systems? Both methods of "reduction" result in release of radioactive materials to the environment through air or water.

Response
Other volume reduction technologies considered in the WM PEIS are identified in Section 7.2.2 in Volume I, especially in Figure 7.2-1. Thermal treatment (incineration) is the generic volume reduction technology considered only for low-level radioactive waste classified as organic liquids or combustible. For low-level waste classified as compactible, compaction/supercompaction is the generic technology considered. For both surface contaminated and activated bulk metals and equipment, size reduction is the generic technology considered. Further information on these technologies is contained in the WM PEIS Low-Level Waste Technical Report available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

DOE is committed to managing its waste to protect the public health and safety and the environment. It does not dispose of radioactive waste in sewerage systems. Rather, it disposes of radioactive waste in land disposal facilities only after a performance assessment has shown that the waste can be disposed of there without endangering human health and safety and the environment. The performance assessment is a systematic analysis of a disposal facility and its environs for the purpose of demonstrating compliance with specific performance objectives.

8.3.1 Treatment

Comment (3990)
How can DOE claim to address treatment alternatives for low-level mixed waste openly in this PEIS, indicate a planned facility for increased aqueous treatment at the Portsmouth Plant, and then publish washing technologies while claiming to allow public comment on WM PEIS decisionmaking?

The WM PEIS does not consider aqueous washing treatment for low-level mixed waste, but indicates plans to increase capacity at the Portsmouth Plant for implementation of this treatment. The WM PEIS should fully address this treatment technology, especially since DOE plans to increase capacity at a specific site.

Response
The WM PEIS analyzes different configurations of these activities for DOE sites across the country and will be used to make programmatic decisions on treatment, storage, and disposal of certain wastes. The WM PEIS will not be used to select technologies for waste management. The technologies used in the WM PEIS are proven waste treatment methods that are representative of technologies that could be implemented at the sites and were used for analytical purposes to allow comparisons of impacts across sites. As shown in Figure 6.2-1, the technologies used for the evaluation included aqueous treatment. The top treatment process (nonwastewater) is an aqueous treatment process train that includes solids separation, neutralizations, wet oxidation evaporation, and water recycling. Thus, aqueous treatment listed for the Portsmouth Plant was evaluated in the WM PEIS.

The Alternative Organic Treatment Technology Technical Report was prepared to compare the impacts of thermal treatment (incineration) to non-thermal washing technology. Impacts for these technologies were found to be similar, supporting the validity of the analysis in the WM PEIS utilizing thermal organic destruction for impacts. The technical report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS.

Comment (4003)
A commentor would like to request that DOE consider onsite treatment and storage alternatives using mobile treatment facilities that can be moved from site to site.

Response
As described in Section C.3.1.2 in Volume III, portable treatment facilities are considered in the WM PEIS for use at sites that have small quantities of waste requiring treatment. Permanent facilities would be constructed at sites having larger quantities of waste.

Comment (4235)
Land and habitat are resources that should be highly valued. Therefore, DOE should treat wastes to reduce volumes before burying them at Hanford.

Response
The alternatives considered in the WM PEIS do not consider specific treatment technologies for each waste type. Generic technologies are employed to provide decisionmakers a relative comparison across sites. Some form of volume reduction treatment technology (such as incineration, compaction, supercompaction, size reduction, evaporation/concentration) applicable for compactible, combustible, or organic liquid waste is assumed for several of the low-level waste alternatives (see Volume I, Section 7.2.2) for the purpose of comparing effects against the alternatives that employ only minimum

8.3.1 Treatment

treatment technologies. From comparison of Tables I.2-3 and I.2-4 in Volume IV, it can be seen that use of volume reduction technologies can reduce low-level waste disposal volume by nearly 50% compared with minimum treatment.

Comment (4460)
What alternative technologies did DOE consider for the treatment of transuranic waste to prevent or control the release of the radionuclides to the environment?

Response
Transuranic waste treatment is outlined in Volume I, Section 8.2.2; more detailed treatment technology data are provided in Volume I, Section 6.2.2 (low-level mixed waste treatment is conceptually similar to transuranic waste treatment). To prevent or control the release of low-volatility heavy metal particulates (including radionuclides), DOE would use particulate collection technologies, such as high-efficiency particulate air filters, in the off-gas stream from thermal treatment technologies.

Alternatives that assume the use of thermal treatment of organic wastes indicate potential releases of small quantities of radionuclides into the atmosphere. Such releases, particularly plutonium-238 and americium-241, would increase cancer risks to offsite populations and the probability of cancer to the maximally exposed individual at treatment sites. Most radionuclides from wastes would remain in residual ash after treatment or would be subject to capture by off-gas scrubbers and high-efficiency particulate air filters in an air pollution control system, which is a typical mitigation measure in a thermal treatment facility. On the other hand, alternatives using non-thermal treatment technologies, such as stabilization or solidification would reduce radionuclide release and consequently lower potential health risks.

Because of its programmatic nature, the WM PEIS does not select treatment technologies. For purposes of analysis and relative comparison of siting alternatives, it assumes uniform application of generic treatment modules such as thermal treatment. Sitewide or project-level NEPA reviews will address questions of technology selection and more fully tailor technology and associated mitigation measures to specific sites.

Comment (4467)
By summarizing only three hazardous waste treatment alternatives in the Draft WM PEIS, DOE has not adequately covered the range of realistic treatment alternatives, or the fact that different treatment processes are applicable to different types of waste, with different quantities and different contaminants.

Response
The PEIS does not select specific technologies for specific sites. The WM PEIS is a National and programmatic study to assist DOE in formulating and implementing a strategy to manage its radioactive and hazardous wastes; therefore, management facilities and treatment technologies are assumed to have a generic design, which allows comparisons across sites based on the uniform application of currently available treatment, storage, or disposal technologies. Thermal treatment was used as a generic technology in the PEIS analysis to enable a relative comparison of potential impacts across sites. DOE will select treatment technologies for sites after more fully considering alternative technologies and site-specific information and any sitewide or project-level NEPA reviews that might be conducted.

8.3.1 Treatment

Additionally, the WM PEIS assumes the use of currently available generic technologies for the treatment of low-level waste, low-level mixed waste, transuranic waste, and hazardous waste. Potential emissions from these treatment technologies, resulting impacts on health, ecological resources, and air quality, and the costs associated with their use are presented in Chapters 6, 7, 8, and 10 in Volume I. More information on these technologies is found in the WM PEIS Low-Level Waste, Low-Level Mixed Waste, Transuranic Waste, and Hazardous Waste Technical Reports available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The specific technologies that DOE will use at a site to implement an alternative will depend on a number of factors that DOE will evaluate further at the site or project level. For the programmatic purposes of this document, the use of generic technologies is appropriate.

8.3.2 Storage

Comment (194)
Read Joanna Macy for the best plan to safely store radioactive waste.

Response
DOE does not agree with Joanna Macy's vision for "Nuclear Guardianship" (i.e. perpetual storage). Perpetual storage would pose too great a risk to waste management workers. DOE believes that properly treated waste can be safely disposed of and intends to pursue disposal to minimize risk.

Comment (438)
Are you studying the safest way to store radioactive waste at ANL-E?

Response
DOE is committed to managing its wastes to protect human health and the environment. DOE is always looking for ways to manage wastes that result in less impact to human health and the environment. Appendix H in Volume IV describes emerging technologies that could improve future waste management. DOE's policy is to maintain radiation exposure to workers and the general public to levels that are as low as reasonably achievable.

Comment (1540)
The WM PEIS shows no evidence of active faults in the LLNL area. It should discuss the procedures for the storage of the waste, given that there is an active fault in the area. DOE should also research the life of the metal containers used to store the waste.

Response
In the WM PEIS, DOE assumes some waste storage capability at each of its sites. The design of these facilities is a site function and would incorporate seismic criteria appropriate to the site. Accordingly, the WM PEIS did not consider seismic faults in the analysis of storage impacts. DOE does consider the expected life of metal storage containers in managing its wastes.

If DOE selected LLNL for a new storage facility, it would conduct additional analyses to identify specific design basis that would consider potential earthquake impacts. DOE would design its waste management facilities to the appropriate local seismic standard. DOE revised Chapter 12 in Volume I to include the potential for natural hazards such as earthquakes as a consideration in identifying programmatic mitigation measures.

Comment (1646)
DOE should prohibit underground storage of wastes anywhere in the U.S., and should plan for only temporary storage of wastes.

Response
DOE is committed to managing its waste to protect human health and the environment, including the safe storage and disposal of waste. For purposes of its programmatic analysis, the WM PEIS defines storage as the collection and containment of waste (in such a manner as not to constitute disposal) to await treatment or disposal. Thus, by definition, storage is not permanent. In the WM PEIS, new storage facilities are assumed to be aboveground facilities.

8.3.2 Storage

With regard to disposal, the disposal facility technology assumed is site dependent. At most sites, underground disposal is assumed. However, for sites where underground disposal would be expected to be inappropriate (e.g., ORR), disposal in aboveground engineered structures is assumed. Prior to construction of a disposal facility, a performance assessment will be done to ensure that human health and the environment will be protected.

Comment (1782)
Transuranic waste storage facilities at RFETS need to be upgraded.

Response
DOE is concerned about the condition of current waste treatment, storage, and disposal facilities throughout the complex and recognizes transuranic waste storage facilities at a number of its sites, including RFETS, need to be upgraded. DOE also is preparing the Sitewide EIS for RFETS, which will provide a basis for nuclear materials storage and waste management at RFETS.

Comment (2214)
I have a problem with the idea that this is going to be a temporary storage. I guess when you consider half lives of millions of years, then your idea of temporary holds true, but I don't consider your timeline very temporary.

Response
The WM PEIS addresses treatment, storage, and disposal strategies for the management of radioactive and hazardous wastes over the next 20 years. By disposal is meant emplacement of waste in a manner that ensures protection of human health and the environment within prescribed limits for the foreseeable future, with no intent of retrieval, and that requires deliberate action to regain access to the waste.

Comment (2302)
Waste forms that waste is put into at Hanford must be retrievable. You cannot count on a future repository given the rate at which Yucca Mountain and WIPP are proceeding.

Response
The waste described in the comment (high-level waste for Yucca Mountain; transuranic waste for WIPP) will have been treated and would be stored at the Hanford Site pending shipment. For the PEIS, storage, by definition, is not permanent, but rather, is the collection and containment of waste or spent nuclear fuel (in a manner that does not constitute disposal) to await treatment or disposal.

The PEIS analysis of high-level waste and transuranic waste, as it pertains to Hanford, discusses treated waste in a retrievable form. NEPA reviews for actual siting will address storage-related issues (aboveground, belowground, timing, etc.), including the storage of untreated high-level waste at Hanford, on a sitewide or project-level basis.

Comment (2381)
Aboveground monitored storage onsite. Watch the stuff.

8.3.2 Storage

Response
DOE is committed to managing its waste to protect human health and the environment, including the safe treatment, storage, and disposal of waste. DOE maintains comprehensive monitoring systems for all handling and management of radioactive wastes.

Comment (2540)
"Nonretrievably stored" sounds like disposal (see Volume I, Section 8.15).

Response
For the WM PEIS, all transuranic waste placed in storage after 1970 is considered retrievable and has been analyzed in the waste management transuranic waste analysis presented in Chapter 8 in Volume I. Nonretrievably stored transuranic waste is that which was buried prior to 1970 and will be managed as environmental restoration waste. DOE revised Section 8.1.2 to replace the term "nonretrievably stored" with "buried."

Comment (3161)
The State of Washington and the U.S. EPA should not allow DOE or the U.S. Department of Defense to transfer to the Hanford site any hazardous and radioactive waste until technical, economic, and equity concerns are addressed. Prolonged storage of offsite wastes prior to treatment, or of post-treatment residuals, generally should not be approved.

Response
The WM PEIS is a broad programmatic analysis of national waste management alternatives that does address technical, economic, and equity issues. Under some PEIS alternatives, the Hanford Site would receive and manage wastes generated at other sites. Under other alternatives, some of the Hanford Site's wastes would be transported offsite for treatment, storage, and/or disposal. The Hanford Site's potential role in managing each of the five types of waste, as considered under each management alternative, is detailed in Chapters 6 through 10 in Volume I of the PEIS. The PEIS analysis considered the technical and economic issues associated with the various waste management alternatives, including those involving storage. DOE will consider equity during the decisionmaking process that results in waste-type specific Records of Decision(s).

As discussed in Section 1.7.3 in Volume I, the implementation of waste management decisions made following the publication of the Final PEIS would require sitewide and project-level NEPA reviews.

Comment (3271)
Treatment and storage alternatives for transuranic waste (TRUW) are not sufficiently analyzed. Treatment and storage decisions are necessarily based on disposal options--where, when, and how waste will be disposed of will determine where, when, and how the waste will be treated and stored.

Response
DOE will decide where to treat and store TRUW based on evaluations in the WM PEIS. To support this, the analysis in the WM PEIS considered three different treatment options for TRUW to provide a range of impacts from different requirements that DOE might impose on TRUW disposal. The results of this analyses do not depend on where or when DOE would begin disposing of TRUW, but rather, what level of treatment is required. DOE is preparing a second WIPP Supplemental EIS prior to making the final decision to proceed with WIPP. The WIPP SEIS-II will be used as a basis for

deciding the minimum level of treatment that would be required, based on the impacts of treatment and performance of the repository, before disposal at WIPP. The Draft WIPP SEIS-II was issued for public review in November 1996.

DOE believes that to the extent possible, the WM PEIS analysis of TRUW takes into account the uncertainties associated with the disposal of TRUW and is appropriate for a programmatic evaluation of alternatives concerning where to treat TRUW.

8.3.3 Disposal

Comment (57)
A commentor believes that there might never be a waste disposal solution because DOE failed to address the problem when nuclear and other programs were started up.

Response
DOE has prepared the WM PEIS to enhance the management of its current and anticipated waste volumes on a national scale and provide an integrated examination of the impacts of Department-wide waste management decisions (including disposal). The potential environmental impacts of radioactive materials are better known now than they were when the nation's nuclear program began. Because of this, DOE has changed some of its practices and now manages wastes differently than in the past. DOE is confident it can make decisions as a result of this study that will help solve its waste problems.

Comment (199)
Why haven't we found a permanent repository for dangerous radioactive wastes?

Response
DOE is investigating the possibility of using the Waste Isolation Pilot Plant near Carlsbad, New Mexico, as a repository for transuranic waste, and a site at Yucca Mountain in Nevada as a repository for spent nuclear fuel and high-level waste. Both of these programs are the subject of separate NEPA evaluations, and are further discussed in Section 1.8.1 in Volume I of the Final WM PEIS. In addition, DOE currently disposes of its low-level wastes at six sites: The Hanford Site, ORR, INEL, LANL, NTS, and SRS. In the WM PEIS, DOE is analyzing the impacts of decentralized, regionalized, and centralized disposal of low-level and low-level mixed wastes. Decentralized disposal would be at as many as 16 sites; centralized disposal would be at either the Hanford Site or NTS.

Comment (389)
A commentor is "troubled" by indications that DOE might consider in-place disposal of most existing Hanford tank wastes.

Response
The WM PEIS only evaluates programmatic alternatives for storage of high-level waste after it is removed from the tanks and vitrified. The Hanford Tank Waste Remediation Systems EIS, identified in Volume I, Section 1.8.1 of the WM PEIS, evaluates alternatives for remediation of the high-level waste tanks. Potential impacts identified in that EIS are considered in the cumulative impacts analysis for the Hanford Site in Section 11.4 in Volume I of the WM PEIS.

Comment (506)
Based on the disposal sites listed and the performance standards being developed, the assumptions about the final waste form at the site need to be discussed in the PEIS.

Response
The assumed generic disposal facility for low-level waste and low-level mixed waste is shallow land burial in the West and aboveground disposal in the East (except at SRS). DOE would use either polymer or grout to stabilize wastes needing stabilization. The selection of form and facility type would depend on sitewide or project-level NEPA reviews and the results of performance assessments. The WM PEIS discusses this information in Sections 6.2.2 and 7.2.3.

8.3.3 Disposal

Comment (691)
Do not use shallow land disposal at LLNL.

Response
The WM PEIS is a national study and, therefore, assumes management facilities and technologies to have a generic design, which allows DOE to make comparisons across sites. DOE evaluated the major waste sites, including LLNL, that it identified in the PEIS as potential treatment, storage, and disposal facilities for comparative purposes.

The assumed generic disposal facility for low-level waste and low-level mixed waste is shallow land burial in the West and aboveground disposal in the East. The selection of the final type of facility depends on sitewide or project-level NEPA reviews and the results of performance assessments. DOE would conduct performance assessments of any disposal units proposed for LLNL at the project level to ensure the safety of the public.

Comment (1020)
DOE must find alternatives to "dumping."

Response
DOE is committed to managing its wastes to protect human health and the environment, including the safe storage and disposal of waste. DOE does not propose to "dump" waste, but to safely manage it. The WM PEIS describes accepted, readily available technologies for managing wastes. Disposal is a safe and proven method for managing waste when the design and construction of disposal facilities are in accordance with regulations and performance assessments.

Comment (1565)
Considering the alternatives for high-level waste, DOE needs to consider the opening of the Yucca Mountain facility questionable.

Response
This WM PEIS considered the impact of a geologic repository opening when it evaluated the impacts of storing of vitrified high-level waste. As discussed in Volume I, Section 9.3, two alternatives for the timing of the opening of the facility were used. In one alternative, DOE assumed that a geologic repository would begin accepting DOE-managed high-level waste in 2015. In the second alternative, acceptance of DOE-managed high-level waste at a repository is delayed past 2015. For the second case, impacts are presented on an annualized or incremental basis.

In addition, DOE will prepare a separate NEPA review that will explore the suitability of Yucca Mountain as a geologic repository for high-level waste disposal.

Comment (1674)
The WM PEIS should be rewritten to include the entire 75-year volume of waste that could be disposed of in Nevada, as described in the Baseline Environmental Management Report. The PEIS is an inadequate discussion of the entire amount of waste that could be sent to Nevada for disposal.

8.3.3 Disposal

Response
The WM PEIS used data from the Mixed Waste Inventory Report and the Integrated Data Base for volumes of waste from the Waste Management Program. The WM PEIS waste-type chapters (6 through 10) discuss the waste management waste volumes that each site generates and the percentage of the total volume of each waste that each site would receive for treatment, storage, or disposal under each alternative.

The WM PEIS considers the effects of environmental restoration wastes on the comparison among waste management alternatives based on estimates in the 1996 Baseline Environmental Management Report of the portion of such wastes that would enter the waste management system. See Appendix B in Volume III and Chapters 6, 7, and 8 in Volume I. The remaining environmental restoration waste would be managed in place or within the environmental restoration system. The PEIS analysis uses the 1996 Baseline Environmental Management Report estimate of 75 years of generating environmental restoration wastes. However, as stated in Section B.7, the PEIS assumes that most of the environmental restoration wastes generated over the 75-year period will be produced between 2003 and 2033.

DOE made the generalizing assumption that all waste management facilities necessary to implement a given WM PEIS alternative would be constructed in an initial 10-year period, which would be followed by a 10- to 20-year operations period. Exceptions to this include site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. DOE recognizes that construction of actual facilities could occur within a much shorter time period and that waste will begin to be processed at some facilities before construction at all facilities is completed.

Most importantly, no EIS can meaningfully evaluate impacts over 75 years, as it is impossible to predict all the changes in technologies, missions, and needs that might occur over this time period.

The NTS Sitewide EIS evaluates the potential impacts of future mission activities, including waste management and environmental restoration activities as well as existing mission activities for the next 10 years.

Comment (1730)
A commentor asked about opportunities to submit proposals and ideas for waste disposal.

Response
The WM PEIS does not evaluate the impacts of private offsite commercial waste management. The WM PEIS assumes the use of generic treatment, storage, and disposal facilities located on DOE sites for waste management actions.

However, commercial facilities will be used as available and appropriate once waste management decisions are made. DOE personnel at individual sites can provide information about potential opportunities for private companies to participate in environmental management actions at that site.

Comment (1754)
The public is concerned about low-level waste dumps leaking. If we cannot fix it now, what makes DOE think they can manage this in the long-term?

8.3.3 Disposal

Response
As described in Volume I, Chapter 2, DOE prepared the WM PEIS to enhance the management of its current and anticipated waste volumes on a national scale. The PEIS provides an integrated examination of the impacts of Department-wide waste management decisions (including disposal). Performance assessments for disposal units proposed at any DOE site would be conducted to ensure the safety of the public, and the development and construction of such facilities would be in strict accordance with regulations and requirements. Further site-specific NEPA reviews would be needed to examine site-specific conditions. DOE is confident, however, that it can make decisions as a result of this PEIS that will enhance and improve the management of DOE wastes.

Comment (1793)
A commentor expressed concern about the location of any future waste management sites in North Carolina, based on the potential impacts to forest lands. These include removal of acreage from timber production and the loss of trees due to the clearing of sites for construction of waste management facilities. The commentor suggested that if any sites are selected for North Carolina in the future, a separate EIS be prepared for each site to address potential impacts, including impacts to forest land. The commentor also expressed concern that hazardous waste disposal sites would become preserves and entry and utilization of timber resources would not be allowed.

Response
Section 1.6 in Volume I of the WM PEIS describes the 54 sites for which DOE has waste management responsibility that are within the scope of document. None of these sites are located in North Carolina. If DOE were to determine the need to construct a waste management facility at a location other than these 54 sites, additional NEPA analyses would be required. Such studies would include reviewing land resources required for such construction and other environmental impacts. If a commercial facility is interested in receiving, treating, or storing DOE waste, DOE could consider the facility. Such a commercial facility would have to comply with appropriate regulations.

DOE intends to maintain institutional control of its waste disposal facilities. Therefore, public access and public or private use of onsite resources probably would be limited. However, DOE has no current plans for constructing facilities in North Carolina. The Southeast Interstate Low-Level Radioactive Waste Management Compact has planned to construct a disposal facility in North Carolina.

Comment (1940)
A commentor from the ANL-E vicinity asked if there will be a written guarantee on how many years into the future there will be no leaks?

Response
DOE assumes that this comment relates to guarantees that there will not be leaks in the future from potential disposal facilities. DOE will comply with all applicable laws and regulations in the development and operation of any such facility. There are usually several barriers to prevent waste from leaking from disposal facilities. The waste itself can be processed into a solid form, such as a glass or concrete. This solidified form can then be encapsulated in a metal canister. Some disposal facilities would have concrete walls and caps.

Three types of disposal facilities were assumed for the WM PEIS analyses. Shallow land burial was assumed for all western sites except RFETS. At these facilities, leaching of wastes could begin

8.3.3 Disposal

immediately, although the rate of leaching would be low because of the arid conditions at those sites. For RFETS and all eastern sites except SRS, aboveground vaults in a tumulus design were assumed. These vaults are designed to maintain their integrity for 300 years. Disposal at SRS was assumed to be in belowground vaults, which are assured to maintain their integrity for 750 years before leaks could occur.

DOE Order 5820.2A requires that performance assessments be conducted for new disposal facilities. These assessments assume that engineered barriers, such as those described above, would degrade after several hundred years and that waste would leach out of the disposal facility. For the disposal facility to be approved, the performance assessment must show that in spite of leaching, a maximally exposed individual would not be at risk. Thus, rather than guaranteeing that there is no leaking, DOE evaluates, using conservative assumptions, future risks to a member of the public from waste disposal. Through careful selection of the location of the disposal facility, choice of an engineering design, selection of a stabilized waste form, and consideration of waste acceptance criteria, future risks from waste disposal are mitigated.

Comment (2445)
A discussion of disposal is needed in Volume I, Chapter 10, Hazardous Waste.

Response
As indicated in Volume I, Table 1.5-1, DOE will not decide where to dispose of hazardous waste on the basis of the WM PEIS and, therefore, it is beyond the scope of this analysis. Commercial facilities will continue to be used for disposal of DOE's hazardous waste. The commercial disposal facilities used for DOE's hazardous waste are permitted under RCRA and comply with all applicable Federal and State environmental regulations.

Limited disposal of hazardous waste in permitted landfills is discussed in Volume I, Section 10.2.2.

Comment (2759)
When Argonne first told Illinois of its research plans, it was not disclosed that our neighborhood would become a permanent waste storage site.

Response
The determination of where to store the radioactive and hazardous wastes from past, present, and future activities within the DOE complex is a controversial issue. To address the issue of safe and efficient management of such wastes, DOE first needs to develop an overall national strategy on which additional studies could be based. DOE evaluated 36 alternatives in the WM PEIS. The WM PEIS determined that the potential public health and environmental risks would be low at ANL-E under any of the waste management alternatives. DOE is committed to an open dialogue with members of the public to discuss any of their concerns.

Comment (2913)
When feasible, contaminants should be segregated by half-life so that short half-life disposal sites can be returned to normal use.

8.3.3 Disposal

Response
DOE's current regulations and practice, which are predicated on protecting human health and the environment, do result in segregation of wastes for disposal based on half-life. DOE plans to dispose of transuranic waste, which has high concentrations of long-lived transuranic radionuclides as its defining characteristic, in a deep geologic repository rather than near the land surface. Also, DOE disposal sites are allowed to classify waste. The waste classification criteria are based on concentrations of specific key radionuclides. Wastes in different classes are disposed of in different disposal units and can require different levels of treatment before disposal. For example, in the classification scheme used at the Hanford Site disposal facility for low-level waste, most of the key radionuclides are long-lived. Thus, segregation is achieved through waste classification.

Comment (3253)
The PEIS relies on shallow land burial at all of its sites west of the Mississippi River for the "disposal" of low-level waste. However, it is impossible to dispose of material that remains radioactive for hundreds of thousands of years; the best you can do is store it until it has decayed. DOE should stop using the word disposal and shift its focus to finding ways to safely *isolate* radioactive waste from the biosphere.

Response
Near-surface disposal of low-level waste is the terminal emplacement of wastes on or near the earth's surface. Near-surface disposal of radioactive waste is used only for wastes of acceptably low radionuclide concentrations. Near-surface disposal facilities include shallow land burial, earth-covered aboveground vaults, and belowground vaults.

Shallow land burial consists of placing waste containers in an excavated trench, backfilling voids between containers with sand or other earthen material, compacting the backfill material, and covering the waste with a cover or cap of earthen material. The cap is multi-layered and serves as a low permeability barrier to restrict the infiltration of water into the disposal trenches. The cover system also restricts human, plant, and animal intrusion into the waste and reduces surface exposure rates. This disposal system safely isolates low-level radioactive waste from the biosphere.

Shallow land burial disposal was the only disposal method evaluated for the western United States disposal sites in the WM PEIS analysis because these sites are more arid, have deeper groundwater systems, and are located farther from highly populated centers than eastern sites. Wastes disposed of at these sites would thus require a lesser degree of isolation from environmental influences than is possible from other near-surface disposal facilities such as vault disposal. The actual disposal facility at a given site would be designed to account for site-specific conditions such as rainfall and depth to groundwater. Wastes would only be accepted at any disposal facility if they meet established site-specific waste acceptance criteria.

Additionally, DOE is conducting a comprehensive Department-wide review of its management of low-level waste and the radioactive component of low-level mixed waste. This review is being conducted in response to a recommendation by the Defense Nuclear Facilities Safety Board (DNFSB), which was established and authorized by Congress to oversee DOE. The DNFSB recommendation concerning conformance with safety standards at DOE low-level waste sites was issued in September 1994, and it is referred to as DNFSB Recommendation 94-2. Details on Recommendation 94-2, including its relationship to WM PEIS decisionmaking, are presented in Volume I, Section 1.8.2.

8.3.3 Disposal

Comment (3741)
Any storage container is designed to leak. The integrity of the cell cannot match the half-life of the radioactive materials. The public needs to understand how the waste storage vessel or container can be engineered to contain the waste throughout the decaying half-life of 15,000 years.

Response
DOE assumes that the comment refers to leakage from a disposal container. The WM PEIS analyses of disposal impacts are based on conservative assumptions that leakage will occur. DOE uses a conservative assumption that shallow land burial facilities lose integrity immediately, while vaults retain their integrity for 300 to 750 years. The analysis of contamination in the groundwater is based on this assumption that leakage begins at 0, 300, or 750 years, depending on the type of disposal facility.

To help ensure that a member of the public will not receive undue radiological dose from a disposal of radioactive waste, DOE requires that a disposal facility performance assessment be performed. This assessment takes into account the inventories and characteristics of waste expected to be disposed of and uses conservative assumptions about when disposal containers and disposal cells will lose physical integrity and allow the radioactive waste to leach into the ground. The performance assessment is conducted before a disposal facility is constructed and it must demonstrate that the maximally exposed member of the public would not receive a radiological dose that could cause harm. The WM PEIS estimates and discusses dose to the maximally exposed member of the public, a hypothetical farm family.

Due to its character as a national programmatic document aimed at developing a Department-wide strategy, the WM PEIS assumes generic storage technologies. At this level of analysis, the WM PEIS is not intended to develop and implement storage technologies. Questions pertaining to the design of an actual waste storage vessel or container will be addressed on a sitewide or project-level basis when actual facilities are sited. In the WM PEIS analysis, storage containers are necessary primarily for waste handling purposes and are assumed to lose their integrity subsequent to disposal.

The Office of Technology within DOE's Office of Environmental Management is responsible for managing a national program of applied research, development, demonstration, testing, and evaluation for waste management and related technologies. The development of new technologies will ensure a substantial reduction in risk to the environment, and improved safety for the public and workers.

Comment (3742)
How many monitoring wells will there be at ANL-E and who will be responsible for them? How often would the ground be tested for leaks? How big would the facility be, would it be aboveground or below ground, and who would monitor for the public's general health and safety? Would results be available to homeowners?

Response
DOE assumes that the commentor is referring to the alternatives for construction and operation of disposal facilities at ANL-E under the Decentralized Alternatives for low-level mixed waste and low-level waste.

As described in Section 2.14.2.2 of the WM PEIS Affected Environment Technical Report, groundwater is monitored for radioactive and nonradioactive parameters at 32 locations at ANL-E.

8.3.3 Disposal

Groundwater from the four onsite drinking water wells is also analyzed for radioactive and nonradioactive contamination. DOE would install additional monitoring wells if new disposal facilities were constructed at ANL-E. The WM PEIS Affected Environment Technical Report is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

DOE would monitor new waste management facilities as required by applicable regulations and DOE Orders. Monitoring results would be published in the site annual environmental monitoring reports that are available to the general public. As described in Section D.3.2.2 in Volume III of the WM PEIS, DOE anticipates that if the Decentralized Alternative was selected, disposal facilities would be constructed aboveground at ANL-E since it is east of the Mississippi River. DOE will address issues relating to actual placement of waste management facilities (e.g., design, size, location, well locations, monitoring frequency, etc.) at the project level.

Comment (3771)
DOE needs to explain what will determine whether the disposal facility will be aboveground or below ground.

Response
As a broad, programmatic study, the WM PEIS does not identify locations for disposal facilities on sites or specify designs of such facilities. This will be done on a site-specific or project-level basis.

For the purpose of analysis, the generic disposal technology assumed in the WM PEIS for eastern sites was aboveground vaults in a tumulus design. However, disposal at the SRS was assumed to be in below-ground vaults. At the western sites, shallow land burial was assumed except at RFETS, where aboveground vaults were assumed.

8.3.3 Disposal

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9. Environmental Restoration Wastes

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(No comments were received for this section)

9.1 Environmental Restoration Program

Comment (265)
The WM PEIS must include information on the timetable for cleanup.

Response
Individual DOE sites currently are developing Ten-Year Plans which will address environmental restoration activities, including the timetable for cleanup. As described in Volume I, Section 1.7.1, environmental restoration (cleanup) activities are site-specific and are not within the programmatic scope of the WM PEIS. Appendix B contains information on environmental restoration activities and their influence on the WM PEIS alternatives.

Comment (276)
Safe, responsible cleanup of existing waste sites at the expense of the responsible parties (the Federal Government and private corporations) is important.

Response
DOE agrees and, as part of its mission, is working to clean up a number of its sites throughout the United States.

The general process for making decisions on cleanup is provided by statutes, including the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA), both of which apply to Federal agencies and private corporations. At specific DOE sites, the process is implemented through agreements among DOE, EPA, and, frequently, the State, or through the RCRA permit process. However, as explained in Section 1.7.1 in Volume I of the WM PEIS, environmental restoration alternatives are not within the scope of this PEIS because decisions related to environmental restoration are not suited to a programmatic analysis. Instead, such decisions should be made at the site level and should reflect local conditions.

Comment (1107)
Several commentors asked for clarification on how the PEIS deals with the environmental remediation wastes at Fernald Environmental Management Project (FEMP), including those that will not be disposed of onsite but instead will need to enter the Waste Management Program. In addition, one commentor specifically asked how the PEIS does or does not deal with the "legacy" wastes such as pit wastes, wastes from the silos, and thorium materials. One commentor stated that the WM PEIS should consider the several billion dollars that DOE will spend on CERCLA activities at FEMP, and that CERCLA decisions and their wastes should be included in the WM PEIS.

Response
Environmental restoration alternatives were included in the original scope of the WM PEIS, but DOE subsequently determined that cleanup activities were primarily site-specific and could not be appropriately addressed at the programmatic level. DOE concluded that remediation decisions, including the level of site remediation, must reflect site-specific conditions. Accordingly, the consideration of a programmatic environmental restoration strategy was dropped from the WM PEIS in January 1995. Section 1.7.1 in Volume 1 of the PEIS discusses the removal of environmental restoration activities from the scope of the PEIS. Appendix A in Volume III contains a discussion of the public notification and participation that occurred with regard to the change in scope.

9.1 Environmental Restoration Program

The Final WM PEIS will support programmatic decisions about DOE's waste management strategy by analyzing the impacts of waste management facilities (those required to treat, store, or dispose of wastes currently in storage and wastes that will be generated in the future as a result of DOE operations). Although this document does not analyze environmental restoration, it does contain information on the anticipated waste volumes generated as a result of environmental restoration and a qualitative discussion of the extent to which these wastes could affect the comparison among waste management alternatives. These discussions appear in Appendix B, which focuses on the Environmental Restoration Program (the types and volumes of materials present at specific DOE sites, and the role of these materials in the WM PEIS), and in Sections 6.15, 7.15, and 8.15 in Volume I. Transfer of responsibility for some environmental restoration waste to the Waste Management Program would not affect the basis for comparison of WM PEIS alternatives, because the sites selected on the basis of the WM PEIS analysis represent the minimum set necessary, regardless of the addition of future environmental restoration transferred waste. If necessary, during future site-specific NEPA reviews of site treatment or disposal facilities, additional capacity for environmental restoration transferred wastes would be analyzed.

DOE has revised Appendix B in Volume III to include updated information on volumes of environmental restoration waste expected to be generated at each site and the planned disposition of these wastes. Appendix B also explains the decisions that have been made under the CERCLA process for the waste pits and the silos at FEMP. As identified in Appendix B, a total of 2,500,000 cubic meters of low-level waste and 4,600 cubic meters of low-level mixed waste generated by environmental restoration activities are anticipated at FEMP. DOE might transfer 180,000 cubic meters of low-level mixed waste, and 2,200 cubic meters of low-level mixed waste to waste management facilities. Appendix B provides further details on the disposition of the remaining volume of environmental restoration waste anticipated at FEMP.

Comment (1685)
A commentor wants SRS cleaned up and has special concerns about environmental impacts, groundwater contamination, adequate medical care, and compensation for damages.

Response
DOE is committed to the cleaning up of all of its sites, including SRS, in accordance with Federal and State agreements under CERCLA and RCRA. Specific medical services and compensation for damages are outside the scope of the WM PEIS but are addressed by Federal regulations and DOE policies. Groundwater impacts and other environmental considerations are included in the PEIS for waste management activities only. Impacts of site cleanup and other environmental restoration activities are not within the scope of this PEIS, as explained in Volume I, Section 1.7.1. Additionally, the SRS Waste Management EIS and other EISs for SRS are described in Volume I, Section 1.8.1.

Comment (2096)
"Congratulations on the cleanup operations at the Portsmouth Plant. You may be doing your best, but the cleanup operations are not good enough."

Response
Cleanup of contamination caused by past practices is outside the scope of the WM PEIS. This comment has been forwarded to the DOE site office at Portsmouth.

9.1 Environmental Restoration Program

Comment (2121)
DOE should use some of its $18 billion in cleanup funds to address the 28 Superfund Areas of Concern on the BNL site.

Response
BNL was added to the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA--also known as Superfund) in 1989. In 1992, DOE, EPA, and the State of New York entered into an interagency agreement that integrates both the response action requirements under CERCLA and the corrective action requirements under RCRA. The interagency agreement addresses the 28 Areas of Concern, which have been grouped into Operable Units and Removal Actions. Operable Units consist of large areas of the site that require extensive study prior to the implementation of a remedial action. In contrast, Removal Actions are expedited responses taken to eliminate a near-term or immediate potential risk to human health or the environment. BNL has completed a number of Removal Actions and continues to make progress on this work. DOE is continuing to fund these cleanup efforts through the Office of Environmental Restoration. As noted in Volume I, Section 1.7.1, environmental restoration activities were deleted from the scope of the WM PEIS. These activities include the Superfund areas of concern.

Comment (2146)
The public is concerned about DOE's past problems with nuclear materials and that the nuclear industry will not properly clean up waste sites. DOE needs to learn how to deal with past problems before they start adding new ones to the community.

Response
The cleanup of contamination caused by past practices is outside the scope of the WM PEIS. These activities are better addressed at each individual site, taking into account local environmental characteristics, the extent of contamination, and the priorities of regulators and local stakeholders. However, the WM PEIS does identify a subset of environmental restoration wastes for which responsibility could be transferred to the Waste Management Program, and considers the potential effect of these environmental restoration transferred wastes on the basis for comparison of WM PEIS alternatives. Environmental restoration transferred wastes are discussed in Appendix B in Volume III, and Chapters 6, 7, and 8 in Volume I.

Comment (2250)
There is no discussion in the WM PEIS of the $50 billion legacy of wastes and cleanup at the Hanford Site.

Response
The WM PEIS is a national and programmatic analysis that will assist DOE in formulating and implementing a strategy to manage its radioactive and hazardous wastes. Environmental restoration activities are not within the scope of this PEIS, as discussed in Volume I, Section 1.7.1. However, the WM PEIS does evaluate the effect that environmental restoration waste volumes for which responsibility may be transferred to the Waste Management Program could have on the WM PEIS alternatives. DOE has prepared the Hanford Remedial Action EIS, which addresses environmental restoration impacts at Hanford. This and other environmental impact statements for the Hanford Site or those that potentially could affect the Hanford Site, which are completed or in draft, are identified in Volume I, Section 1.8.1, of the WM PEIS.

Information on the cost of cleanup of legacy waste at Hanford can also be found in the Baseline Environmental Management Report described in Volume I, Section 1.8.2. The Environmental Management Ten-Year Plan identified in Section 1.8.2 is being developed to address cleanup costs at Hanford.

Comment (2610)
A commentor wants Hanford cleaned up.

Response
Cleanup at the Hanford Site is occurring now under the Tri-Party Agreement between DOE, EPA, and the State of Washington. These cleanup activities will continue at the Hanford Site regardless of any decisions based on the WM PEIS. Although environmental restoration alternatives are outside the scope of the WM PEIS analysis, Appendix B, Section B.5, in Volume III identifies specific environmental restoration activities at Hanford and other DOE sites.

Comment (3346)
Digging up contaminated dirt and the like and moving it from one point to another is containment, not cleanup.

Response
Because radioactive elements cannot be eliminated through treatment, all forms of radioactive waste management endeavor to safely isolate the contaminants and waste from the public. The waste disposal facilities in which radioactive wastes would be isolated are facilities specifically designed for that purpose, and, at times, are preferred to containment in place. In situations involving chemical contaminants, it is often possible to treat and remove or stabilize the contaminant. In any case, the term "cleanup" is used broadly by DOE to describe activities that are intended to eliminate risks to the public or the environment caused by past practices. The evaluation of cleanup options are not suited to a programmatic analysis, such as that contained in the WM PEIS, and, therefore, will be performed at the local level.

Comment (3359)
PGDP is moving ahead with restoration projects, oblivious of the programmatic NEPA studies underway, and is doing so deliberately and with intent. This threatens to render the WM PEIS moot by the time it is finalized. The end result of this is that DOE is moving ahead with uninformed decisionmaking, in violation of NEPA. Is the public wrong to think that all the possible environmental considerations are being taken before actions are implemented, as NEPA requires, or is DOE just saying one thing and doing another?

Response
The WM PEIS is a programmatic analysis that evaluates alternatives for the management of wastes generated by DOE operations. DOE removed environmental restoration alternatives from the scope of the PEIS because environmental restoration alternatives must reflect specific conditions at each site. DOE is in compliance with NEPA with regard to the WM PEIS analysis. Environmental restoration projects such as those at underway PGDP are part of the Environmental Restoration Program, not the Waste Management Program. Site- or project-specific NEPA reviews will be conducted for environmental restoration activities, where appropriate. Those sites whose environmental restoration projects are subject to the requirements of CERCLA engage in the review process set forth in

9.1 Environmental Restoration Program

CERCLA for restoration activities, incorporating NEPA values or performing project-specific NEPA analyses where appropriate.

Although environmental restoration alternatives are beyond the scope of the WM PEIS, the waste that DOE projects it will generate from environmental restoration activities and transfer responsibility to the Waste Management Program were considered in the WM PEIS to determine whether they would influence the comparison of the WM PEIS alternatives (see Appendix B in Volume III, and summarized in Sections 6.15, 7.15, and 8.15 in Volume I).

Comment (3652)
Where will DOE treat and store the environmental restoration transuranic waste? What happens to the environmental restoration transuranic waste once it has been processed? DOE does not discuss disposal of the environmental restoration transuranic waste.

Response
The management of environmental restoration transuranic waste is outside the scope of the WM PEIS. However, the PEIS does contain estimates of volumes of environmental restoration wastes at each site, including the volume of transuranic waste expected to be generated from DOE's cleanup activities and transferred to the Waste Management Program for final disposition. Table B.5-3 in Volume III identifies the volumes of environmental restoration transuranic waste to be managed under the various disposition categories. Section B.3 explains that the remediation activities depend on the proposed land use for each site, and are generally categorized as either containment or removal. The WIPP SEIS-II examines alternatives for treatment and disposal of all volumes of transuranic waste estimated to be currently stored or buried, and transuranic waste that would be newly generated during the projected 35-year operational life of WIPP. This could provide the basis for a decision to dispose of environmental restoration transuranic waste at WIPP.

Comment (3807)
The last environmental restoration document in the library is dated 1993. DOE needs to get more current information to the public.

Response
Environmental restoration reports and studies conducted under CERCLA are available at each site in the Administrative Record and in their information repositories. A summary of environmental restoration activities at individual sites can be found in the 1996 Baseline Environmental Management Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final WM PEIS. Individual Site Treatment Plans also discuss environmental restoration activities, and can be found in the public reading room associated with a particular site.

Comment (3856)
The ANL-E 800 Area landfill has volatile organics. It is not easy to remove waste materials from a densely populated community.

Response
The activity referred to in the comment is an environmental restoration activity. The 800 Area landfill is located in an isolated part of the ANL-E site, relatively distant from other ANL-E activities. Being within the ANL-E fence, the 800 Area landfill is also separated from the surrounding community. The

closest habitations are nearly a mile from the 800 Area landfill. For those reasons, remediation of the 800 Area landfill would not be expected to affect the surrounding community. An environmental assessment is currently in preparation which discusses potential remedial activities for the 800 Area landfill.

Environmental restoration activities are not within the scope of the WM PEIS, primarily because of their site-specific nature. Site-specific issues include questions of cleanup levels, future land use, etc. The WM PEIS, on the other hand, lays out a programmatic strategy on waste management options. Volume I, Section 1.7.1, explains why environmental restoration activities were removed from the scope of the EIS.

9.2 Waste Management PEIS Scope Modification

Comment (207)
A number of commentors believe that environmental restoration and decontamination and decommissioning wastes should be included in the WM PEIS; one commentor stated that the exclusion severely reduces the value of the WM PEIS; some asked DOE to explain why those wastes are not included. Others questioned how the WM PEIS could be considered programmatic and whether DOE has violated NEPA, given that environmental restoration is not included in the analysis. One commentor asked whether the addition of environmental restoration waste would change impacts sufficiently to change the relative preferability of waste management alternatives. Another commentor stated that the WM PEIS should discuss environmental restoration wastes because the large volumes will affect storage facilities. Another commentor asked DOE to consider in the WM PEIS scales and types of technology appropriate for handling environmental restoration (ER) waste, backlogs of DOE waste, and the new waste generated at DOE sites on an ongoing basis. Some waste treatment alternatives may be more suited than others for handling the ER waste with minimum impacts than others that would require more shipping of waste, etc. In accordance with NEPA requirements, the impacts of all other actions at DOE sites should be included in the cumulative impacts section. Measures to reduce the amount of new waste generated should also be considered among the WM PEIS alternatives.

Response
On January 24, 1995, DOE announced in the *Federal Register* that it was removing ER, or "cleanup," from the scope of the WM PEIS. The Department felt that decisions related to ER (e.g., such as remediation of areas containing buried transuranic waste) were not suited to a programmatic level analysis, but instead should be focused at the local level and reflect site conditions. The 1995 announcement and response by the public is contained in Appendix A in Volume III of the WM PEIS.

Responsibility for the treatment, storage, and/or disposal of a subset of the wastes that will be generated by ER activities will be transferred to the Waste Management Program. It is not possible, however, to analyze the impacts from these "ER transferred" waste volumes in the same manner as the waste management waste volumes were analyzed because the current information about ER transferred waste is limited to volumetric estimates, and is not adequate to perform for a meaningful impact analysis. Unlike the information available for waste management wastes, DOE does not know the extent of radiological or chemical contamination, the physical/chemical characterization, or treatment categories of the ER transferred waste. In addition, DOE does not know when ER waste would be transferred to waste management facilities. Acquiring this information would require characterization of the ER waste at each ER site and a schedule for restoration.

Despite the absence of this information regarding ER transferred waste, DOE needs to proceed with programmatic decisions for its Waste Management Program, in order to make progress toward improving DOE's management of its wastes. The sites selected for waste management facilities on the basis of analysis in the WM PEIS are the minimum requirement, based wholly on the locations and quantities of waste management wastes, which would remain valid regardless of future ER waste requirements. Therefore, the analyses contained in the WM PEIS provides an adequate foundation to proceed with programmatic waste management decisions.

Decisions on which sites should host waste management facilities will consider trade-offs between transportation impacts and site-specific impacts. The necessity and justification for a waste management site selected on the basis of the WM PEIS analysis would remain, regardless of whether

additional ER transferred wastes are present at that site or some other site. Should ER transferred wastes be generated at a site that was not selected to host a facility based solely on the WM PEIS analysis. DOE would perform a site-specific review for that site, possibly adding onsite treatment or disposal capability or transporting that ER transferred waste to a site that was selected for treatment, storage, or disposal based solely on the WM PEIS analysis.

When there is sufficient information to fully evaluate ER transferred wastes, DOE will perform site-specific reviews. If there is ER transferred waste at a site already selected to host a facility based upon the WM PEIS analysis, DOE would examine the specific conditions posed by the ER transferred wastes and determine whether that facility should manage the additional wastes and whether additional NEPA analysis is required to examine the impacts and alternatives. If that ER transferred waste is at a site not selected for a waste management facility, DOE would evaluate whether new treatment or disposal capability should be added to the site or whether the wastes should be transported to a site with the capability to treat or dispose.

Comment (2059)
The cost numbers used for remediation wastes are too low.

Response
As noted in Section 5.1.1 in Volume I, the WM PEIS analysis determined costs for waste management activities. The WM PEIS does not discuss the costs of managing environmental restoration wastes. DOE removed environmental restoration wastes from the scope of this programmatic EIS because it determined that environmental restoration decisions should reflect site-specific conditions, as well as input from State regulators and local stakeholders. Appendix A in Volume III contains public comments on DOE's proposed revisions to the scope of the WM PEIS, as well as the *Federal Register* notice announcing the scope change. The 1996 Baseline Environmental Management Report contains information on environmental restoration costs. That report is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS.

Comment (2415)
The WM PEIS states that environmental restoration decisions are usually made at the site-specific level and, therefore, are not covered in this PEIS. Such an approach is inadequate because looming budget cuts might force programmatic decisions on environmental restoration.

Response
The WM PEIS is a programmatic analysis that evaluates decentralized, regionalized, and centralized configurations for treating, storing, and disposing of wastes generated by DOE operations. DOE recognized after conducting preliminary analyses that programmatic decisions regarding environmental restoration cannot be made because these decisions should reflect the particular conditions at each site, as well as the involvement of State regulators and local stakeholders. This is why DOE decided to remove the environmental restoration alternatives from this document, as noted in Section 1.7.1 in Volume I, and why there are no current plans to prepare another programmatic EIS to address environmental restoration activities.

DOE believes the removal of the environmental restoration alternatives from the original scope of the PEIS will not affect the basis for comparison of the alternatives analyzed in the WM PEIS.

9.2 Waste Management PEIS Scope Modification

Because the Federal budget is ultimately controlled by the President and Congress, DOE is unable to guarantee full funding for specific projects and programs. However, DOE continues to request appropriate funding to meet its commitments and implement its decisions.

Comment (3183)
Some commentors stated that the WM PEIS should more clearly identify the fact that it does not include consideration of environmental restoration waste. Other commentors specifically identified Sections 6.2.3 and 6.15 as including environmental restoration waste in the scope of the WM PEIS, which seemingly conflicts with the decision to remove environmental restoration wastes during re-scoping.

Response
Sections 1.3 and 1.7 of the WM PEIS Summary document have been revised to explain that although the WM PEIS does not evaluate programmatic alternatives for environmental restoration wastes, Appendix B in Volume III provides estimates of environmental restoration waste volumes and identifies the potential effects of the environmental restoration waste for which responsibility will be transferred to the Waste Management Program on the comparison of WM PEIS alternatives.

The reference to Section 6.2.3 in Volume I which has been clarified to indicate that the section pertains to low-level mixed waste that is in storage awaiting treatment or disposal, and that is the responsibility of the Waste Management Program. Section 6.15 in Volume I summarizes the discussion, which is in Appendix B, regarding environmental restoration-generated low-level mixed waste that is expected to be transferred into the Waste Management Program.

Comment (3656)
The WM PEIS assumes that radiation and chemical exposure to offsite populations and noninvolved workers to treat environmental restoration wastes would be additive to their exposure to waste management emissions. The environmental restoration transuranic waste (TRUW) volumes are so small compared to waste management TRUW, however, that environmental restoration wastes are not likely to change the trends of impacts examined in the WM PEIS (Draft WM PEIS, p. 8-81). This assumption is difficult to believe, particularly since the WM PEIS also states that projections of future environmental restoration wastes are uncertain both in quantity and composition and that less than one-fourth of the environmental restoration release sites have been fully characterized and therefore the extent and type of contamination is largely unknown. (Draft WM PEIS, p. 8-77, footnote 1); and DOE projects that only RFETS, SRS, and ORR will have environmental restoration TRUW requiring treatment at waste management facilities when transuranic materials were used at the majority of DOE sites prior to 1970. In addition, because the amount of environmental restoration TRUW that exists is unknown, conclusions about transportation impacts based on the estimated environmental restoration TRUW volumes makes the public wary. Finally, all the relevant factors were not considered and no alternatives are given, as required under the NEPA mandate.

Response
DOE did not include environmental restoration alternatives in the PEIS, as described in Section 1.7.1 in Volume I, because of the site-specific nature of decisions to be made about environmental restoration activities. However, although the WM PEIS will not be used to make decisions about DOE's Environmental Restoration Program, DOE's projected volumes of environmental restoration waste

were considered in the WM PEIS to determine whether they could impact decisions regarding WM PEIS alternatives.

Section 8.15 in Volume I and Appendix B in Volume III of the WM PEIS have been revised to update the estimates of volumes of TRUW generated by environmental restoration. Table B.5-3 in Appendix B identifies ANL-E, the Hanford Site, INEL, ORR, RFETS, and SRS as the major sites with environmental restoration TRUW for which responsibility will be transferred to the Waste Management Program. All other environmental restoration TRUW will be addressed by the Environmental Restoration Program. The volume of environmental restoration TRUW requiring treatment in the waste management system is currently estimated to be about 70% of waste management TRUW requiring treatment. Typically, large volumes of environmental restoration transferred waste are found at sites that also have sizable volumes of similar waste management waste. The addition of environmental restoration transferred TRUW is not expected to affect the basis for comparison of the WM PEIS alternatives. At some sites, the environmental restoration transferred waste could affect the scale of site treatment or disposal facilities, which will be addressed in site-specific reviews. The effects can be managed by increasing the capacities of individual site waste management facilities, building facilities for environmental restoration TRUW, or sending environmental restoration TRUW to other sites for management.

The discussion in Appendix B does not include the effects due to transportation of environmental restoration wastes; however, transportation of environmental restoration waste is assumed to follow the same routing to sites for treatment and disposal as waste management waste. Section B.9 in Appendix B acknowledges uncertainties associated with environmental restoration activities at DOE sites.

Because the current data do not sufficiently characterize the environmental restoration transferred waste that might be sent to waste management facilities, the potential impacts to human health and the environment from treatment or disposal of environmental restoration waste cannot be determined. However, these impacts could be analyzed in sitewide or project-level studies. Further detail is provided in Appendix B in Volume III.

Comment (4047)
The Draft WM PEIS does not address the potential consequences of an EPA Cleanup Rule on present DOE environmental restoration and waste management projections, although a stringent cleanup rule could significantly influence the volume of low-level mixed waste and low-level waste to be treated and disposed of by projected hazardous waste facilities.

Response
DOE is not sure as to which rule the commentor refers. However, DOE must comply with all applicable laws and regulations in all of its activities. Waste management activities are not an exception to this policy. However, laws and regulations frequently are amended, and requirements that were effective when the WM PEIS was issued could change before facilities are permitted and constructed. While DOE cannot predict these changes, sitewide and project-level NEPA reviews would comply with regulatory requirements applicable at the time these reviews are prepared.

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Comment (4436)
Although DOE's consideration of the change in scope (i.e., to remove environmental restoration) was known by word of mouth prior to the decision, notification of the change in the *Federal Register* and discussion with the Environmental Management Advisory Board were inadequate in that requests for notification to the commentor were not met, and individuals such as the commentor were not given an opportunity to comment on the change in scope as a result of the inadequate notification.

Response
As noted in Section 1.7.1 in Volume I DOE placed a notice in the *Federal Register* on January 24, 1995 (60 FR 4607), inviting the public to comment on the proposed change in scope and name of the PEIS. In response to public requests, the comment period was extended to April 10, 1995. Thus, DOE complied with the NEPA requirements for advance notification, and took comments longer than required. DOE made this scope modification decision after consultation with and review by DOE's Environmental Management Advisory Board. Appendix A in Volume III of the WM PEIS contains a more detailed chronology of the decision and a summary of the comments and DOE's responses. Appendix A also outlines the means for public involvement in planning and decisionmaking for DOE's environmental restoration activities.

Another opportunity to comment on the scope of the PEIS became available during the public comment period on the Draft WM PEIS. DOE has incorporated all such comments, including those from this commentor, and DOE responses in this volume of the Final PEIS.

It is not clear to whom in DOE the commentor's request for individual notification was directed. DOE makes every reasonable effort to respond to public requests for information. DOE, nevertheless, regrets any inconvenience that might have been caused for the commentor.

Comment (4439)
Reasons for removing environmental restoration from the scope of the PEIS involved inadequacies in the alternatives identified and methods of analysis, although work continued on the study because some alternatives and methods were valid, a deadline existed, and a change in the team (providing data still needed) would have been costly. However, significant environmental restoration-related issues exist in terms of funding for remedial actions among sites, whether to implement the Keystone Report, potential differences in decision criteria for environmental restoration and waste management, and whether environmental restoration and waste management functions such as regulatory compliance, health and safety, and financial oversight should be integrated.

Response
The WM PEIS is a programmatic analysis that evaluates decentralized, regionalized, and centralized approaches for treating, storing, and disposing of wastes generated by DOE operations. As such, it is a programmatic NEPA document. DOE recognized, after conducting preliminary analyses, that decisions regarding environmental restoration should reflect the particular conditions at each site, and must involve State regulators and local stakeholders. This is why DOE decided to remove the environmental restoration alternatives from this document and why there are no current plans to prepare another programmatic EIS to address environmental restoration.

The potential effect of those environmental restoration wastes for which responsibility might be transferred to the Waste Management Program was considered in the WM PEIS. DOE recognizes the

need to integrate information from the Environmental Restoration Program with the WM PEIS analysis, to the extent that this information could affect the basis for comparison of the WM PEIS alternatives. This approach allows for decisions about the Waste Management Program at the national level, while reserving decisionmaking about alternatives for the Environmental Restoration Program for the site level. If the integration of such functions as health and safety and financial oversight for environmental restoration and waste management can provide cost savings and improve the program, DOE will integrate them at the individual sites. DOE implements other functions, such as regulatory compliance, at the site level as required.

The implementation of the Keystone Report is beyond the scope of the WM PEIS, as are funding allocations among sites for remedial actions.

Comment (4458)
When is a PEIS covering the impact of alternatives for transuranic waste (TRUW) generated prior to 1970 to be produced, and could the cumulative impact in combination with that from treatment of wastes generated after 1970 impact the relative cumulative impacts and costs of treatment alternatives? The fact that TRUW generated prior to 1970 is being examined as part of the Environmental Restoration Program rather than the Waste Management Program suggests that the PEIS should have retained its original scope, environmental restoration and waste management.

The Final PEIS should include the results of efforts covering environmental restoration by academic groups, the National Academy of Science, and others. If the timetables for the environmental restoration and waste management efforts cannot be meshed, then a Draft Environmental Management (both environmental restoration and waste management) PEIS should be written when the data are available, and a schedule for this effort should be provided.

Response
The WM PEIS analyzes the potential environmental impacts from treatment and storage of current retrievably stored inventory of TRUW and TRUW that will be generated during the next 20 years.

As explained in Section 1.7.1 in Volume I, the scope of the WM PEIS does not include environmental restoration alternatives. Programmatic decisions regarding environmental restoration cannot be made because environmental restoration wastes have not been sufficiently characterized, and these decisions must reflect particular conditions at each site. Therefore, there are no current plans to prepare a programmatic EIS to address environmental restoration activities. The volumes of pre-1970 (buried) TRUW that might be generated by environmental restoration activities are identified for individual DOE sites in Volume III, Appendix B, of the WM PEIS. Appendix B also contains information on the planned disposition of environmental restoration wastes at individual sites. The data in Appendix B were revised using the 1996 Environmental Restoration Core Database, which was used for the 1996 Baseline Environmental Management Report as well. DOE has determined that, while environmental restoration waste for which responsibility may be transferred to the Waste Management Program could affect the scale of site treatment operations at specific sites, this transferred waste would not affect the basis for comparison of the WM PEIS alternatives.

As described in Volume I, Section 1.8.1 of the Final WM PEIS, DOE has prepared the WIPP SEIS-II to evaluate the potential impacts from disposal of TRUW at WIPP, including previously disposed of buried TRUW. Information from the WIPP SEIS-II will be used to inform DOE's decisions as whether

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to operate WIPP as a disposal facility and, if so, what TRUW should be disposed of there, as well as the minimum level of treatment needed to meet the waste acceptance criteria for disposal.

The cumulative impacts analysis in Chapter 11 of the WM PEIS includes the potential impacts of the preferred alternative discussed in the WIPP SEIS-II.

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Comment (488)
If the WM PEIS does not include environmental restoration wastes, the 20-year projected waste inventory needs to be clarified.

Response
The WM PEIS analyzes waste management wastes directly and addresses environmental restoration wastes only in the context of how environmental restoration wastes might affect the basis for comparison of alternatives. DOE has clarified the waste volume tables in the Summary document, and Chapters 6, 7, and 8 in Volume I, to indicate that the volumes of waste are from waste management activities only.

The Draft WM PEIS was based on the best information available at the time for waste inventories in storage, plus 20 years of expected waste generation. These data have subsequently been revised. The new data are reported in Volume IV, Appendix I, and were used in selected analyses to determine whether the waste volume revisions would significantly change the analytical results in the WM PEIS.

Environmental restoration wastes for which responsibility will be transferred to the Waste Management Program are discussed in Appendix B in Volume III, and Sections 6.15, 7.15, and 8.15 in Volume I. The remaining environmental restoration waste would be managed by the Environmental Restoration Program.

Comment (517)
What is the status of the groundwater pump-and-treat activities at Test Area North injection wells and will they be included in waste management activities resulting from this PEIS?

Response
The SNF/INEL EIS describes the impacts of environmental remediation activities such as groundwater pump-and-treat at INEL. In addition, the annual INEL Site Environmental Reports, which are available to the public, describe the status of environmental monitoring and remediation activities.

Groundwater pump-and-treat activities are environmental restoration activities. Contaminated groundwater collected as part of a remedial action would be treated onsite, as necessary, and would not involve decisions at a programmatic level, or influence decisions to be made about the WM PEIS alternatives.

Comment (1100)
Several commentors questioned the basis for the transportation analysis in the WM PEIS with respect to how it dealt with environmental restoration wastes. In one case, the commentor asked that the waste volumes and increased rail and truck shipments associated with environmental restoration wastes be clearly identified. Another challenged the conclusion that because there will be less shipment of environmental restoration-generated low-level waste than waste management low-level waste, transportation risks and costs for the environmental restoration low-level waste are expected to be less than for waste management low-level waste. This perspective may not adequately account for potential cumulative effects.

Response
DOE revised those sections of the WM PEIS dealing with environmental restoration wastes based on updated estimates of waste. As part of this revision, DOE estimated the volume of environmental restoration waste for which responsibility would be transferred to the Waste Management Program and

9.3 Environmental Restoration Waste and Its Effect on the WM PEIS

considered whether environmental restoration wastes would affect the alternatives evaluated in the WM PEIS (see Volume III, Appendix B). The analysis indicated that although the transferred environmental restoration waste could impact the waste management activities at some sites, it is not expected to affect the basis for comparison of the WM PEIS alternatives.

Based on the updated information on environmental restoration wastes used in the Final WM PEIS, the total volumes of environmental restoration transferred low-level waste are greater than the total volumes of waste management low-level waste. Therefore, the number of environmental restoration low-level waste shipments will not necessarily be less than the number for waste management low-level waste. Most DOE environmental restoration activities are not yet sufficiently characterized to determine precisely how much environmental restoration waste will be classified as waste that will need to be shipped and how much material (e.g., soil) will not be classified as waste.

Transportation risks and costs depend on the number of shipments. The number of shipments depends on the volume of waste requiring shipment. Moreover, as noted in Section B.9 in Appendix B (Volume III), because environmental restoration wastes transferred to waste management facilities would be shipped as generated during site clean-up, the volume that will be delivered to waste management facilities at any given time is uncertain.

DOE did not include transportation of environmental restoration waste in the cumulative impacts analysis because information on the volume of environmental restoration waste requiring shipment is not known for many sites.

Comment (1664)
Environmental restoration wastes are not included in the WM PEIS impacts and could result in much higher waste volumes for disposal at NTS. Draft PEIS Appendix B indicated that disposal volumes could be up to 60% higher based on the PEIS assumption that only 5% of the low-level waste from site restoration would be transported to an offsite location for disposal. The reasonableness of these results could not be determined since the shipping volume estimate is based on an unpublished draft of the Baseline Environmental Management Report. The impacts of increased low-level waste volumes were not estimated in Appendix B.

Response
The PEIS does not quantitatively evaluate the impacts of environmental restoration wastes at DOE sites. Volume III, Appendix B, of the WM PEIS does evaluate the potential effects of transferring responsibility for some environmental restoration waste to the Waste Management Program. The evaluation indicates that, although this environmental restoration transferred-waste could impact the treatment at specific sites, it is not expected to affect the comparison among waste management alternatives.

Appendix B was revised in the Final WM PEIS to include updated estimates of environmental restoration waste volumes at individual sites and the expected disposition of those wastes. The PEIS environmental restoration waste totals are based on data developed for the 1996 Baseline Environmental Management Report. The updated data presented in Table B.5-1 indicate that NTS estimates its environmental restoration waste volume to be approximately 1,101,200 cubic meters, with 1,100,000 cubic meters of that volume to be transferred to waste management facilities. However, the environmental restoration transferred low-level waste volumes presented in Appendix B are estimates

only for volumes to be treated within the Waste Management Program. Although the Draft WM PEIS did present information on estimated volumes of environmental restoration waste for disposal, DOE subsequently determined that information regarding environmental restoration waste disposal volumes is too uncertain to allow a meaningful discussion of these waste volumes in the WM PEIS.

The impacts of environmental restoration activities was also considered in the cumulative impact analysis in Volume I, Chapter 11, where the information was available. WM PEIS technical reports were revised to include updated waste volumes, including those for environmental restoration wastes.

Comment (1689)
Dirty cleanup is not acceptable. The amount of waste generated from environmental restoration depends on the cleanup standards.

Response
The cleanup process is generally implemented through agreements among DOE, EPA, and frequently the host State. Cleanup standards are generally based on site-specific studies conducted pursuant to CERCLA- or RCRA-mandated cleanup actions. The studies consider a number of important factors, including the extent of contamination in relation to background concentrations, planned future use of the site, and the technical and economic feasibility of the proposed standards. The rulemaking process provides an opportunity for public participation and comment on cleanup standards mandated by regulations.

Planned future land use was estimated in Appendix B using the Baseline Environmental Management Report published by DOE in 1996. The Baseline Environmental Management Report looked at more than 10,000 contaminated sites and facilities and applied generic "base case" criteria, which included potential site land use and technical feasibility. The "base case" is detailed in the Summary document and Volume I of the Baseline Environmental Management Report.

Comment (1696)
The public is concerned about dust flying into neighboring communities. DOE should consider designing a tent to contain the particulates.

Response
The WM PEIS analyzed the potential impacts of emissions of criteria air pollutants from waste management construction activities, as discussed in Section 5.4.2 in Volume I. Estimates were made for each site under each alternative, and are discussed in each waste-type chapter.

DOE is committed to managing its waste materials and to constructing facilities in a manner that is protective of human health and the environment, including controlling emission of dust. DOE must comply with all applicable regulations pertaining to the control of fugitive dust emissions. Therefore, DOE does not anticipate any unacceptable emissions of dust from its environmental restoration or other activities.

Comment (2190)
DOE needs to consider contaminated groundwater as waste.

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Response
Contaminated groundwater is managed by DOE's Environmental Restoration Program. The estimates of wastes from the Environmental Restoration Program that are given in Appendix B of the WM PEIS, however, do not include contaminated groundwater because of the difficulties in calculating the total volume projected to be extracted over the duration of the pump-and-treat operations. Contaminated groundwater collected as part of a remedial action would be treated onsite, as necessary, and does not involve decisions at a programmatic level.

Comment (2427)
Volume I, Section 1.7.4, states that the extent to which a site is cleaned up will depend largely on assumptions regarding future land use and that for most sites, the process of determining future site use has just begun. Land-use decisions will determine cleanup levels, which largely determine the amount of environmental restoration waste generated, which, despite what this PEIS says, will have a great impact on waste management. Has DOE considered this?

Response
Appendix B in Volume III of the WM PEIS discusses the potential impacts on WM PEIS alternatives of managing environmental restoration waste for which responsibility will be transferred to the Waste Management Program. Appendix B was revised for the Final WM PEIS based on updated and additional information obtained from the data used to prepare the 1996 Baseline Environmental Management Report. Appendix B now provides updated estimated volumes of environmental restoration-generated waste, as well as the planned disposition of those wastes, at individual DOE sites. The planned disposition of a particular volume of waste (e.g., via treatment, access controls, *in-situ* containment) (see Section B.4) at a given site provides some indication of the clean-up level at a site. Moreover, DOE incorporated the land-use scenario provided in the 1996 Baseline Environmental Management Report, which also was based partly on this waste disposition information. However, DOE acknowledges in Section B.9 that the adoption of alternate land-use scenarios might alter the amounts of environmental restoration transferred waste. Section B.9 also states that adoption of the least restricted scenario is unlikely and that slightly more restricted land uses would result in only minor changes in environmental restoration waste volumes.

As noted in Section B.3 in Appendix B, environmental restoration remedies using *in-situ* technologies where the contaminated media remains in place are usually coupled with decisions that control or restrict site land use. At those sites where future land-use plans allow for more unrestricted public access, it is more likely that remediation will involve removal of contaminated materials.

Comment (2437)
Volume I, Page 6-111, Table 6.15-1; Page 7-109, Table 7.15-1; Volume III, Page B-8, Table B.5-1: "The blank (or *) boxes under ER waste volumes in these tables should be better explained or estimates should be found and inserted. For example, it is absolutely incredible that ER at Hanford, LANL, PGDP, and Pantex will generate neither any LLMW nor any LLW. The estimate of the impact of ER waste is distorted by these estimates being omitted."

Response
The Final WM PEIS discussions of environmental restoration waste volumes have been revised based on updated data used for the 1996 Baseline Environmental Management Report. The Draft WM PEIS contained 1994 or earlier data, which were the best estimates available at the time. Updated data

concerning the current environmental restoration-generated low-level waste and low-level mixed waste volumes are summarized in Tables B.5-1 and B.5-2 in Appendix B. Appendix B and Sections 6.15 and 7.15 were revised to discuss the revised volumes of environmental restoration low-level mixed waste and low-level waste, respectively.

Table B.5-1 shows that the sites identified in the comment each plan to generate environmental restoration low-level waste. Table B.5-2 shows that each of these sites, with the exception of Pantex, plan to generate environmental restoration low-level mixed waste. Environmental restoration activities are not within the scope of the WM PEIS, primarily due to their site-specific nature. However, the WM PEIS discusses the potential influence on the comparison of WM PEIS alternatives of that portion of the environmental restoration waste for which responsibility could be transferred to the Waste Management Program.

Comment (2607)
Will the transuranic wastes generated from the Pit 9 project at INEL be considered environmental restoration wastes or pre-1970 waste?

Response
In the WM PEIS, DOE defines all pre-1970 transuranic waste (also known as buried transuranic waste) as environmental restoration waste, which will be managed in accordance with CERCLA. The waste generated from the Pit 9 project at INEL fits that definition and is included in the qualitative discussion on environmental restoration waste impacts in Appendix B, Volume III of the WM PEIS.

Comment (2629)
Volume III, Table B.5-1, provides projected environmental restoration waste volumes through 2033, estimated by the computer model ARAM. However, estimated waste volumes differ substantially from those given in *Waste Stream Projections for Environmental Restoration at the Idaho National Engineering Laboratory* (DOE/ID-10417, Revision 6, June 3, 1995). Where good estimates are available, the PEIS should use them. Please explain. The EIS also appears to ignore the hundreds of structures that will need to undergo decontamination and decommissioning.

Response
The quantities of environmental restoration waste used in the Draft WM PEIS analysis were based on 1994 or earlier data, which were the best data available at the time DOE prepared the Draft WM PEIS. Updated data concerning the current environmental restoration waste volumes are provided in Appendix B in Volume III of the Final WM PEIS.

Environmental restoration waste volumes presented in Appendix B of the Final WM PEIS have been updated using information that was provided by each site and incorporated into a computerized database called the Environmental Restoration Core Database. The 1996 Baseline Environmental Management Report incorporated volumes from this database as well. Individual DOE sites control the information in this database and, understandably, they continually update their waste inventory calculations as more information is gathered and remedies are selected. For the purposes of the Final WM PEIS, DOE "locked" in May 1996 data from the Core Datebase. DOE recognizes that when the Final WM PEIS is published the volumes given in Appendix B might not match quantities reported in site-specific documents containing newer information. Section B.4 in Volume III, identifies environmental restoration waste volumes at INEL, and the planned disposition of these wastes. These

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estimates reflect only those facilities within the current scope of the Environmental Restoration Program, and do not include other structures or facilities that might require decommissioning in the future but have not yet been transferred to the Environmental Restoration Program. More information on facilities to be decontaminated and decommissioned at INEL and other sites can be found in the 1996 Baseline Environmental Management Report.

The WM PEIS was not prepared to support decisions for the Environmental Restoration Program (which includes decontamination and decommissioning), but does consider the amount of environmental restoration waste for which responsibility is expected to be transferred to the Waste Management Program (see Appendix B). Although this analysis indicates that this environmental restoration transferred waste could affect the scale of waste management activities at specific sites, it is not expected to affect the basis for comparison of the WM PEIS alternatives.

Comment (2782)
The predominance of Environmental Restoration Program wastes over other kinds of wastes underscores all [commentor's] reservations regarding impacts to groundwater, surface waters, and ecological resources, etc., at BNL. BNL is a special case because of these factors, and that it is inappropriate not to consider the site-specific factors associated with BNL. Any hard look at these factors would lead to elimination of BNL as a possible disposal site.

Response
The WM PEIS analysis will not be used to make decisions regarding the Environmental Restoration Program. Although the WM PEIS does not consider environmental restoration alternatives, it does present the most recent projected volumes of environmental restoration waste at individual sites and discusses the potential affect of environmental restoration waste for which responsibility could be transferred to the Waste Management Program. BNL's estimated volumes of this environmental restoration transferred-waste are less than the corresponding volumes of waste management wastes (see Table B.6-1 in Volume III).

Evaluating BNL as a potential site for waste management activities does not mean that the site will be selected. However, there is no basis for rejecting the site without evaluation. NEPA requires evaluation of reasonable alternatives. The preferred alternatives for low-level mixed waste treatment and disposal are identified in Section 3.7 in Volume I of the WM PEIS. As necessary, DOE will analyze impacts on a sitewide or project-level basis in separate NEPA reviews. Those reviews will include the potential impacts from environmental restoration activities to the extent possible. Cumulative impacts of waste management actions combined with past, present, and reasonably foreseeable future environmental restoration actions were considered in the WM PEIS to the extent possible (see Chapter 11 in Volume I).

As shown in Section B.5, the projected volume of environmental restoration low-level mixed waste to be managed onsite at BNL is 3,200 cubic meters. However, the portion, if any, of that waste to be disposed of onsite is uncertain.

Comment (2809)
Several of the DOE sites have Comprehensive Environmental Response, Compensation, and Liability Act and/or Resource Conservation and Recovery Act cleanup actions that have a different decision process than the National Environmental Policy Act. It would be helpful to further classify the waste

types under these statutes. The cost effectiveness of treatment options is very dependent on waste volumes. Decisions on portions of the waste streams discussed in the WM PEIS might already be made under other statutory authority.

Response
The commentor is correct in that DOE is proceeding with its environmental restoration decisions on a site-specific basis under CERCLA or RCRA. Although environmental restoration activities are outside the scope of the WM PEIS, DOE does assess the potential impacts on the WM PEIS alternatives of those environmental restoration wastes for which responsibility could be transferred to the Waste Management Program (see Volume I, Sections 6.15, 7.15 and 8.15, and Volume III, Appendix B). DOE has determined that, while for specific sites the transfer of responsibility for some environmental restoration waste to the Waste Management Program could impact some sites, it is not expected to affect the basis for comparison of WM PEIS alternatives.

Comment (2814)
The last paragraph in Volume I, Section 1.5.3, states that the waste volumes from retrieval of pre-1970 transuranic waste (TRUW) might affect the conclusions in the WM PEIS. If this is the case, then wastes generated from all remediation at DOE sites for all waste types must also be analyzed in the same way to maintain consistency and to ensure that all wastes generated at DOE sites are accounted for.

Response
Prior to 1970, DOE disposed of TRUW by burial in shallow land disposal units. This waste is known as "pre-1970 TRUW" or "buried TRUW." After 1970, DOE "retrievably stored" all TRUW pending the development of a deep geologic repository for disposal of this TRUW.

DOE considers pre-1970 TRUW to be environmental restoration waste. The WM PEIS focuses on waste management facilities (those required to treat, store, or dispose of existing and future wastes). While this PEIS does not analyze environmental restoration alternatives, it does contain information on the anticipated environmental restoration waste volumes (for low-level mixed waste, low-level waste, and transuranic waste) and a qualitative discussion of the extent to which those waste volumes could affect waste management decisions. Appendix B provides an estimate of environmental restoration waste and how it could affect the portion of environmental restoration waste for which responsibility could be transferred to the Waste Management Program. Appendix B was extensively revised for the Final WM PEIS and now contains updated information on volumes of environmental restoration waste and the disposition of environmental restoration waste for individual DOE sites. This information is summarized in the individual waste-type chapters. DOE has determined that, while the portion of environmental restoration waste for which responsibility could be transferred to the Waste Management Program could affect the waste management activities at specific sites, this transferred waste would not affect the basis for comparison of WM PEIS alternatives.

Comment (2826)
In the discussion of disposal in Section 6.15.2, it is stated that increased disposal volumes of environmental restoration-generated low-level mixed waste require additional land, but may pose capacity problems at smaller facilities such as BNL. An option is mentioned regarding shipping overflow wastes to another offsite facility. As stated previously, BNL is highly environmentally-

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sensitive, lies over a sole-source aquifer, and is in an area of high population density. Therefore, *all* such wastes should be shipped offsite.

Response
The National Environmental Policy Act requires that reasonable alternatives be evaluated. As noted in Section 6.3.2 in Volume I, BNL has less than 200 cubic meters of waste management low-level mixed waste. BNL would manage only its own low-level mixed waste and dispose of such wastes only under the Decentralized Alternative. It would ship its wastes for disposal in all other alternatives. For the Decentralized Alternative, the relatively small amount of waste management low-level mixed waste at BNL indicates that impacts to human health and the environment at BNL may be considered low. Chapter 6 in Volume I of the PEIS provides more detail on potential low-level mixed waste impacts, and the preferred alternative for low-level mixed waste is identified in Section 3.7 in Volume I. Before actual waste management facilities are sited, DOE will conduct NEPA reviews on a sitewide or project-level basis. As shown in Section B.5 in Appendix B, Volume III, the projected volume of environmental restoration low-level mixed waste to be managed by the Environmental Restoration Program at BNL is 3,200 cubic meters. This waste will not be transferred to waste management for disposition. Disposition of this waste will be determined under the CERCLA decisionmaking at the site.

Comment (3011)
The large amount of environmental restoration wastes generated at BNL relative to the small amount of wastes requiring disposal is worthy of notice. There are two causes for such a situation. The first is past (and perhaps current?) operating practices were so poor as to create disproportionately large environmental problems. The second is that site specific environmental factors tend to magnify small releases into large cleanups. The Town of Brookhaven believes that both apply to BNL. This supports the commentor's position that BNL is not a suitable candidate site under any disposal option, and that the only consideration for wastes from BNL should be what is considered for the "excess wastes" described in this paragraph: offsite disposal.

If a disposal facility is created at BNL, the analysis must consider the possibility that all wastes appropriate for disposal at that facility will be disposed of there. It is unlikely that only a portion of a site's wastes will be treated and disposed at a site facility, for economic and practical considerations. The commentor takes strong exception to the suggestion that DOE will, in a matter of course fashion, automatically ship wastes from BNL if an on-site disposal facility is permitted and available. Although the scope of the WM PEIS was limited to exclude environmental restoration activities, BNL's particular situation requires such an analysis.

Response
Evaluation of disposal at BNL was conducted to determine the suitability of the site. The act of evaluating the site does not imply that the site will be selected. NEPA requires evaluation of reasonable alternatives. Moreover, DOE is not considering shipping wastes from other sites to BNL for disposal, and could not implement such a practice without having considered it in a NEPA analysis. BNL would dispose of low-level waste and low-level mixed waste only under the Decentralized Alternative, and only its own waste.

As shown in Tables B.5-1 and B.5-2, the volumes of environmental restoration low-level waste and low-level mixed waste to be managed onsite at BNL are relatively small. Current plans are for

16,000 of 19,000 cubic meters of low-level mixed waste and more than 99% of low-level waste from environmental restoration activities to be shipped offsite for commercial disposal. DOE believes that decisions with regard to the disposition of environmental restoration-generated waste are site-specific in nature and, therefore, will be further evaluated in site-specific analyses.

Comment (3012)
Table 6.15-1 shows that over three orders of magnitude more waste will be generated at BNL from the environmental restoration activities than from "normal" site operations. BNL has a two orders of magnitude greater increase in wastes than any other site. This again shows BNL's unique position. BNL should not be considered with other DOE sites under this programmatic review. Please note that the footnote to the table compounds this difference.

Response
BNL was included in the WM PEIS because it generates waste management waste that will be managed according to the alternatives that will be selected based on the WM PEIS analysis. In the revised Appendix B, Table B.5-2 indicates that the total estimated volume of environmental restoration low-level mixed waste at BNL is 19,000 cubic meters, while Table B.6-1 indicates that the estimated volume of waste management low-level mixed waste is 190 cubic meters. These tables similarly indicate a relatively high volume of environmental restoration low-level mixed waste compared to waste management low-level mixed waste for PGDP and INEL, and also that none of the environmental restoration low-level mixed waste at these sites would be transferred to waste management facilities. Therefore, BNL does not appear to be "unique" in the sense referred to in the comment. Table 6-15.1 was deleted from the Final WM PEIS, as site-specific environmental restoration information is now contained in Appendix B.

The WM PEIS does not analyze environmental restoration alternatives, but provides a qualitative analysis of the potential impacts of environmental restoration waste for which responsibility could be transferred to Waste Management Program on the comparison of WM PEIS alternatives. Environmental restoration actions will be further evaluated in site-specific analyses. DOE does not believe that the environmental restoration transferred waste would affect the basis for comparison of WM PEIS alternatives, including the waste management activities at BNL.

Comment (3013)
Volume I, Section 7.15.2, states that environmental restoration low-level waste amounts are greater than "normal" activity low-level waste amounts for BNL. How was this computed, as nowhere has an estimate for low-level waste production at BNL been made? Furthermore, the conclusion in this section is contradictory to the approach used in Volume I, Chapter 6, where environmental restoration wastes were not to be used to expand a facility constructed for wastes generated in the course of regular activities. The WM PEIS has made some linkages between low-level waste and low-level mixed waste treatment and disposal strategies. Therefore, the assertion in this chapter that environmental restoration wastes could merely be added to the normally produced waste stream (which has never been quantified for BNL) is very disturbing.

Response
The Final WM PEIS was revised to include updated waste volumes for both environmental restoration (ER)- and waste management-generated wastes. Appendix B in Volume III of the WM PEIS shows a total of 120,000 cubic meters of ER low-level waste at BNL (see Table B.5-1), and 5,640 cubic meters

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of waste management low-level waste at BNL (see Table B.6-1). Table B.6-1 also indicates that responsibility for a comparatively small volume of 400 cubic meters of ER low-level waste will be transferred to waste management facilities. Disposition of environmental restoration low-level waste will be further evaluated in site-specific analyses. For both low-level waste and low-level mixed waste, DOE considered the effects of ER waste for which responsibility would be transferred to the Waste Management Program and determined that the transferred waste would not affect the basis for comparison of the WM PEIS alternatives. The transfer of some environmental restoration waste to the Waste Management Program could impact the treatment or disposal at specific sites.

The waste management low-level waste analysis in the Draft PEIS was based on inventory and projected waste volumes for each generating site as listed in the 1992 Integrated Data Base. Since then, new information for waste management low-level waste from the 1995 Integrated Data Base has become available. Appendix I of the PEIS discusses the newly updated waste management waste volumes. The 1995 Integrated Data Base indicated a sufficiently increased volume of low-level waste at BNL (5,640 cubic meters) to warrant a reevaluation of impacts at BNL using the BNL updated waste-volume data for the Final PEIS.

Section 7.15 in Volume I summarizes the information on ER low-level waste in Appendix B. Table 7.15-1 was deleted from the Final PEIS, as Appendix B now contains site-specific ER information. Section 7.15 no longer notes that ER low-level waste is greater than waste management waste from normal activities. At BNL, the ER transferred wastes that are currently estimated to be 400 cubic meters (waste management wastes are estimated at 5,640 cubic meters).

Comment (3019)
Section 6.15.2 indicates that each site would have sufficient capacity to treat environmental restoration waste only after the 10-year building phase and the 10-year treatment period. This is an unacceptable position to put many sites in, particularly those where restoration is the primary mission and cleanup is attainable in the near term.

Response
DOE did not intend to imply that wastes from the Environmental Restoration Program could only be brought into the Waste Management Program for treatment after a 10-year processing period for waste management wastes, i.e., sequentially rather than concurrently. Volume I, Section 6.15.2, of the Final PEIS has been clarified to indicate that environmental restoration waste could be transferred to waste management facilities whenever capacity is available.

Comment (3082)
The analysis does not adequately consider all the ramifications of the Hanford Tri-Party Agreement requirements for the Regionalized or Centralized Alternatives. For example, thermal treatment of Hanford wastes will require large units. Please evaluate Hanford-specific circumstances.

Response
The Hanford Tri-Party Agreement concerns cleanup actions at the Hanford Site that are environmental restoration activities. Environmental restoration alternatives are outside the scope of the WM PEIS, although the potential impact of environmental restoration waste for which responsibility could be transferred to the Waste Management Program is discussed in Appendix B (Volume III) and summarized in Sections 6.15, 7.15, and 8.15 (Volume I). Because the majority of the Hanford Site's

environmental restoration wastes would be managed in place or in the environmental restoration disposal facility. DOE estimated that relatively small percentages of the environmental restoration wastes generated at the site would be transferred to the Waste Management Program (see Table B.5-1, B.5-2, and B.5-3). Impacts from environmental restoration activities combined with waste management activities are considered in the WM PEIS cumulative impacts analysis (Chapter 11, Volume I) to the extent possible. Additional information on site-specific impacts is addressed in the Draft Hanford Remedial Action EIS, which was published in September 1996.

Comment (3096)
Section B.1 erroneously leads the reader to the conclusion that all environmental restoration wastes complex-wide, and their cumulative impacts, are analyzed to determine their impacts on DOE waste management decisions, although this analysis only looks at a small portion of environmental restoration wastes.

Response
Appendix B provides information on all non-liquid environmental restoration wastes. The WM PEIS qualitatively analyzes the portion of environmental restoration wastes that is expected to be transferred to waste management facilities, to determine the effect of these wastes on the basis for comparison of WM PEIS alternatives. This information is provided in Volume III, Section B. Appendix B has been updated with the most recent environmental restoration waste volumes. Most environmental restoration wastes would be managed in place, in facilities dedicated to environmental restoration, or by commercial vendors. Volume I, Chapter 11, discusses for each site the impacts of environmental restoration activities combined with waste management activities, where that information is available, as noted in Section 11.1.

Comment (3097)
Sections B.1, 2, and 3 are deficient because: (1) they include an inaccurate description of the CERCLA remediation process; (2) they do not reference RCRA; and (3) volume estimates are virtually useless in light of the caveats related to land-use determinations, DOE installations, and field offices.

Response
The environmental restoration waste volume estimates presented in the Draft WM PEIS were the best available data at the time of the analysis on the amount of environmental restoration waste that may potentially be managed by waste management facilities. Appendix B has been extensively revised in the Final WM PEIS, and includes environmental restoration waste volumes used to develop the 1996 Baseline Environmental Management Report. DOE recognizes, however, that waste-volume data will continually change as sites refine their estimates. The waste volumes calculations reflect the scenario that is described in the 1996 Baseline Environmental Management Report. The assumptions affiliated with this scenario are described in detail in the appendices to the Baseline Environmental Management Report.

Appendix B is not intended to give a detailed description of the CERCLA remediation process and has been revised to give only a simplified overview of how cleanup decisions are made. Section 1.4 in Volume I of the PEIS also identifies RCRA and CERCLA as key statutes applicable to hazardous waste management activities, and provides descriptions of these statutes as well.

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As noted in Volume III, Section B.3, environmental restoration remedies using in-situ technologies where the contaminated media remains in place are usually coupled with decisions that control or restrict site use. At those sites where plans for future uses of land allow for more unrestricted public access, it is more likely that remediation will involve removal of contaminated materials.

Comment (3098)
It is erroneous to assume [in Appendix B] that CERCLA actions, or treatment in place, produces no wastes requiring treatment and disposal.

Response
The WM PEIS does not assume that CERCLA actions do not produce waste. Appendix B has been extensively revised in the Final WM PEIS. It now provides more complete information about the wastes expected to be generated by the Environmental Restoration Program. Tables B.5-1, B.5-2, and B.5-3 identify the planned disposition of each segment of environmental restoration waste at each site, and each site's projected environmental restoration waste volumes. The response actions fall into four major groups: ex-situ actions (i.e., those requiring removal from the original location, followed by treatment, if needed, then disposal); in-place actions using treatment, containment, or both; access and institutional controls with no further action; and actions not yet determined. Appendix B also contains a discussion of the potential effects of environmental restoration transferred wastes on the basis for comparison of the WM PEIS alternatives.

Comment (3099)
DOE received comments noting that Appendix B does not include specific information on Hanford's environmental restoration wastes. One commentor felt it was hard to understand how DOE arrived at the numbers presented in Table B.5.1 and Section B.5, stating that there were no references cited. In addition, the commentor said it was hard to believe that Hanford has no environmental restoration wastes that might be appropriate for waste management treatment and disposal. Another commentor pointed out that Section B.4 states the volume estimates do not include areas of contamination that have been determined to be prohibitively expensive to clean up, but the term "prohibitively expensive" is not defined. Therefore, it is not clear how much of Hanford falls under this criterion, particularly when Table B.5-1 does not give any volumes for Hanford.

Response
The focus of the qualitative analysis in Volume III, Appendix B, of the WM PEIS discussed the effects that estimated volumes of environmental restoration waste for which responsibility may be transferred to waste management facilities could have on the comparison of WM PEIS alternatives. In the Draft PEIS, DOE estimated that none of the environmental restoration wastes generated at the Hanford Site would be managed in waste management facilities. Therefore, no volumes were given for environmental restoration waste at Hanford in the Draft WM PEIS.

Appendix B has been extensively revised in the Final WM PEIS. Updated waste volumes for the Hanford Environmental Restoration Program are now included in Tables B.5-1, B.5-2, and B.5-3, which now identify some Hanford environmental restoration waste to be transferred to waste management facilities. The waste volume estimates in the WM PEIS were provided by the sites and were used to develop the 1996 Baseline Environmental Management Report as well. Appendix B was revised to indicate all references used.

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Section B.3 notes that the Hanford Environmental Restoration Program is planning to place the majority of waste from site remediation projects and building decommissioning in its Environmental Restoration Disposal Facility. This facility will be operated by the Environmental Restoration Program, not the Waste Management Program. Consequently, there is relatively little waste currently slated for transfer to the Waste Management Program.

For Hanford, the projects that are not included in the Appendix B estimates are: (1) Columbia River, Hanford Reach, excluded because there is no feasible remediation approach available; and (2) groundwater, excluded because the current approach is to conduct limited "pump-and-treat" followed by natural attenuation and monitoring. No groundwater projects involving "pump-and-treat" have been included in the estimates in Appendix B.

Comment (3100)
Table B.4-2, third bullet. Disposal volumes are generally not estimated at one-to-one ratio. A 30% "fluff factor" has been used in the volume estimates in the 100 Areas. Last bullet. Generation of environmental restoration wastes is said to occur over a 30-year period from 2003 to 2033. This does not match the Hanford Tri-Party Agreement (2018) or DOE-Richland long range plan (2047).

Response
Appendix B was revised to state that *the majority* of the environmental restoration wastes will be produced between 2003 and 2033. Further, Section B.8 was revised to eliminate the assumption of a one-to-one ratio for waste treated and waste disposed. This assumption is no longer necessary because environmental restoration waste volumes are now being provided directly by the individual sites.

Comment (3185)
The PEIS must address whether the 50,000 cubic meters of low-level waste reported for PGDP in the PEIS is associated with environmental restoration or decommissioning and decontamination activities.

Response
The 50,000 cubic meters cited in the comment refers to the waste volumes used in Volume I, Chapter 7 of the Draft WM PEIS, which were current inventory and 20-year projections of waste management low-level waste at PGDP reported in the 1992 Integrated Data Base. The 1992 Integrated Data Base did not report any environmental restoration or decommissioning and decontamination wastes at PGDP. However, estimated volumes of environmental restoration low-level waste are discussed in the Final WM PEIS in Section 7.15 and presented for each site in Volume III, Appendix B, Table B.5-1.

New waste-volume information for waste management low-level waste from the 1995 Integrated Data Base has been incorporated in the Final PEIS and is reported in Volume III, Appendix I. Appendix B has been revised to incorporate updated environmental restoration volumes.

Comment (3244)
Managing transuranic wastes (TRUW) should also include wastes previously disposed of at Hanford. Recent DOE information presented at the Secretary's presentation on openness indicate that 1,522 kilograms of plutonium have been discarded into the ground or into tanks at the Hanford Site. The information also reports DOE cannot account for 1,266 kilograms of plutonium at the Hanford Site. This additional plutonium might be in tanks, waste sites, or facilities. These need to be included in the WM PEIS.

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Response
Plutonium contaminated TRUW that was previously disposed of is considered environmental restoration waste. Management of environmental restoration wastes is outside the scope of the WM PEIS. However, the PEIS does consider the effect of environmental restoration wastes for which responsibility could be transferred to the Waste Management Program (see Volume I, Section 8.15, and Volume III, Appendix B). As indicated in Table B.6-1, the Hanford Site has an inventory and projected 20-year generation of about 50,000 cubic meters of waste management TRUW, and 1,800 cubic meters of environmental restoration transferred TRUW. Table B.5-3 identifies approximately 84 cubic meters of environmental restoration TRUW for which disposition has not yet been determined. Environmental restoration wastes are also included to the extent possible in the cumulative impacts analysis in Volume I, Chapter 11. Site-specific conditions for the Hanford Site are analyzed in more detail in the Hanford Remedial Action EIS.

The disposition of surplus plutonium stored at Hanford is outside the scope of the WM PEIS, but is discussed in the Storage and Disposition of Weapons-Usable Fissile Materials PEIS. The scope of the Fissile Materials PEIS is described in Section 1.8.1 in Volume I of the WM PEIS.

Comment (3247)
Commentors stated that the Final WM PEIS should accurately characterize environmental restoration wastes. One commentor stated that DOE's environmental restoration waste generation estimates vary as much as 100 to 200% and, therefore, the risk assessments are suspect. One commentor stated that the assumption that environmental restoration waste volumes are insignificant compared to current inventories and projected waste from waste management operations should be reevaluated because of inconsistencies with Baseline Environmental Management Report estimates, which in many cases are higher than the WM PEIS estimates.

Response
The WM PEIS was not prepared to inform decisions on the Environmental Restoration Program. However, it does consider the effects of the portion of environmental restoration waste for which responsibility may be transferred to the Waste Management Program on the comparison of WM PEIS alternatives. Appendix B in Volume III, which has been extensively revised, discusses the factors in estimating the amount of environmental restoration waste that might be managed at waste management facilities. DOE used the 1996 Environmental Restoration Core Database (which was also used for the 1996 Baseline Environmental Management Report) to update its environmental restoration waste volumes for each site in Appendix B.

Appendix B also contains updated information on how DOE plans to manage contaminated media at each of its sites. In some cases, the media will be left in place, usually with controlled public and worker access. This type of response action generates little, if any, waste. In other cases, DOE plans to remove the contaminated media or structures, which often generates a substantial quantity of waste.

As shown in Appendix B, the updated information indicates that overall, the amount of environmental restoration low-level waste that will enter the waste management system is slightly greater than the amount of waste management low-level waste. Other environmental restoration waste types projected to enter the waste management system are estimated to be less than the waste management generated waste types. DOE expects the estimates provided in Appendix B will change as the environmental restoration and decontamination and decommissioning activities progress. Environmental restoration

wastes that would be managed in place, in environmental restoration facilities, or by commercial vendors would not affect waste management facilities. Although this analysis indicates that environmental restoration waste transferred to waste management facilities could influence waste management activities at specific sites, it is not expected to affect the basis for comparison of the WM PEIS alternatives.

The human health risk results presented in the WM PEIS are for waste management activities only and do not include human health risks from managing environmental restoration wastes, because there is insufficient information on the constituents of all environmental restoration wastes. However, DOE believes that risks from physical hazards associated with operation of environmental restoration waste treatment and disposal facilities would tend to be the same or less than those for comparable volumes of waste management wastes.

Comment (3256)
The WM PEIS socioeconomics analysis should include an analysis of cleanup costs associated with the past, present, and future shallow land burial of radioactive wastes, since it appears that these impacts are appearing now and are certain to appear in the future.

Response
The comment pertains to the costs of environmental restoration activities. DOE does not evaluate environmental restoration alternatives in the WM PEIS because it determined that programmatic decisions cannot be made for environmental restoration (see Volume I, Section 1.7.1). These decisions should reflect the particular conditions at each site. Although the WM PEIS does not evaluate alternatives for the Environmental Restoration Program, it does consider the effects of the volume environmental restoration waste for which responsibility could be transferred to the Waste Management Program. The cost of managing the portion of environmental restoration transferred waste is not well known. DOE expects the Department-wide estimates provided in Appendix B to change as the environmental restoration and decontamination and decommissioning activities progress. Environmental restoration wastes that would be managed within the Environmental Restoration Program would be analyzed in site-specific reviews.

Comment (3282)
The WM PEIS considers only legacy waste and operations waste, but not environmental restoration waste. Although it appears that DOE has performed a sensitivity analysis to determine if the consideration of environmental restoration wastes would significantly change any impacts, it is unclear why restoration waste is not included directly in the analysis. The rationale given in the Draft WM PEIS for the segmentation of waste management from environmental restoration activities is that DOE has not yet acquired sufficient data from its contaminated facilities to adequately assess the impacts of its planned site remediation actions. The analysis claims that environmental restoration wastes are uncertain, depending on cleanup levels, which depend on future-use assumptions. However, if sufficient estimates were available to do the sensitivity analysis and produce the 1995 Baseline Environmental Management Report, and after 6 years of substantial environmental restoration budgets, it seems as though environmental restoration wastes should be fully considered along with waste management wastes in a single environmental review. One commentor specifically stated that the PEIS must estimate the volume of low-level mixed waste expected to be generated from environmental restoration activities and asked, "What are anticipated waste volumes?" Another commentor stated the WM PEIS should clarify its analysis of waste generated as a result of restoration activities and the

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assumption behind these estimates, and should clearly define the entire inventory of waste addressed in the document.

Response
The WM PEIS is a programmatic analysis that evaluates decentralized, regionalized, and centralized approaches for treatment, storage, and disposal of wastes generated by DOE operations. DOE recognized, after conducting preliminary analyses, that programmatic decisions regarding environmental restoration cannot be made because these decisions must reflect the particular conditions at each site, as well as the involvement of State regulators and local stakeholders. This is why DOE eliminated the environmental restoration activities from the scope of the WM PEIS. The site-specific nature of environmental restoration activities is due partly to their dependency on decisions regarding future-use plans and cleanup agreements. Such decisions involve input from State and local governments, as well as EPA, and were evolving at different rates during the WM PEIS process.

The term "anticipated waste volumes" is used in the WM PEIS to refer to projected volumes of waste management waste to be generated by DOE sites. While DOE has generated substantial data on environmental restoration waste volumes at some sites, it has much less at others. Appendix B in Volume III discusses the factors in estimating the amount of environmental restoration waste that might be managed at waste management facilities. DOE expects the Department-wide estimates provided in Appendix B would change as the environmental restoration and decontamination and decommissioning activities progress. However, the impacts of future environmental restoration activities at each of the major sites have been incorporated into the cumulative impact analysis where that information is available in existing NEPA documents or in CERCLA or RCRA program documents (see Volume I, Chapter 11).

DOE believes the elimination of the environmental restoration alternatives from the original scope of the PEIS did not compromise the programmatic decisions to be made based on the waste management analyses. The WM PEIS has been prepared in accordance with NEPA and CEQ implementing regulations, which recognize that NEPA reviews might be warranted for individual agency programs due to timing or the need for specificity or in-depth analysis.

Although the WM PEIS will not be used to inform decisions about DOE's Environmental Restoration Program, DOE's projection of the environmental restoration waste for which responsibility could be transferred to the Waste Management Program was considered in the WM PEIS to determine whether it could affect the decisions to be made based on the WM PEIS. The Final WM PEIS provides updated information on environmental restoration waste volumes and their disposition. DOE has determined that, while the transfer of responsibility for some environmental restoration waste to the Waste Management Program could affect waste management activities at specific sites, it is not expected to affect the basis for comparison of the WM PEIS alternatives.

Environmental restoration activities at DOE sites consist mainly of CERCLA actions. Pursuant to the 1994 DOE Secretarial NEPA Policy, DOE will rely on the CERCLA process for environmental review of actions to be taken under CERCLA, and will address NEPA values and public involvement procedures in its CERCLA processes to the extent possible. However, NEPA reviews are undertaken for siting, construction, and operation of treatment, storage, and disposal facilities that, in addition to supporting CERCLA actions, also serve as waste management facilities. DOE might also, after consultation with stakeholders and as matter of policy, integrate the NEPA and CERCLA processes for

other specific proposed actions. DOE will conduct NEPA reviews of non-CERCLA related, site-specific environmental restoration activities, where appropriate.

During each stage of environmental restoration from characterization of contaminated media to final remediation, waste might be generated. The projected volumes of waste that reasonably might be generated by environmental restoration were analyzed by each DOE site during development of the BEMR. These analyses included consideration of treatment, storage, and disposal capabilities, specific restoration requirements, and negotiations with State and Federal regulatory agencies in order to estimate how much of the contaminated media would need to be managed as waste. Estimates and descriptions of total quantities of the contaminated media to be managed, and the wastes that will be generated during environmental restoration, are contained in Volume III, Appendix B. Although most wastes that are generated as a result of DOE's environmental restoration activities would be managed outside of the alternatives evaluated in the WM PEIS, a subset of the wastes generated by environmental restoration could be transferred for management in facilities evaluated in the WM PEIS. However, given the incomplete information about the final volumes and contaminant composition of the transferred wastes, it was not practical to analyze the potential impacts of managing these wastes in the WM PEIS.

Comment (3422)
A number of commentors stated that the WM PEIS is totally inadequate if it fails to disclose the quantities of and consider the impacts of environmental restoration waste that might be shipped to Hanford for treatment or disposal. One commentor added that the waste and materials that have been present at Hanford for years still are not properly vitrified or stored. Another commentor noted that Hanford has "a minuscule portion of known waste from all the nuclear weapons sites in this PEIS" and is concerned that decisions from the PEIS will set precedent without having considered environmental restoration waste.

Response
Environmental restoration alternatives were included in the original scope of the analysis for the PEIS, but DOE subsequently determined that cleanup activities are primarily site specific and cannot appropriately be addressed at the programmatic level. Accordingly, consideration of programmatic environmental restoration cleanup strategies were removed from the PEIS in February 1995. Volume I, Section 1.7.1 discusses this modification in scope regarding environmental restoration activities.

As presently modified, the WM PEIS analyzes alternative configurations for waste management sites (those required to treat, store, or dispose of inventory wastes and wastes that will be generated in the future as a result of DOE operations). While this document does not analyze environmental restoration alternatives, it does contain information on the anticipated waste volumes generated as a result of environmental restoration activities. Updated estimates on management approach for environmental restoration are given in Volume III, Appendix B of the PEIS, and are used to qualitatively ascertain the extent to which environmental restoration wastes that are transferred into the Waste Management Program could affect programmatic waste management alternatives. Specifically, for each major site, including the Hanford Site, there is information given about the projected environmental restoration actions and resultant waste volumes that would be generated at the site. Sections 6.15, 7.15, and 8.15 summarize these data as well. The transfer of environmental restoration waste is not expected to affect the basis for comparison of WM PEIS alternatives.

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The volumes presented in Appendix B are based on current planning assumptions and, in many cases, decisions on final disposal locations are yet to be made using the CERCLA and/or RCRA processes underway at each site.

Volume I, Chapter 11, presents the cumulative impacts by site from many different programs. Environmental restoration activities have been considered to the extent possible, including the potential impacts of the preferred alternatives in the Hanford Remedial Action Draft EIS and the Final Tank Waste Remediation System EIS.

Comment (3655)
It is difficult to believe the assumption that impacts relating to capacity and processing rates with regard to the environmental restoration (ER) waste treated after the 10-year period for the waste management transuranic waste (TRUW) loads would be "less than those anticipated for waste management TRUW," (WM PEIS p. 8-80) especially in light of the following:

- That less than one-fourth of the environmental restoration release sites have been fully characterized; therefore the extent and type of contamination is largely unknown. (WM PEIS p. 8-77);

- DOE projects that only RFETS, SRS, and ORR will have environmental restoration TRUW requiring treatment at waste management facilities when transuranic materials were used at the majority of DOE sites prior to 1970;

- and that, historically, DOE waste management practices have not been particularly environmentally sensitive.

Response
More recent data on projected ER waste volumes have been received since publication of the Draft WM PEIS. These updated data are contained in the revised Appendix B. The discussions in Volume I, Sections 6.15, 7.15, and 8.15 of the effects of projected ER waste volumes have been updated accordingly. Only SRS would have higher volumes of ER TRUW than waste management TRUW. The updated data also indicate that, of the major sites analyzed in the WM PEIS; ANL-E, the Hanford Site, INEL, ORR, RFETS, and SRS would transfer ER TRUW to waste management facilities. This information is contained in the revised Appendix B.

As indicated in Table B.5-3, Appendix B, in Volume III of the WM PEIS, most of the total volume of ER TRUW will be transferred to waste management facilities. The total volume of ER TRUW is expected to be less than the total waste management TRUW volume.

Section 8.15 in Volume I of the WM PEIS states that in order to analyze the effect of ER wastes on TRUW decisions, DOE compared (1) the most current projection of ER wastes for which responsibility would be transferred to the Waste Management Program for treatment to (2) the volume of waste management wastes used in the WM PEIS analyses. Because radiological activities and chemical concentrations of ER transferred waste are, in general, expected to be lower than those of comparable waste management waste, risks from additional ER transferred wastes are expected to be lower than the risks resulting from the treatment of equivalent volumes of waste management wastes.

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Comment (3729)
The WM PEIS fails to disclose that Hanford's "clean" environmental restoration wastes will require the sacrifice of 1,791 football fields worth of land and habitat for landfills.

Response
Environmental restoration activities are beyond the scope of the WM PEIS. These activities are addressed in detail in the Draft Hanford Remedial Action EIS, published September 1996, as well as through cleanup actions taken under CERCLA. However, Appendix B in Volume III of the WM PEIS presents the total estimated volumes of environmental restoration waste at the Hanford Site, as well as the expected disposition of these volumes (see Tables B.5-1, B.5-2, and B.5-3).

Cumulative impacts of land-use requirements at the Hanford Site are presented in Volume I, Section 11.6. This includes cumulative impacts of current activities and reasonably foreseeable future activities. Environmental restoration activities are considered to the extent possible.

Comment (3930)
The WM PEIS should consider buried transuranic waste (TRUW) because buried TRUW constitutes the most urgent and serious of TRUW problems.

Response
The WM PEIS evaluation of TRUW included analysis of material placed in "retrievable" storage since 1970. Pre-1970 TRUW, known as "buried TRUW," was not included in the analysis. This buried waste is considered environmental restoration waste and will be managed in accordance with CERCLA and RCRA. Section 8.15 in Volume I and Appendix B in Volume III of the WM PEIS contain information regarding TRUW generated as a result of environmental restoration activities (including retrieval of pre-1970 TRUW) and the extent to which these waste volumes could affect the basis for comparison of the WM PEIS alternatives.

Comment (3969)
Commentors questioned apparent discrepancies between environmental restoration low-level waste volumes in the WM PEIS and other sources. One commentor asked DOE to explain the variance (14,518,000 cubic meters) between the environmental restoration low-level waste volumes reported in the 1995 Baseline Environmental Management Report and the environmental restoration waste volumes reported in the WM PEIS, and provide the documentation to support the numbers derived from Baseline Environmental Management Report that correspond with the WM PEIS. Commentors questioned the estimated 87,000 cubic meters of environmental restoration low-level waste at FEMP. One commentor stated that the WM PEIS estimates 87,000 cubic meters of FEMP environmental restoration low-level waste for disposal, which conflicts with the Fernald Citizens Task Force 1995 report estimates of 2,352,796.5 cubic meters of waste. What is the source of the WM PEIS estimate? Another commentor inquired whether the 87,000 cubic meters of environmental restoration low-level waste was the number used in the dose calculations and Appendix E, Transportation, and if so, how or when would these calculations be recalculated to include the actual volumes of waste at FEMP?

Response
At the time the Draft WM PEIS was prepared, scant data were available on the expected amounts of environmental restoration wastes that would be managed in waste management facilities. For Appendix B of the Draft WM PEIS, the volumes of environmental restoration wastes were estimated by

9.3 Environmental Restoration Waste and Its Effect on the WM PEIS

using the Baseline Environmental Management Report database and internal working documents developed for the Baseline Environmental Management Report. DOE substantially revised the WM PEIS to include updated information from the data used for the 1996 Baseline Environmental Management Report.

This updated information identifies a total of 2,500,000 cubic meters of environmental restoration low-level waste at FEMP, with 180,000 cubic meters of the total to be transferred to waste management facilities (see Table B.5-1 in Appendix B).

Only waste generated from waste management activities was analyzed in the WM PEIS. As a result, the volume of environmental restoration low-level waste at FEMP for which responsibility will remain in the Environmental Restoration Program was not considered in the dose calculations and transportation estimates.

Comment (3976)
At what point will the volume of waste at FEMP that meets the waste acceptance criteria (1,804,150.2 cubic meters) for disposal onsite in the engineered disposal cell be considered to fall under the Waste Management Program, given that DOE will be responsible for this disposal cell for perpetuity?

Response
As presently envisioned, the Environmental Restoration Program will retain responsibility for the onsite engineered disposal cell at FEMP--it will not fall under the Waste Management Program.

Comment (3978)
FEMP Operating Unit 1 contains approximately 480,321.72 cubic meters of low-level waste to be transported by rail and disposed of at a commercial facility located in Utah. This is a major transportation undertaking, yet it does not appear to be included in the WM PEIS.

Response
All of FEMP's estimated low-level waste volume is generated from environmental restoration activities. Waste from environmental restoration activities was included in the original scope of the WM PEIS, but DOE subsequently determined that cleanup activities were primarily site-specific and were not appropriate for decisions at the programmatic level. Accordingly, the consideration of programmatic environmental restoration strategies was removed from the WM PEIS in January 1995. Section 1.7.1, in Volume I of the PEIS discusses the modification of the scope of the WM PEIS.

The decision to ship waste from FEMP Operating Unit 1, the Waste Storage Area, to a commercial disposal facility was made in March 1995 under the CERCLA process. The transportation impacts were analyzed in the associated CERCLA documents that were made available to the public and remain in the FEMP Administrative Record.

Volume I, Chapter 11, presents cumulative impacts by site from many different programs. To the extent possible, environmental restoration and existing operations have been considered.

Comment (3994)
In Tables 7.15-1, 7.15-2, and 7.15-3, disposal alternatives are listed by chart comparisons for 16 disposal sites, 6 disposal sites, and 1 disposal site. Waste management treatment at Portsmouth is

constant for the three alternatives--97,000 cubic meters to be treated at this site. I am confused that under Table 7.15-1, all sites treat; 16 dispose. Portsmouth is listed for disposal of 290,000 cubic meters of environmental restoration waste, and disposal of 200,000 cubic meters of waste management low-level waste. How can "all sites treat and 16 dispose" result in such an increase in the amount of low-level waste scheduled for disposal at the Portsmouth Plant? The "6 sites dispose" and "1 site disposes" alternatives list no environmental restoration waste at Portsmouth. Could DOE please provide detailed information on how these figures were calculated?

Response
Environmental restoration waste volumes have been updated in the Final WM PEIS. Section 7.3.2 in Volume I shows that under the Decentralized Alternative, Portsmouth would dispose of wastes from 5 of the 27 offsite generators; Bettis, Knolls Atomic Power Laboratory, Princeton Plasma Physics Laboratory, Mound, and RMI Titanium Company. These sites contribute more than half of the volume of waste management wastes for management at the Portsmouth Plant. Table B.7-1 in Volume III shows that under the Decentralized Alternative, the Portsmouth Plant would manage 97,000 cubic meters of waste management low-level waste, and 190 cubic meters of environmental restoration low-level waste. The Portsmouth Plant itself will generate 730,000 cubic meters of environmental restoration low-level waste (see Table B.5-1). The majority of this waste will be managed within the Environmental Restoration Program.

9.3 Environmental Restoration Waste and Its Effect on the WM PEIS

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10. Compliance with Laws and Established Agreements and Plans

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(No comments were received for this section)

10.1 Regulatory Compliance

Comment (221)
What is the regulatory relationship between DOE and NRC; are they cooperating agencies? Which agency regulates reactors? What are the criteria for regulating nuclear reactors?

Response
For purposes of the WM PEIS, NRC and DOE are not cooperating agencies. In general, NRC and DOE regulatory powers regarding radiological and nuclear safety are independent of each other. NRC regulates commercial use of atomic energy and radioactivity, including power reactors and non-DOE research reactors; DOE regulates its own use of atomic energy and radioactivity, including the nuclear reactors on its sites. There are a few DOE activities that, by statute, are regulated by NRC. For example, pursuant to the Nuclear Waste Policy Act of 1982, NRC will license the geological repository where DOE will dispose of high-level radioactive waste. This PEIS is concerned with waste management and regulation of nuclear reactors is outside its scope.

The regulation of nuclear reactors by DOE and NRC has the same objective--to help ensure that nuclear reactors operate safely and do not pose undue radiological risks to the public or to onsite workers. NRC regulates non-DOE reactors. The regulation of nuclear reactors by NRC is in accordance with the rules found in 10 CFR Part 50. One of the means used to regulate nuclear reactors is to impose criteria governing their design. NRC's 64 general design criteria are found in Appendix A to 10 CFR Part 50. These design criteria fall into six main categories: (1) overall requirements; (2) protection by multiple fission product barriers; (3) protection and reactivity control systems; (4) fluid systems; (5) reactor containment; (6) fuel and radioactivity control. DOE has similar design criteria for its reactors, which are documented in DOE Order 5480.3.

Comment (222)
Does anyone in the nuclear community monitor small radiation sources or is it left only to the Town Zoning Board?

Response
NRC has regulatory jurisdiction over small commercial radiation sources, although some States have agreements with NRC to assume this regulatory responsibility (Agreement States). To possess such sources, NRC and Agreement States require owners of such sources to have licenses that include conditions to help ensure that the public is not endangered by the sources, and that the sources are properly disposed. NRC or the Agreement State will terminate the license if the licensee does not comply with the terms of a license. DOE has regulatory authority for DOE sites. DOE Order 5400.5 and regulations found in 10 CFR Part 835 provide the standards for radiation protection at DOE sites.

Comment (392)
Disposal decisions should go through the NRC siting process because DOE cannot credibly act as its own regulator in siting nuclear and hazardous waste disposal facilities. Actions that DOE takes must comply with Federal and State laws and must be subject to oversight by the State. Self-regulation by DOE has not worked and we will not allow it to continue.

Response
The WM PEIS is DOE's national strategy for the safe and efficient management of its radioactive and hazardous waste. While the WM PEIS identifies waste management options, it does not actually site waste management facilities.

10.1 Regulatory Compliance

Hazardous, radioactive, and mixed waste management have differing requirements established by State and Federal laws. DOE's hazardous and mixed waste management (treatment, storage, and disposal) facilities are subject to the same Federal and State laws as private waste management facilities. Management of hazardous waste and the hazardous portion of mixed waste are regulated by the Resource Conservation and Recovery Act (RCRA) and corresponding State acts. The EPA and corresponding State regulatory agencies closely regulate DOE's waste management facilities.

Both NRC and EPA regulate radioactive waste disposal; their requirements are very similar. Any DOE radioactive waste disposal facilities will be sited and operated in accordance with all applicable requirements. DOE does not operate hazardous waste disposal facilities at this time, nor does the WM PEIS suggest that it will.

In January 1996, the Secretary of Energy's Advisory Committee on External Regulation of Department of Energy Nuclear Safety issued a report. *Improving Regulation of Safety at DOE Nuclear Facilities,* recommended external regulation of DOE facilities and operations. The Secretary created a Workgroup, including representatives of other Federal agencies, to review the Advisory Committee recommendations and provide recommendations for implementing external regulation of DOE nuclear safety.

Comment (1146)
The Draft WM PEIS uses existing regulatory standards and does not consider the effects of a different waste classification system based on hazard. The Draft WM PEIS also does not consider the effects of a different regulatory regime, even though you have appointed an advisory committee to make such recommendations. As a result, the Draft WM PEIS does not include all reasonable alternatives, as required by NEPA.

Response
The evaluation of the effects of a different waste classification system based on hazard rather than existing statutory definitions would be highly speculative and impossible to meaningfully analyze. The effects of a waste classification system based on hazard would depend on the features of that system and how they differ from the existing regulatory standards. It is outside the scope of the WM PEIS to analyze a change in the waste classification system. Without a proposed change in the classification system, it would be highly speculative to assess the impact of an abstract waste classification based on hazard.

The DOE advisory committee on external regulation has recommended external regulation of DOE facilities, but has not recommended whether the NRC or the Defense Nuclear Facilities Safety Board should be the regulatory agency.

Sections 1.7.3 and 3.5 in Volume 1 address the definition of alternatives. The sites identified in each alternative configuration were chosen for evaluation based on the volume of waste they had in inventory, the amount of waste they were expected to generate in the future, the waste origin and characteristics, and the waste facilities at each site.

10.1 Regulatory Compliance

Comment (1509)
The WM PEIS did not adequately address the impact of making Lawrence Livermore National Laboratory's (LLNL's) Site 300 a disposal facility on its Superfund cleanup status. The PEIS should discuss the impacts on cleanup, and on risk levels of putting a dump there that would accept new waste.

Response
If DOE selects LLNL as a waste management site as a result of the WM PEIS analysis, DOE would need to conduct a site-specific NEPA study that would examine where to site specific facilities. If a new waste management facility was to be selected at Site 300, this would not affect the site's listing as a National Priorities List site. Any new facility would be designed and located such that existing operations and areas of contamination would not be affected.

DOE expects that health risks from new disposal facilities would not add to health risks associated with existing contamination because (a) waste management workers employed at a new disposal facility would be different workers than those who work at remediation activities; (b) waste management facilities would be geographically separated from environmental restoration sites; and (c) environmental restoration sites are being contained and remediated and should not result in a substantial long-term health risk.

Chapter 11 in Volume I of the WM PEIS addresses cumulative impacts. To the extent that impacts from environmental restoration areas are known, they have been identified, along with identified impacts from other programs. Cumulative impacts are a consideration for DOE in making waste management decisions.

Comment (1673)
Rail transportation could reduce concerns about the environmental management activities in Nevada. Currently, truck shipments travel primarily through the largest cities in Nevada and then to the Nevada Test Site (NTS) due to routing restrictions imposed by U.S. Department of Transportation regulations. Rail shipments could allow greater DOE discretion in the development of alternative routes that could avoid these areas, because currently there are no rail routing regulations.

Response
The commentor's preference for rail shipments over truck is noted. Although rail shipments appear to result in a lower number of estimated fatalities in comparison to truck shipments, analyses presented in Volume IV, Sections E.7 and E.17, indicate that the risk of transportation operations generally are small for both modes. A discussion of uncertainties involved when comparing the truck and rail transportation impacts is presented in Appendix E, Section E.8.5. Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process described in Section 4.3.10, in Volume I of the WM PEIS. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE will continue to work with States, regional entities, and carriers during large shipping campaigns to ensure that safe routing alternatives and safe havens are utilized.

Comment (1816)
DOE has developed waste acceptance criteria for the Nevada Test Site (NTS), but these criteria are not based on a completed performance assessment clearly delineating the type and character of the wastes that can be disposed of at either the Area 3 or the Area 5 radioactive waste management sites. This

means that DOE is not only out of compliance with the requirements of NEPA, but is also in violation of its own waste management order (5820.2A, Chapter III, a and b).

Response
On September 8, 1994, the Defense Nuclear Facilities Safety Board issued Recommendation 94-2, which concluded that the DOE's low-level waste (LLW) program had not kept pace with the evolution of commercial practices, and that no DOE LLW disposal facilities had completed the radiological performance assessments that are required by DOE Order 5820.2A. In its response to the Defense Board recommendations, DOE submitted to the Defense Board a revised Implementation Plan in May 1996. The objective of the plan is to improve the LLW management system so that performance assessments are written and are approved, demonstrating that DOE LLW disposal facilities meet DOE Order 5820.2A objectives. In addition, the performance assessments will assure that all appropriate LLW is included in the evaluation and that LLW is disposed of with a margin of safety adequate to protect workers, the public, and the environment.

As part of the implementation of Defense Board Recommendation 94-2, DOE has a schedule for completing performance assessments at all sites. Under this schedule, the performance assessment (including the composite analyses for interacting source terms) for NTS Areas 3 and 5 would be completed by March 1998 and September 1999, respectively. The performance assessment for Area 5, without the composite analysis, has already been reviewed by DOE Headquarters. It should be noted that the performance assessments will be updated periodically through the performance assessment maintenance program, and all additional wastes disposed of since the last update are considered.

Neither the basis for DOE's waste acceptance criteria nor the status of the performance assessments affect DOE's compliance with NEPA.

Comment (1821)
All solid and hazardous waste must be managed in accordance with all applicable Federal, State and local environmental regulations. The Norfolk Naval Shipyard currently holds a permit to operate as a hazardous waste storage facility. If change in the type or quantity of hazardous waste is anticipated, the current permit might have to be modified, or an additional permit might have to be obtained.

Response
DOE is not responsible for the management of hazardous waste at Navy facilities, such as the Norfolk Naval Shipyard. This is in contrast to radioactive waste, for which DOE has management responsibilities. The 11 sites analyzed in the WM PEIS accounted for more than 90% of DOE's hazardous waste generated in 1992. Although only 11 sites were analyzed, the decisions for hazardous waste related to the WM PEIS apply to all DOE sites.

Comment (2061)
Facilities managing hazardous waste and low-level mixed waste must comply with air emission standards of the Clean Air Act and RCRA. As of December 6, 1995, all facilities managing hazardous waste and low-level mixed waste in containers, tanks, surface impoundments, and miscellaneous units must comply with 40 CFR 264, Subparts AA, BB, and CC. The WM PEIS should reflect this.

10.1 Regulatory Compliance

Response
DOE revised Section 6.5 in Volume I and Section C.4.2.1.1 in Volume III of the WM PEIS to describe the additional RCRA and Clean Air Act emissions standards contained in 40 CFR Part 264, Subpart AA (air emissions from process vents), Subpart BB (air emissions from process leaks), and Subpart CC (air emissions of volatile organic compounds from tanks, surface impoundments, and containers).

Comment (2063)
Some sites might manage their own as well as other sites' low-level waste and low-level mixed waste. The Final PEIS should clarify that such alternatives will not interfere with the sites' Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) activities, both geographically and programmatically.

Response
DOE revised the environmental restoration sections in the Summary document and in Section 1.8.2 in Volume I of the WM PEIS to include a statement that the decisions made based on the WM PEIS should not interfere with remediation activities at individual sites. The Final WM PEIS reflects DOE's intent to vigorously pursue environmental restoration plans independent of the Waste Management Program, and notes that excess waste management capacity would be available for treating certain environmental restoration wastes.

Comment (2287)
We are afraid that Congress will exempt DOE and the contractors who work at Hanford from any kind of accountability for compliance with environmental regulations and other laws.

Response
DOE and its contractors must comply with all applicable laws and regulations. Section 1.4 in Volume I of the WM PEIS provides a description of consultations, laws, and requirements that apply to DOE's Waste Management Program. DOE encourages the public to stay informed about environmental laws and regulations, and to report incidents of noncompliance with the law to the appropriate authorities.

Comment (2297)
Any facility or process DOE chooses to store, treat, process, or dispose of waste must comply with all existing Federal, State, and local laws. DOE should not wait for laws to be changed by the new Congress. DOE must also honor Tribal rights guaranteed by treaty.

Response
DOE must comply with all applicable treaties, Federal, State, and local laws and regulations related to the WM PEIS waste management decisions. The WM PEIS considers the legal requirements as they now exist; projecting possible changes to the law would be speculative. Section 1.4 in Volume I of the WM PEIS, Consultations, Laws, and Requirements, provides a more detailed description of the Federal laws with which DOE must comply. In addition to the Federal laws, DOE must also comply with applicable State and local laws and ordinances. DOE has revised Section 1.4 to more clearly acknowledge DOE's obligation to honor Tribal rights. Local governments generally have the greatest control over real property, zoning, emergency response, and other local matters. Some of the local requirements are not applicable to DOE's operations; however, this determination must be made on a case-by-case basis.

DOE agrees that it is inappropriate to delay needed programmatic waste management decisions based on speculation concerning future legislation.

Comment (2331)
It is not clear what authority issues the permits (Tennessee, NRC, EPA, etc.), on what basis permits are approved, and what independent oversight of performance is in place at Oak Ridge National Laboratory (ORNL).

Response
The WM PEIS, which is intended to help DOE make broad programmatic waste management decisions, does not analyze the jurisdictions and functions of each authority that administers environmental laws or that issues permits. Any permit for ORNL would be approved based on the applicable regulations for that site.

DOE is aware that Tennessee is an "Agreement State" for purposes of accepting delegations of authority from NRC under the Atomic Energy Act. Tennessee is also an "Authorized State," meaning it has authority to administer its hazardous waste laws, which are at least as stringent as the Federal regulations. Both NRC and EPA retain some regulatory oversight authorities over Tennessee's enforcement of the Atomic Energy Act and RCRA.

These delegations authorize Tennessee to issue various permits and take other actions that would otherwise be the responsibility of Federal agencies. The authority of NRC over activities of the DOE and its contractors is limited in scope (and, thus, authority delegated from NRC to Tennessee under the Atomic Energy Act is similarly limited). In general, NRC's authority to regulate DOE activities is limited to express statutory grants such as licensing high-level waste repositories under authority of the Nuclear Waste Policy Act, which is not relevant to Tennessee. DOE, under the Atomic Energy Act, is the authorized agency for radioactive material management at DOE facilities. DOE Orders are the means to implement this authority.

The State of Tennessee has broad RCRA authority from EPA over hazardous waste matters. Tennessee has issued permits for treatment, storage, and disposal to DOE for its hazardous and mixed waste management activities at its facilities near the City of Oak Ridge--Y-12, K-25, and ORNL.

In Tennessee, State and local permitting agencies have authority to issue air emission permits pursuant to the Clean Air Act. The State of Tennessee is authorized to issue water discharge permits according to the Clean Water Act. Toxic Substances Control Act authority resides exclusively in EPA.

In addition to licensing and permitting activities of the State government, independent oversight of DOE facilities in Tennessee was facilitated through an agreement in principle that provides funding for that State's oversight of DOE's waste management. Also, a State of Tennessee/DOE Monitoring and Oversight Agreement was signed May 13, 1991, for operations in the ORNL area. This agreement is intended to assure Tennessee citizens that their health, safety, and environment are being protected in ongoing cleanup activities and emergency response efforts, and the agreement is available to the public at the DOE Information Resource Center in Oak Ridge.

The agreements assist DOE in complying with all applicable laws, regulations, and Orders. The State's roles according to the agreements are to (a) establish programs for environmental monitoring,

10.1 Regulatory Compliance

emergency response, and project oversight; and (b) promote a better understanding by the public and local governments of past and present operations at the DOE facilities and their impacts on human health and the environment.

Comment (2438)
In 1993, the State of Idaho, Idaho National Engineering Laboratory (INEL) Oversight Program reviewed DOE low-level waste (LLW) disposal practices at INEL against NRC requirements in 10 CFR 61. While INEL operations were largely in accord with the requirements of DOE Order 5820.2A, those requirements are less stringent than NRC requirements. Plans to upgrade LLW disposal practices at INEL and through the revision of DOE Order 5820.2A have been placed on hold pending DOE's response to Defense Nuclear Facilities Safety Board Recommendation 94-2, which also seeks to upgrade DOE LLW management. This is unacceptable. DOE must begin work immediately to upgrade its disposal of LLW to civilian and international standards at both existing and planned facilities.

Response
Appendix H of the Savannah River Site Waste Management Final EIS (1995) contains a comparison of LLW requirements of DOE Order 5820.2A and NRC regulations in 10 CFR 61. This appendix states that apart from the licensing procedural elements of NRC regulations, the most substantial distinctions between the requirements of NRC and DOE affecting the disposal of low-level radioactive waste are in the specificity of NRC regulations in 10 CFR 61, which are not reflected in DOE Order 5820.2A. To a considerable extent, that is the result of the formal regulatory process prescribed for NRC and its licensees. Additionally, the more general nature of the DOE Order reflects the greater flexibility required to manage the diversity of waste materials and forms which are produced by the wide variety of missions and activities carried out by and for DOE, as well as the broad range of existing DOE site characteristics that are not reflected at likely licensed disposal sites.

Despite these distinctions, the performance objectives specified for the protection of the public and workers from the operation of low-level radioactive waste disposal facilities are essentially identical, and the means specified for demonstrating compliance (i.e., performance assessments) are also essentially identical in approach. Accordingly, there are no substantive differences in the degree of protection afforded public health and safety inherent in the different agency regulations.

DOE is required by existing law (Atomic Energy Act) to regulate its low-level radioactive waste disposal activities. A change in regulatory authority for these activities would constitute a major change in approach, including changes in legislation. Such considerations are beyond the scope of this PEIS.

DOE has established a task force to address Defense Nuclear Facilities Safety Board Recommendation 94-2 and a workgroup to address associated disposal issues, including updating DOE Order 5820.2A. This comment has been forwarded to them for their considerations. As described in Section 1.8.2 in Volume I of the WM PEIS as part of Defense Nuclear Facilities Safety Board Recommendation 94-2, DOE has undertaken a Department-wide review of its LLW management system. The review report and site-specific assessment reports serve as the basis for identifying corrective actions to address safe disposition of past, present, and future volumes of LLW. Each site is responsible for identifying and developing the corrective actions necessary to address the site-specific vulnerabilities identified in their respective site-specific assessment reports. Additionally, the Department-wide vulnerabilities identified

in the Department-wide review report require DOE to identify and develop corrective actions. While the report might include recommendations, the corrective actions will be addressed by DOE management as followup to the review. The final Department-wide review report, available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS, was published April 30, 1996, and will be used in conjunction with the WM PEIS in making decisions about the configuration of waste management activities.

Comment (2548)
Volume II, Page 15, Paragraphs 2 and 3. The last sentence of Paragraph 2 states that an entity exceeding the General Conformity Rule Limits in a nonattainment area must first obtain a permit. That is not true. For the State of Idaho, IDAPA 16.01.01.204 discusses the permit-to-construct requirements for major facilities or major modifications in nonattainment areas. The first sentence of Paragraph 3 states that only new sources are regulated. That is also not true. All sources operating in the State of Idaho are regulated by the State rules and Federal regulations. This statement is also made in Volume I, Page 6-67, Paragraph 2.

Response
DOE has revised Section 1.4 in Volume II of the WM PEIS to indicate that a Federal entity that seeks to engage in an activity that will result in emissions equal to or greater than those limits in a nonattainment area, in addition to obtaining a New Source Review permit, must also conduct a formal conformity determination.

DOE also has revised Section 1.4 in Volume II and Section 6.5 in Volume I of the WM PEIS to clarify that all stationary sources in attainment areas that are emitting pollutants at levels above the regulatory limits are subject to prevention of significant deterioration regulation. In nonattainment areas, new stationary and mobile (e.g., construction equipment) sources are regulated under the General Conformity Rule. Those entities that would exceed emissions limits under the General Conformity Rule must obtain a permit.

Comment (2584)
Draft WM PEIS Summary document, Section 7.2.5. How is centralization at West Valley Demonstration Project (WVDP) inconsistent with the West Valley Demonstration Project Act?

Response
The West Valley Demonstration Project Act (Public Law 96-368), enacted in 1980, authorizes DOE to demonstrate that solidification can be used to prepare high-level waste for disposal at the Western New York Nuclear Service Center near West Valley, New York.

The WM PEIS high-level waste Centralized Alternative involves storage of all high-level waste canisters at a single location. The activities that are allowed at the WVDP are defined in Section 2(a) of the WVDP Act. These activities involve demonstrating solidification techniques that can be used for preparing high-level radioactive waste for disposal. As defined in Section 4(b) of the Act, "high-level radioactive waste" is limited to high-level radioactive waste produced by the reprocessing at WVDP of spent nuclear fuel. Thus, the solidified high-level waste produced at INEL, the Hanford Site, and the Savannah River Site (SRS) would not be high-level radioactive waste within the definition of the WVDP Act because it was not produced by reprocessing of spent nuclear fuel at WVDP. The WVDP Act does not authorize any activities, including storage, of waste from other sites.

10.1 Regulatory Compliance

Comment (2652)
Volume IV, Section E.12.4. Reliance on EPA reference concentration values and U.S. Department of Transportation poison inhalation hazards designations as the *sole* criteria for the selection of chemicals of concern is not a sound practice.

Response
The transportation accident analysis for wastes containing hazardous chemicals evaluated both the potential acute and chronic toxic effects resulting from the releases of these materials. Potentially acutely toxic compounds were assumed to be gases and liquids identified by the U.S. Department of Transportation as poison inhalation hazards and those identified by EPA as inhalation toxicants. Gases and low-boiling point liquids have the greatest potential dispersion following an accident. In addition, chemicals selected for analysis must be characterized for potential toxicity. The chemicals identified by the U.S. Department of Transportation and EPA satisfy these criteria and include most of the compounds of interest for the hazardous and mixed wastes evaluated in the WM PEIS.

Comment (2795)
DOE states that it must obtain permits for disposal facilities either from EPA or from States delegated the authority under RCRA by EPA. The State of New York is in the process of receiving that authority. Therefore, the WM PEIS should be subject to the State of New York expression of RCRA.

Response
DOE must comply with applicable laws. Facility permitting would be subject to the appropriate RCRA permitting authority at the time DOE seeks to locate new facilities. The State of New York has been given full RCRA authority.

Comment (2796)
Prohibitions regarding disposal of hazardous waste and radioactive waste in 6 NYCRR Parts 373 and 374 and 6 NYCRR Parts 382 and 383, respectively, also appear to restrict disposal of radioactive and hazardous wastes at BNL.

Even if DOE was exempt from New York State statutes and regulations pursuant to NY ECL 27-0704 regarding radioactive or hazardous wastes, the Long Island Landfill Law would still preclude disposal of these materials at BNL and BNL would be prohibited from disposing of low-level waste and low-level mixed waste onsite.

Response
NEPA requires Federal agencies to analyze reasonable alternatives to a proposed action, even alternatives that might not comply with all regulatory requirements. DOE will comply with applicable laws in its management of low-level waste and low-level mixed waste at BNL, or any site.

As stated in Section 2.15.2.2 of the WM PEIS Affected Environment Technical Report, BNL has been identified as being over a deep recharge zone for the lower aquifer system. About two-fifths of the recharge from rainfall moves into the deeper aquifers. If DOE were to select BNL to host new waste management facilities, site-specific NEPA reviews would consider this and other issues. While the State of New York does prohibit siting of radioactive disposal sites over the Long Island Aquifer per 6 NYCRR Part 382.22(b)(2), DOE and its contractors are exempt from this regulation, in accordance

with 6 NYCRR Part 380-1.2(e) and (f). BNL is not being considered for hazardous waste disposal, and does not infringe on the requirements of 6 NYCRR Parts 373 and 374.

Comment (2797)
In 1993, New York State, pursuant to ECL Article 57-0101 *et seq.*, created the Long Island Pine Barrens Reserve on Long Island. ECL 57 preserves and protects undeveloped regions of the Deep Recharge zones in order to maintain water quality on Long Island. BNL is located completely within the New York State Central Pine Barrens. In fact, much of BNL is located within the Core Preservation Area of the Central Pine Barrens, in which generally complete preservation is required. New disposal and treatment activities at BNL would be incompatible with the spirit and intent of this law.

Response
BNL is located within an area designated by the Pine Barren Protection Act as "Compatible Growth Area" and "Core Preservation Area." A Compatible Growth Area is that portion of the pine barrens that has been designated to be compatible for limited development. The Core Preservation Area is the area designated to receive greater protection from development.

BNL considers impacts to the pine barrens in all project-level NEPA reviews. Additionally, the Central Pine Barrens Planning Commission is consulted with for many activities at BNL and is given the opportunity to comment on environmental assessments prepared under NEPA. Also, NYSDEC considers the pine barrens during various permit actions. This type of open communication between DOE, BNL, NYSDEC, and the Central Pine Barrens Planning Commission will continue.

Comment (2923)
In the WM PEIS descriptions of low-level wastes ("These wastes are subject to provisions of the Atomic Energy Act"), add the phrase "which allows DOE an exemption from external regulation of these wastes."

Response
DOE has not made the suggested change because the WM PEIS does not specifically identify low-level waste as being subject to the Atomic Energy Act. Rather, it states that DOE must comply with the Atomic Energy Act in managing all of its radioactive waste. The EPA and corresponding State regulatory agencies closely regulate DOE's waste management facilities. Both NRC and EPA regulate radioactive waste disposal; their requirements are very similar. Any DOE radioactive waste disposal facilities will be sited and operated in accordance with all applicable requirements.

In January 1996, the Secretary of Energy's Advisory Committee on External Regulation of Department of Energy Nuclear Safety issued a report, *Improving Regulation of Safety at DOE Nuclear Facilities*, recommending external regulation of DOE facilities and operations. The Secretary created a workgroup, including representatives of other Federal agencies, to review the Advisory Committee recommendations and provide recommendations for implementing external regulation of DOE nuclear safety.

Comment (3152)
The WM PEIS does not provide information needed to meet the legal requirements of the Waste Isolation Pilot Plant (WIPP) Land Withdrawal Act because it fails to describe and analyze various

alternatives for the disposal of all transuranic waste (TRUW) by (1) excluding pre-1970 TRUW, which amounts to 141,100 cubic meters; and (2) not discussing in another NEPA document its proposal for disposal of all TRUW.

Response
The WM PEIS analyzes alternatives for treating and storing post-1970 defense transuranic waste generated after 1970 preparatory to disposal in a geologic repository. These alternatives are not subject to the WIPP Land Withdrawal Act, which is a regulatory framework for TRUW disposal at WIPP. The WM PEIS does not analyze the repository itself nor alternatives for managing environmental restoration waste, which are covered by other programs.

As described in Section 1.8.1 in Volume I of the WM PEIS, which discusses a number of NEPA documents related to this WM PEIS, DOE has already examined alternatives to geologic disposal at WIPP in other NEPA documents. Moreover, the disposal impacts from operating WIPP as a TRUW repository are analyzed in the WIPP SEIS-II.

The WIPP SEIS-II analyzes the potential impacts from disposal of all TRUW, including pre-1970 buried TRUW, which is considered environmental restoration waste. As described in Section 1.7.1 in Volume I of the WM PEIS, alternatives for the management of environmental restoration waste are outside the scope of the WM PEIS. However, the pre-1970 buried TRUW volume is discussed in the revised Appendix B in Volume III of the WM PEIS with regard to whether those environmental restoration waste volumes, for which responsibility could be transferred to the Waste Management Program, could affect the comparison among waste management alternatives. The revised Appendix B contains the most recent updates on TRUW volumes. Appendix B identifies approximately 80,000 cubic meters of environmental restoration TRUW. DOE has revised the discussion of impacts in both Appendix B and Chapter 8 in Volume I of the WM PEIS to reflect the potential effects on WM PEIS alternatives of environmental restoration transferred waste based on the updated environmental restoration volumes. DOE believes that the revised Appendix B addresses the commentor's concern within the constraints of the scope of the WM PEIS.

Comment (3187)
Commercial disposal of low-level mixed waste should be subject to licensure and regulation by the NRC.

Response
By law, commercial disposal of low-level mixed waste must comply with NRC regulations for its radioactive components and with EPA regulations for its hazardous waste components. Under certain circumstances, both NRC and EPA delegate their authority for issuing necessary permits and licenses for waste disposal to the States.

Comment (3694)
The WM PEIS should list U.S. Department of Transportation and NRC transport regulations as part of the list of laws governing implementation of the WM PEIS.

Response
DOE added Section 1.4.4 to Volume I of the WM PEIS to provide a description of hazardous and radioactive materials transportation regulations. As stated in Section 1.4.4, U.S. Department of

10.1 Regulatory Compliance

Transportation, NRC, and EPA regulations may be found in 49 CFR 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Part 262, respectively. The PEIS transportation analysis identifies the governing regulations in various sections of the PEIS; for example, Section 6.2.4 in Volume I and Sections E.3.1 and E.4.1 in Volume IV.

Comment (3784)
DOE needs to review the Illinois-Kentucky Waste Management Compact Act, which states that it is illegal to site an aboveground facility.

Response
In Title II of the *Omnibus Low-Level Radioactive Interstate Compact Consent Act* of Public Law 99-240, Congress gave its consent to the Central Midwest Interstate Low-Level Radioactive Waste Compact entered into by the State of Illinois and the Commonwealth of Kentucky. Article 1 of the Compact states that it is the policy of the party States to enter into the Compact for the purpose of "...(7) ensuring the ecological and economical management of low-level radioactive waste, including the prohibition of shallow land burial of waste; and (8) promoting the use of aboveground facilities and other disposal technologies providing greater and safer confinement than shallow land burial." Thus, it appears that Central Midwest Compact encourages, rather than prohibits, the development of aboveground disposal facilities.

10.2 Site-Specific Agreements and Plans

Comment (1485)
Commentors support the Federal Facility Compliance Act (FFCAct) strategy of identifying separate waste streams and separate treatment by specific expertise. The WM PEIS should recognize the Site Treatment Plans (STPs) as driving the decisions that will be made about low-level mixed waste treatment. The reason given in WM PEIS, Volume I, Section 3.7, for selecting the preferred alternatives for low-level mixed waste treatment is that they closely approximate the STPs. The STP for LLNL, for example, left the door open for taking waste from offsite. Given the relationship between waste management preferred alternatives and STPs, commentors want DOE to know they oppose moving the LLNL Site Treatment Plan forward without adequate public review. Another commentor stated that DOE ignored the Hanford Advisory Board advice, the State FFCAct principles, and the report of the Hanford Future Site Uses Working Group.

Response
As discussed in Section 1.4.1 in Volume I of the WM PEIS, the FFCAct directs DOE to address the treatment of unused waste that DOE generates or stores by preparing STPs. DOE's commitment to the FFCAct is described in Section 1.8.2 in Volume I of the WM PEIS. The Act, which amended RCRA, requires DOE to prepare STPs for the development of capacity and technologies for treating mixed waste to meet RCRA land disposal restrictions and to submit them to the States or EPA for approval. A plan is required for each facility at which DOE stores or generates mixed waste.

DOE followed a three-phased approach for developing the STPs. In October 1993, DOE sites submitted Conceptual Plans to their State/Federal regulating agencies, which identified a broad range of options for treating DOE's mixed waste. Draft plans, submitted in August 1994, presented the individual sites' proposed treatment options for mixed waste. Proposed Plans were submitted in April 1995 to the appropriate regulatory agency for approval, approval with modification, or disapproval, as required by the FFCAct.

DOE worked closely with the regulatory agencies and the public throughout the process. The National Governors' Association coordinated representatives from 20 States and EPA to assist DOE in evaluating candidate treatment options and developing mixed waste treatment plans. The conceptual, draft, and proposed plans were also made available to the public, with additional opportunities provided for information and input on the plans at the site and national levels.

These plans, taken together, establish a Department-wide treatment configuration, including schedules for bringing new treatment facilities into operation.

The approved plans contain the treatment configuration that resulted from discussions among States, EPA, Tribal Governments, and the public, and from DOE's evaluation of its treatment needs. However, the evaluation will continue as the plans are implemented to streamline and improve the configuration. For example, individual sites continue to pursue commercial and privatized treatment options for some waste streams. The Compliance Orders that govern implementation of the STPs all provide for modification and changes as new technical and cost information becomes available. Any changes to the configuration or to schedules will be made through formalized modification processes.

The unused waste treatment alternatives described in the Draft WM PEIS are broad enough to envelop the potential environmental impacts that result from the FFCAct process. The WM PEIS and the FFCAct STPs were developed in parallel to ensure consistency and integration. The preferred

alternative for low-level mixed waste is discussed in Section 3.7 in Volume I of the Final WM PEIS. The WM PEIS provides the NEPA basis for the low-level mixed waste treatment configuration, while the FFCAct STPs detail the low-level mixed waste treatment program.

DOE has not ignored the advice of the Hanford Advisory Board, nor other (sometimes countervailing) recommendations of stakeholders or sources of information identified in the comment. The WM PEIS analysis will not be the only basis for making waste management decisions. Actual programmatic waste management decisions, which will be announced in Records of Decision to be published in the *Federal Register*, will be based on a number of factors and criteria, including this WM PEIS, regulatory compliance, and compliance agreements, including STPs.

Comment (1817)
DOE has yet to clarify existing legal constraints that directly conflict with DOE's self-imposed mission for making the NTS a primary low-level waste disposal site. Specifically, the NTS land withdrawal orders restrict the use of the site to atomic testing activities only.

State officials contend that to legally implement disposal decisions for low-level, low-level mixed, and high-level waste, including spent nuclear fuel, DOE must obtain exclusive jurisdiction over the lands comprising the disposal facilities in Nevada. Of particular interest to Nevada is the requirement that DOE obtain the consent of the Nevada Legislature in order to acquire exclusive jurisdiction.

Response
Disputes regarding possible legal constraints on DOE's ability to site a low-level waste facility at NTS are outside the scope of the WM PEIS EIS. These concerns and positions have been addressed in the NTS Sitewide EIS.

Issues related to land withdrawal for the high-level waste repository are also outside the scope of this PEIS and will be addressed in the Yucca Mountain Repository EIS. DOE spent nuclear fuel decisions are outside the scope of this WM PEIS; they were addressed in the SNF/INEL PEIS.

Comment (1999)
Several commentors commented on the relationship between low-level mixed waste disposal alternatives and Federal Facility Compliance Act (FFCAct) Site Treatment Plans (STPs). One commentor asked DOE to state that the selection of low-level mixed waste disposal alternatives is not determined by FFCAct STPs. Another commentor asked for more detail on the relationship between the FFCAct Workgroup's analysis on low-level mixed waste and the PEIS methodology for selecting and identifying alternatives. Another commentor pointed out that it is important for the Final WM PEIS to recognize that, although there was no requirement for discussion of mixed waste post-treatment disposal in the STPs, many of the Plans did address post-treatment disposal. Post-treatment disposal is a significant issue for the States in which the DOE sites are located. Regionalized disposal was not favored by all States involved. In finalizing the PEIS, DOE should address the disposal agreements resulting from the STPs, associated State consultation requirements, and any related agreements resulting from the FFCAct Mixed Waste STP process. Another commentor indicated that the Mixed Waste STPs were not finalized at the time of PEIS publication. The approved versions should be taken into account, as there are some conflicts between the STPs and the PEIS. Another commentors asked that the PEIS explain the impact of approval of the WM PEIS on current permits and permit applications, and suggested that DOE is not guaranteed the needed permits simply because

10.2 Site-Specific Agreements and Plans

an alternative is selected. Another commentor stated that in selecting preferred alternatives and in preparing the content of the subsequent Records of Decision for establishing a national configuration for disposal facilities for low-level mixed waste and low-level waste, DOE must give careful consideration to the findings and recommendations under development by the FFCAct Disposal Workgroup.

Response
The studies conducted by the Disposal Workgroup and the results of performance assessments, as well as any site-specific analyses, will be considered by the Waste Management Program. Section 1.8.2 in Volume I of the WM PEIS discusses the relationship between the WM PEIS and the FFCAct process, including disposal issues. The WM PEIS alternatives and the FFCAct-required STPs were developed in parallel and were closely coordinated. One of the factors considered in formulating a decision on the future configuration of low-level mixed waste and low-level waste disposal facilities will be the FFCAct recommendations resulting from this process.

As a result of the negotiations with the States on the STPs developed in response to the FFCAct, DOE created the FFCAct Disposal Workgroup to evaluate disposal considerations. Although not specifically addressed as part of the FFCAct, disposal was identified by the States and DOE as an important issue.

The Workgroup consists of DOE representatives and State regulators to evaluate low-level mixed waste disposal issues. Its purpose is to identify, from among the sites currently storing or expected to generate mixed waste, those sites that could be suitable for further evaluation of their disposal capability. This evaluation includes conducting performance assessments involving a detailed technical investigation to better understand a site's potential for disposal and to better identify what types of disposal activities are suitable at a given site.

DOE has identified its preferred waste management alternatives and the reasons they are preferred in Section 3.7 in Volume I of the WM PEIS. Actual programmatic decisions, which will be announced in Records of Decision, will be based on a number of factors and criteria, including this WM PEIS, regulatory requirements, and compliance agreements (including STPs), and the Disposal Workgroup's evaluations.

One factor DOE currently believes it will need to evaluate closely in its disposal decisionmaking is the necessity of limiting the volume and type of radioactive components in wastes disposed of to minimize the potential risks of releases from disposal units.

Section 1.4 in Volume I of the Final WM PEIS includes a description of the relationship between the decisions DOE makes regarding its wastes, and regulatory and permitting requirements and agreements. DOE anticipates that wherever new waste management facilities are sited, after sitewide or project-level NEPA reviews are completed, existing permits would need to be amended or new permits would be required.

Comment (2184)
You ignored the Hanford Advisory Board advice, the State Federal Facility Compliance Act (FFCAct) principles, and the report of the Future Site Use Working Group for Hanford. The Hanford Advisory Board advised that DOE must fully disclose all projected wastes types and quantities that might be shipped to Hanford prior to any consideration by Washington State of treatment, storage, and disposal

permits for mixed waste generated at other facilities. The Advisory Board advice makes it clear that we are not going to accept long-term storage, post- or pre-treatment of other regions' wastes. The Future Site Use Working Group report stated that we are open to the idea of you sending wastes from other sites to Hanford solely for treatment, where it makes sense, but you failed to integrate and disclose the nature of the Site Treatment Plans (STPs) of other DOE sites, and we are going to stop you.

Response
DOE has considered the advice of the Hanford Advisory Board, as well as other (sometimes countervailing) recommendations of stakeholders or sources of information identified in the comment. The WM PEIS analysis will not be the only basis for making waste management decisions; budgets, schedules, stakeholder concerns, national priorities, as well as other DOE studies and recommendations, such as STPs, will be considered in developing the Records of Decision. Preparation of the PEIS was accomplished in parallel with the STP development process. As stated in Section 1.8.2, the Final PEIS preferred alternative for treatment of low-level mixed waste is consistent with the configuration established through the FFCAct process. In addition, DOE has continued discussions with site-specific advisory boards and DOE stakeholders, including State and Tribal Governments.

In addition to the data and analyses contained in the PEIS and other studies and recommendations, DOE will consider both local values and national goals and values as part of the waste management decisionmaking process. The PEIS itself, however, is not the appropriate means for the examination of such values, except as they affect environmental resources, which has been done in the document.

Comment (2426)
Volume I, Section 1.7.3 states that DOE is planning to begin treating the tank-stored high-level waste at the INEL in 2014. According to the recently signed settlement agreement between DOE and the State of Idaho, all high-level waste tank wastes are to be calcined by 2012. The assumptions and schedules that went into this PEIS will need to be reviewed for other possible changes resulting from this agreement.

Response
The WM PEIS assumptions and schedules were evaluated based on the agreement with the State of Idaho. However, 2014 is the date to begin the further treatment of high-level waste that has already been at INEL to obtain a form suitable for disposal in a geologic repository. Therefore, the 2012 calcination date in the 1995 agreement did not necessitate a change in the 2014 treatment date contained in the WM PEIS.

Comment (2634)
Commentors addressed "agreements" regarding the Hanford Site. One commentor pointed out that DOE must fully comply with the Hanford cleanup agreements to protect the communities from radiation exposure. Another commentor stated that the Federal Government is displaying a complete disregard for previous agreements between the Federal Government and Washington State regarding Hanford.

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Response
DOE will comply with applicable laws under which site agreements have been made, and fully intends to continue to comply with Hanford cleanup agreements. DOE appreciates the concern that is shown by those who have commented on various aspects of this WM PEIS. DOE takes its commitments to the States and to other regulators very seriously. Site-specific agreements will be addressed in project-level documents.

Comment (2842)
In the discussion of Site Treatment Plans (STPs) in Volume I, Section 1.7.4, a list of proposed STPs should be provided, together with summaries of DOE's proposed treatment options for each site, so that the STPs can be compared to WM PEIS alternatives to ensure there are no conflicts.

Response
Section 1.8.2 in Volume I of the Final WM PEIS contains a discussion of the relationship of STPs to the WM PEIS and was revised to include a more comprehensive description of the STP process. Individual STPs, as well as a summary of the STPs, may be obtained from DOE's Center for Environmental Management Information and local site reading rooms.

STPs for the various sites are regularly updated. Therefore, no individual WM PEIS alternative identically matches the STPs taken together. DOE would select a hybrid low-level mixed waste alternative that more closely reflects the STPs. This concept is discussed in Volume I, Section 3.4, of the PEIS. Alternatively, there is a possibility that some STPs might be renegotiated based on the evaluations presented in the WM PEIS.

Comment (3195)
The WM PEIS should properly identify how it relates to the Federal Facility Compliance Act (FFCAct) Site Treatment Plans (STPs) and to the performance evaluation of DOE sites for low-level mixed waste disposal.

Response
Section 1.8.2 in Volume I of the WM PEIS describes the relationship of other DOE actions and programs to the WM PEIS, including the FFCAct STPs and the DOE Disposal Workgroup process. Both the FFCAct and Disposal Workgroup processes will be considered along with information contained in the WM PEIS during the development of a low-level mixed waste Record of Decision. Section 6.3.5 in Volume I of the WM PEIS describes the criteria for low-level mixed waste treatment and disposal site selection.

Comment (4058)
Several commentors commented on the relationship between the WM PEIS and the Federal Facility Compliance Act (FFCAct) Site Treatment Plans (STPs). One commentor asked why the Summary document does not list agreements (such as the INEL STP) as posing legal obstacles for the various alternatives. The California Department of Toxic Substances Control finds that regional treatment alternatives (DOE's preference for low-level mixed waste treatment) are inconsistent with treatment alternatives set forth in the STPs. For example, if DOE decides to use LLNL as an offsite regional treatment center, DOE will have to seek and obtain approval from the California Department of Toxic Substances Control for revisions to all approved STPs. Another commentor characterized the FFCAct

as being in great danger and asked that DOE assure the public that it is committed to cleanup and supports its previous commitments.

Response
The WM PEIS Summary document provides an overview and highlights the basic content of the WM PEIS. More detailed information is contained in the main document. Section 1.4 in Volume I of the WM PEIS identifies and summarizes major laws that might apply to the programmatic alternatives, including the FFCAct.

NEPA requires Federal agencies to evaluate reasonable alternatives, even those that are inconsistent with the STPs. DOE believes the WM PEIS does provide a sufficiently adequate basis on which to make informed programmatic decisions. The WM PEIS and the FFCAct STPs were developed in parallel. However, to achieve consistency and integration, some STPs might require modification (with State approval) and hybrid alternatives (see Volume I, Section 3.3) might need to be selected. There are still disagreements between State regulators and DOE regarding three STPs, including LLNL's. Accordingly, Section 2.3, in the Summary document and Section 1.8.2 in Volume I note that negotiations are underway with a few regulatory authorities regarding DOE's proposed STPs, and that the DOE preference for low-level mixed waste treatment could be affected by these negotiations.

As discussed in Section 1.8.2 in Volume I of the WM PEIS, the FFCAct directs DOE to address the treatment of mixed wastes that DOE generates or stores by requiring the development and submission of STPs to the appropriate Federal and/or State environmental regulatory agency. DOE worked closely with the regulatory agencies in the development of the STPs. Public meetings were held on the STPs. The STPs have all been submitted to the appropriate State authorities, and reflect DOE's commitment to properly managing its low-level mixed waste.

However, the WM PEIS considered other non-FFCAct aspects of the actions that would be required to implement treatment of low-level mixed waste. These aspects include the risks of transporting and handling these wastes, and the likely impacts of ultimate disposal of treated low-level mixed waste. NEPA requires that DOE consider a broad range of alternatives and to analyze the likely environmental impacts associated with those alternatives.

DOE identifies its preferred alternatives and the reasons they are preferred in Section 3.7 in Volume I of the WM PEIS. Actual programmatic waste management decisions, which will be announced in Records of Decision, will be based on a number of factors and criteria, including this WM PEIS, regulatory compliance, and compliance agreements including the STPs.

Comment (4466)
The pertinent details of Site Treatment Plans published in 1995 for hazardous waste and mixed waste should be incorporated into the No Action Alternative for hazardous waste in the WM PEIS. Other alternatives could include contracts with specific transporters and treatment, storage, and disposal facilities, environmental auditing of such contractors for large waste volumes, and the use of brokers for small waste quantities.

Response
The WM PEIS and the FFCAct Site Treatment Plans were developed in parallel and were coordinated. Under the WM PEIS No Action Alternative, hazardous waste that is currently being treated onsite at

10.2 Site-Specific Agreements and Plans

DOE facilities would continue to be treated onsite, and other hazardous waste would continue to be treated and disposed of offsite at commercial facilities.

DOE will not make decisions on the use of brokers from the analyses in the WM PEIS. DOE will make implementation decisions on contract specifications, inspection and enforcement procedures, or the use of brokers for small waste quantities, as suggested by the commentor, following the issuance of WM PEIS Records of Decision.

10.3 Tribal Treaties and Trusts

Comment (1643)
Some commentors expressed objections to nuclear testing, potential waste disposal, and other related activities being proposed or undertaken by DOE in Nevada, citing (1) the Western Shoshone National Council resolution designating their territory as a nuclear-free zone, and (2) the Ruby Valley litigation. DOE's activities are viewed as being contrary to the principles and interests of the Western Shoshone Government and in violation of the conditions of existing treaties.

Response
NEPA requires Federal agencies to analyze reasonable alternatives, even those that may not comply with existing requirements.

DOE understands that the Western Shoshone have disputed the U.S. Government's ownership of lands at NTS and Yucca Mountain. In 1863, the Ruby Valley Treaty was concluded between the United States and the Western Bands of the Shoshone Indians. In effect, the treaty ceded the NTS and surrounding area to the U.S. Government. In 1951, the Shoshone sought compensation and were awarded $26 million by the Indian Claims Commission, under the Indian Claims Commission Act. The money was deposited for the Tribe in an interest-bearing account in the U.S. Treasury.

The Ruby Valley Treaty has been subject to court actions on several occasions, but the U.S. Supreme Court has upheld the Treaty. The U.S. Government (here, DOE) must abide by the current Supreme Court ruling on this issue and will consider potential environmental impacts in the area in making its decisions. DOE is aware that there is significant disagreement with the rulings, especially by the Western Shoshone, and that there are likely to be additional challenges and appeals. DOE will abide by any new rulings made on this subject.

DOE seeks input from native peoples through the NEPA process and has instituted and follows the DOE American Indian Policy, as well as regulations under the American Indian Religious Freedom Act, the National Historic Preservation Act, the Native American Graves Protection and Repatriation Act, and Executive Order 13007 regarding sacred sites. For the WM PEIS, scoping meetings were held for stakeholders to discuss and influence the course of the project prior to document preparation. Prior to document preparation, a Notice of Intent was published in the *Federal Register*. All Federally recognized Tribes were sent a copy of the Notice of Intent, a notification of the scoping meetings, and a copy of the Implementation Plan. After the Draft PEIS was issued, public hearings were held, and Federally recognized Tribes received advance notice of these hearings.

Comment (3315)
We call your attention to some specific issues that your government must become responsible for and involved in correcting:

- Nation to Nation relations, sovereignty and treaty violations;
- Political, civil, social, economic, cultural issues of minimization, degradation and devastation;
- Cooperative processes and understandings;
- Cumulative radiological risk to identify exposure from past, present activities;
- Health and well-being issues;
- Analysis of cumulative radiological impacts at NTS;
- Global radioactive risks of U.S. nuclear activities at NTS;
- Radiation doses to our citizens and travelers enroute;

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- Obstruction and complications resulting from the illegal application of U.S. legislation in our country;
- Environmental restoration and waste management;
- Historical and prehistoric archaeological sites;
- Air, water, and land quality concerns and impacts and effects;
- Monitoring and measurement plans, compensation and mitigation for victims and illnesses;
- Socioeconomic effects of employment, procurement, economy, tourism, property values;
- Risk perception and stigma;
- Sociocultural effects including political controversy, quality of life and risk perception;
- Transportation related to all aspects of environmental restoration and waste management;
- Costs related to all of the aforementioned issues.

Response
DOE recognizes that consultation requirements with Tribal Governments under NEPA and other Federal statutes exist, and that a unique government-to-government relationship exists between the U.S. Government and Tribal Governments. This relationship is detailed in DOE's American Indian Policy. DOE added Section 1.4.5 to Volume I of the WM PEIS to identify and discuss DOE's consultation obligations with other agencies and Native American Tribes.

The WM PEIS analysis focuses mainly on alternatives to address national-level waste management issues. Site-specific NEPA reviews will more fully explore implementation proposals at specific sites. During such analyses, local DOE offices will continue to work with Tribal representatives, as well as other agencies and members of the public, to identify and address issues of concern.

DOE offices have agreements in place with Tribal Governments about a range of environmental issues. The sites' Tribal contacts will assist in the consultation process for site-specific and transportation issues related to implementing programmatic waste management decisions, as they do now on other similar programs.

Other issues such as political, civil and social issues, cooperative processes, (non-waste) nuclear activities at NTS, application of U.S. legislation, risk perception and stigma, controversy, and quality of life, which are not direct or indirect effects of waste management on the environment are outside the scope and, therefore, not analyzed in the WM PEIS. Site-specific issues such as historical and prehistoric archaeological sites and monitoring and mitigation of site-specific or facility-specific impacts will be analyzed for sitewide and project-level proposals that result from WM PEIS decisions.

Comment (4009)
Although considerations of population density, arid land, and the ready availability of Federal lands appear to have been determining factors in siting DOE facilities, and appear to be benign, they also work to discriminate against Indian Reservation communities because, as a result of the historic U.S. policies toward Indian Tribes, reservations are almost always located in these areas. The Hanford and INEL facilities are sited adjacent to Indian Reservations because of the Tribes' lack of political clout.

Response
DOE policy recognizes the sovereignty of Native American Tribal Governments, and the unique government-to-government relationship with the Tribal Governments as defined by history, treaties, statutes, court decisions, and the U.S. Constitution. DOE recognizes that it must consider the treaty

rights of Native American Tribal Governments and the Federal Government's trust responsibility toward them when making decisions.

DOE policy requires the agency to consult with Tribal Governments to assure that Tribal rights and interests are considered; that the potential impacts of proposed DOE actions on cultural or religious resources are disclosed; and that any unnecessary interference with traditional religious practices is avoided. DOE is committed to incorporating this policy into its ongoing and long-term planning and management processes, including the NEPA process, and has worked through its site representatives to notify the Tribes of the WM PEIS scope and availability for comment. The Final WM PEIS has been revised to include a general discussion of the relationship of the PEIS to these Tribal agreements and regulations.

The WM PEIS analysis focuses on alternatives addressing national waste management issues. The individual character of Native American cultures at DOE sites, and the specialized nature of each Tribe's concerns in site activities, while considered in the WM PEIS at the programmatic level, is more productive as part of a site-level analysis.

For example, the WM PEIS classifies Native Americans as minority populations for numerical purposes only to describe the demographic characteristics of the regions surrounding the DOE sites. This is not intended to undermine the unique government-to-government relationship or the Federal Government trust responsibility. Site-specific NEPA reviews will more fully explore specific concerns related to Native American issues, such as the protection of sacred lands, cultural properties, and Tribal and religious practices. During these reviews, local DOE officials will continue to work with Tribal representatives to hear their concerns regarding the need for and location of any necessary facilities and related activities, such as transportation requirements, and to consider specific Tribal values, potential environmental impacts, and appropriate mitigative measures. Some DOE Operations Offices (e.g., Richland, Idaho, and Albuquerque) have cooperative agreements in place with Tribal Governments about a range of environmental issues, and the sites' Tribal contacts will assist in the consultation process for site-specific and transportation issues related to implementing WM PEIS decisions.

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11. WM PEIS

Comment (24)
Commentors state that errors and omissions in the Draft WM PEIS distort the "waste picture" and might distort the analysis of alternatives. [These commentors did not identify errors and omissions.]

Response
DOE evaluated all comments concerning errors and omissions and revised the WM PEIS as appropriate.

Comment (531)
Some commentors expressed approval of the WM PEIS. One commentor commended DOE for producing the WM PEIS, and stated that it is technically sufficient and consistent to make programmatic and site-specific decisions. Another commentor thanked DOE for a very comprehensive PEIS and for including operating and maintenance costs, and stated that this demonstrates continuing commitment to this project.

Response
DOE's intent was to make this document the best study possible and appreciates support from the public in this process. DOE believes the WM PEIS is technically sufficient to make programmatic waste management decisions. Site-specific decisions would be made based on site-specific NEPA reviews and other studies.

Comment (1113)
The WM PEIS does not meet the requirements of the NEPA for an adequate EIS because it does not fully consider all wastes and impacts to sites and regions, including cumulative impacts, such as those at Fernald Environmental Management Project (FEMP) and other sites. The WM PEIS should be driven by environmental impacts and not just by political decisions on types of materials.

Response
The WM PEIS is a national study that provides environmental input into broad Department-wide management decisions to be made by DOE. The PEIS analyzes on a broad, programmatic level, potential human health risks, and air quality, water resources, ecological resources, economic, social, environmental justice, land use, infrastructure, cultural resources, and cost impacts. The analysis methodology is presented in Chapter 5 in Volume I of the WM PEIS, and the waste-type analyses are provided in Chapters 6 through 10 in Volume I. In addition, Chapter 11 in Volume I of the WM PEIS contains information on cumulative impacts at each of the 17 "major" sites, and Volume II of the WM PEIS presents Site Data Tables for a variety of impact parameters.

Because of its programmatic character, the WM PEIS does not evaluate detailed site- or project-level impacts for particular sites such as FEMP. The WM PEIS does not identify locations for waste management facilities on sites or select technologies for use at the sites. Sitewide and project-level NEPA reviews would analyze specific locations of waste management facilities and technologies. DOE programmatic decisions will be based, in part, on the environmental impacts identified in the WM PEIS and on other criteria such as cost and equity (see Volume I, Section 1.8, for a complete discussion of these criteria).

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Comment (1114)
The WM PEIS should include the complete impacts of carrying out all the alternatives, including No Action.

Response
When there is a very large number of potential alternatives, a reasonable number of alternatives covering the full spectrum of alternatives may be analyzed and compared in an EIS. DOE believes that the alternatives analyzed in the WM PEIS provide a reasonable number of examples of treatment, storage, and disposal configurations to cover the full spectrum of alternatives for making programmatic selections of sites to manage the five types of waste considered in the PEIS. Chapters 6, 7, 8, 9, and 10 in Volume I of the WM PEIS evaluate environmental, human health, and socioeconomic impacts at the programmatic level for all the alternatives, including the No Action Alternative, for managing low-level mixed, low-level, transuranic, high-level, and hazardous wastes, respectively. Chapter 11 in Volume I of the WM PEIS provides the cumulative impacts analysis.

Comment (1773)
The WM PEIS is too generic for States to be able to evaluate proposed alternatives as they relate to their individual programs.

Response
DOE believes that this PEIS is an important tool for making decisions on the future configuration of its waste management activities. The implementation of alternatives analyzed in this document will be based, in part, on site-specific NEPA reviews that identify precise locations, capacities, and facility designs at DOE sites. Each of these studies will address applicable State regulations and offer opportunities for public participation and comment.

Further, this WM PEIS addresses such impact parameters as human health risks, air quality, water resources, ecological resources, and population at each site. DOE believes, therefore, that the PEIS is technically sufficient to serve as the basis for its programmatic waste management decisions and to link to sitewide and project-level NEPA analyses.

Because it is a programmatic study that will not provide direct input to decisions on the locations of facilities at the sites, the PEIS does not evaluate some site-specific environmental impacts. In addition, DOE will not use the PEIS to select final waste management technologies for the sites. Again, DOE will base such decisions on more specific studies.

Comment (2127)
A commentor concerned about Brookhaven National Laboratory (BNL) believes Table 1.3-1 and page 8 of the WM PEIS Summary document should read "and/or host disposal facilities sites" in lieu of defining "major" candidate sites as those that will receive waste generated from offsite, because such lack of definitional clarity could cloud the issues, get people upset, and open the door for accepting wastes.

Volume I, Section 4.2.1, of the Draft WM PEIS states that major sites are those which "...are candidates to receive wastes generated offsite, to host major disposal facilities or manage high-level waste." At an Interactive Video Teleconference sponsored by DOE at BNL on November 21, 1995, the DOE representative present stated emphatically that BNL would not receive any offsite waste and

that the preferred alternative for BNL entailed transporting BNL-generated waste off the BNL site. Therefore, the statement noted above is misleading because it contradicts what was stated by DOE at the teleconference, i.e., that BNL would not receive any offsite waste and would not become a major disposal facility.

Response
DOE has made the requested changes in fulfillment of a commitment made at the BNL public hearing on November 21, 1995. Footnote "a" of Table 1.4-1 (formerly Table 1.3-1) of the WM PEIS Summary document provides a clarified definition of "major" sites and footnote "c" has been added to Table 1.4-1 to state that although this site is designated as a major site, none of the alternatives would result in wastes being received from offsite for treatment or disposal. BNL is one of the sites to which this footnote applies. Accordingly, under the WM PEIS analysis, BNL would manage only its own low-level mixed waste and low-level waste. BNL would dispose of such wastes only under the Decentralized Alternative. It would not dispose of any wastes from other sites.

Comment (2206)
The WM PEIS is confusing. It was not written very thoroughly, and there are so many loopholes in it, I am not sure it is legal.

Response
DOE believes that the WM PEIS meets the requirements of NEPA and the CEQ implementing regulations. Section 1.7.1 in Volume I describes the changes DOE made to the Draft PEIS in its preparation of the final document. Because of the complexity of the waste management decisions and the degree of public interest during the scoping activities, DOE believes the detailed impacts evaluation and discussion in the PEIS are warranted, and that the PEIS is sufficient to serve as the basis for its programmatic waste management decisions. The WM PEIS attempts to reach a range of readers with different levels of review interest and technical knowledge. The Summary document is intended for readers interested in a quick and concise overview of the essential content of the document. The necessary details of the PEIS analysis are presented in Volume I of the PEIS with Volumes II, III, and IV presenting technical data and appendices supporting Volume I. Additional details are included in supporting technical reports that are available in the DOE public reading rooms listed in Section 1.9 in Volume I.

Comment (2222)
Why did DOE prepare this PEIS? Might it have been influenced by litigation brought against DOE?

Response
On June 27, 1989, the Natural Resources Defense Council and 21 other citizens groups filed suit to compel DOE to prepare a programmatic environmental impact statement on proposals for the cleanup and modernization of the nuclear weapons complex. As a consequence, on January 12, 1990, the Secretary of Energy decided to prepare two programmatic EISs, one on the modernization of the nuclear weapons complex and the other on environmental restoration and waste management. This PEIS is the latter. See Volume I, Section 1.7.1, for an explanation of the subsequent change in the scope of the WM PEIS.

11. WM PEIS

Comment (2288)
The PEIS is based on assumptions, for example, that vitrification is going to be a wonderful solution to things, even though vitrification has never been tried in this country successfully. Thus, the PEIS has no basis in reality.

Response
DOE has begun to vitrify high-level waste at two DOE sites. The Defense Waste Processing Facility at the Savannah River Site (SRS) began full-scale operations on March 12, 1996, after an extensive review and operational readiness process. This facility uses a proven vitrification process to immobilize high-level radioactive materials within a glass-like matrix that is then encased in stainless-steel canisters, which are placed in interim storage at SRS. The West Valley Demonstration Project (WVDP) began vitrifying high-level waste on July 2, 1996.

DOE has based its analyses in the WM PEIS on accepted and proven scientific and technical methodologies. The assumptions made for the WM PEIS analysis are described throughout the document. DOE believes these assumptions were necessary to compare impacts consistently across all of the DOE sites considered in the PEIS. The WM PEIS analytical methods and assumptions selected for high-level waste are described in Sections 9.1.1 and 9.2 in Volume I of the WM PEIS.

Comment (3023)
The WM PEIS assumption that new facilities will be built appears overly optimistic in light of current funding. DOE is in the process of transitioning older facilities that could prove useful, but that currently have no foreseen mission. The WM PEIS should be revised to reflect present budgetary constraints on site infrastructure and present options for using existing facilities. DOE needs to develop a 5- to 10-year rolling strategic plan to make more efficient use of existing facilities and new construction.

Response
As described in Sections 6.1.3, 7.1.3, 8.1.3, and 9.1.3 in Volume I of the WM PEIS, DOE identified existing capacities for the treatment and disposal of specific waste types at major sites to establish a baseline and to help determine under which WM PEIS alternatives new or expanded facilities are needed. Some facilities that are not currently operating were considered, for the analysis, to be in existence based on the assumption that they could become operational if required. Planned facilities include only those facilities for which a conceptual design has been completed. Analysis in the WM PEIS assumes use of existing and planned waste management facilities until their capacities are met. If additional capacity is needed under certain alternatives, use of new facilities is assumed.

DOE would attempt to minimize cost and schedule impacts of new construction by redeploying existing non-waste management facilities for necessary waste management functions. Such redeployments, while not practical to consider in programmatic documents like the WM PEIS, will be considered in site-level planning documents. Assuming that new facilities would be required ensures that the impacts analysis is conservative (by overestimating impacts from, for example, construction) and would include the impacts from implementation of the alternative. Section C.3.2 in Volume III of the WM PEIS describes the cost estimating approach that tied the cost of facilities and transportation to waste quantities. Section C.3.2.2.3 in Volume III describes the existing facilities assessment cost estimating process used where existing capacities were identified. Where facilities exist, their capacities were

taken into account, and the total required capacity was reduced by that amount so only the minimum necessary new facility construction was costed.

As stated in Section 1.2 in the Summary document and Section 1.8.2 in Volume I of the WM PEIS, DOE is moving forward with the Ten Year Plan vision. This strategy would result in addressing most of DOE's cleanup and waste management challenges on accelerated schedules and within existing budgets. The Ten Year Plan will be used when considering the budget decisions, sequencing of projects, and actions taken to meet program objectives. DOE will implement this vision in collaboration with regulators and the public. Costs under the Ten Year Plan would be less than the costs reported in the WM PEIS because use of existing infrastructure and commercial vendors would need to be optimized to meet accelerated schedules.

Comment (3035)
The WM PEIS is not adequate to support the "assignment of sites for the coordinated implementation of each strategy" (Volume I, Section 1.8).

Response
DOE believes that the WM PEIS meets the requirements of NEPA and the CEQ implementing regulations for a programmatic EIS. DOE recognizes that other information, in addition to the WM PEIS, would be used to make programmatic decisions, which will be published in Records of Decision. In addition to the environmental analyses and the preferred alternatives identified in the Final PEIS, DOE will consider budgets, schedules, national priorities, and other factors in reaching its decisions.

Comment (3228)
What will happen with the radioactive waste throughout the DOE nuclear weapons complex is a serious matter that affects the Rocky Flats Environmental Technology Site (RFETS) and the citizens of Colorado. National agreement and local actions will be needed to achieve needed solutions to this problem. The WM PEIS does not provide the framework needed to solve this problem.

Response
The WM PEIS is a national decisionmaking tool to assist DOE in its strategy to address actions related to its waste management activities, including wastes from nuclear weapons activities at RFETS. The PEIS analyzes alternative configurations for the management of its radioactive and hazardous wastes. DOE believes this PEIS will help with long-term planning efforts and be the basis for future decisions concerning the configuration of DOE's waste treatment, storage, and disposal activities. No single analysis can provide a complete solution for this large and complex problem.

Public participation is an important component of DOE's effort to obtain national agreement and local action to achieve solutions to waste management problems. DOE currently has a variety of public outreach programs in place to facilitate public participation at both the national and local levels. Specifically in conjunction with the WM PEIS, DOE held 23 scoping meetings, 6 regional workshops on the PEIS Implementation Plan, and 2 public workshops on the risk assessment methodology; published 3 newsletters and 20 fact sheets; produced 2 videos; provided periodic briefings for the Environmental Management Advisory Board and several site-specific advisory boards; and most recently, conducted 13 public hearings and provided a 150-day public comment period for the Draft PEIS. These and other outreach activities are described in Volume I, Section 1.7.2, of the Final PEIS.

11. WM PEIS

DOE plans to use the input it received during the public comment period on the Draft WM PEIS in developing its final decisions.

Public input will also be solicited during the preparation of sitewide or project-level NEPA reviews that will be prepared to implement the selected waste management alternatives.

Comment (3336)
The document is a vague overview that does not address site-specific issues.

Response
The purpose of the WM PEIS is to develop broad programmatic alternatives for the safe and efficient management of DOE's radioactive and hazardous waste. Although DOE intends to identify a configuration, that is, select sites for waste management activities, it will take a closer look (including site-specific design, locations of waste, operating parameters for new facilities, and site-specific impacts) in site-specific NEPA reviews. In other words, DOE will look at the big picture first and then take a closer look at specific details. The relationship of different levels of NEPA reviews to the WM PEIS is described in Section 1.8.1 in Volume I of the WM PEIS.

Certain environmental impacts caused by particular types of actions are inherently specific to a location, that is, the effects of an action such as construction of a waste treatment facility on a particular aspect of the environment could be significant when the action occurs at one location, but could diminish rapidly at a distance and might be readily mitigated or eliminated if the action is relocated. These effects include impacts on geology and soils, noise and aesthetic, and cultural resources impacts, impacts on sensitive species and habitats, environmental justice, and impacts on offsite land use. Because the specific locations of the waste management facilities on sites are not being proposed at this time, these impacts cannot be assessed fully in this programmatic analysis. Although a number of these site-specific impacts are identified and discussed in this PEIS in Chapters 6 through 10, they can be analyzed fully only in sitewide or project-level NEPA reviews. DOE anticipates that, in most cases, any potentially significant impacts can be reduced or eliminated by alteration of a proposed facility location or other mitigation measures.

Comment (3341)
The WM PEIS is inadequate because it does not analyze long-term costs or risks. The realities of nuclear waste extend many generations into the future, not just 70 years.

Response
The WM PEIS uses different time frames depending on the subject of analysis. For action alternatives, the costs evaluated were life-cycle costs of facilities plus transportation costs. Facility costs include the cost of planning, design, construction, operations and maintenance, and decontamination and decommissioning. The total costs of each alternative include the sum of treatment, storage, disposal, and transportation costs, and in some instances, any special costs. For purposes of analysis, the following assumptions were made regarding the construction and operation of the waste management facilities: The facilities were assumed to be built over a 10-year period and operate over a 10-year period to treat and/or dispose of wastes generated within a total 20-year period.

The No Action Alternatives addressed costs associated with a full 20-year operations (i.e., storage) phase (i.e., within a total construction phase not applicable). The site-specific operational periods for

high-level waste storage facilities addressed costs associated with various lengths of storage, which are discussed in Chapter 9 in Volume I of the WM PEIS. In both instances, costs would substantially increase if DOE decides to store the waste indefinitely.

In the human health risk analysis, for example, different populations and individuals at risk were analyzed. Risks to the offsite and onsite populations were estimated for 70 years (the lifetime of a person living during the period when treatment and storage activities occur). A hypothetical intruder scenario analyzes two different time frames (100 and 300 years after closure of the disposal facility) and a hypothetical farm family analysis evaluates 143 lifetimes, each assumed to be of 70 years duration, thus covering a period of 10,000 years. Further details are provided in Chapter 5 in Volume I and Appendix D in Volume III of the WM PEIS.

Comment (3661)
Regarding population impacts, DOE has disregarded the full impacts of its activities on Native Peoples and has falsely minimized the impacts of DOE sites on poor communities who cannot leave due to financial hardships.

Response
DOE's site and waste management strategies are being developed to minimize the health and environmental effects from potential releases across the complex. The WM PEIS compares waste management alternatives on the basis of added risk from proposed waste management operations. The exposure pathways that were examined used conservative assumptions that include the potential for ingestion of radioactivity.

In developing the WM PEIS strategies, potential environmental justice concerns were identified and analyzed. For the WM PEIS, DOE mapped the minority, low-income, and Native American communities within an 80-kilometer (50-mile) radius of each of the 17 sites that were evaluated for waste management activities. These maps are located in Appendix C in Volume III of the WM PEIS. Section 5.4.7.2.1 in Volume I of the WM PEIS and Appendix C also contain information on the mapping and minority population identification procedures. The results of the environmental justice analysis are presented in Sections 6.10.1, 7.10.1, 8.10.1, 9.10.1, and 10.10.1 in Volume I of the WM PEIS.

DOE is aware of the impacts, including those on Native American cultures, that DOE's activities have made on the surrounding environment. DOE also recognizes that it must not only consider the interests of Native American groups and their Tribal lands, but also of individual Native Americans who are minority members of the community surrounding DOE sites. The results of the WM PEIS assessment indicate that DOE should have sufficient flexibility in locating proposed facilities on sites to avoid disproportionately affecting minority or Native American interests near the sites. For any of the waste management alternatives to be implemented, sitewide or project-level NEPA reviews will analyze any potential impacts on Native American Tribal cultures at the site-specific level.

DOE is committed to continuing to address the concerns and interests of stakeholders at the DOE sites in all its decisionmaking. DOE seeks input from native peoples through the NEPA process and has instituted and follows the DOE American Indian Policy, the American Indian Religious Freedom Act, the National Historic Preservation Act, the Native American Graves Protection and Repatriation Act, and Executive Order 13007 regarding sacred sites, as well as any separate agreements that have been

made with particular Native American Tribes. For the WM PEIS, extensive scoping meetings were held for stakeholders to discuss and influence the course of the project prior to document preparation. All Native American Tribes were sent a copy of the Notice of Intent to prepare the PEIS and a notification of the scoping meetings. After the Draft PEIS was issued, another extensive series of public hearings was held, and Native American Tribes received invitations to comment. DOE Field Offices routinely consult with interested Tribal Governments on DOE activities and plans. These consultations have included briefings on the development of the WM PEIS.

Comment (3677)
Section 9.1 is completely inadequate. DOE's evaluation of the management of high-level waste must be completely re-done.

Response
DOE believes that Section 9.1 in Volume I of the WM PEIS provides useful background information relating to high-level waste management. The WM PEIS analyzes only the impacts of storing vitrified high-level waste. It does not evaluate alternatives for treatment or disposal of high-level waste. DOE must decide where to store vitrified high-level waste canisters prior to the availability of a geologic repository, since the decision to immobilize the high-level waste before transporting it was made in the early 1980s. The evaluation of high-level waste storage alternatives contained in the WM PEIS is adequate and appropriate for a programmatic EIS. In response to public comments, DOE has made some changes and corrections to the high-level waste analysis. These changes are reflected in the Final WM PEIS.

Comment (4032)
DOE's effort to develop a programmatic waste management EIS has cost taxpayers $56 million. However, the PEIS does not consider many major foreseeable impacts. DOE should reissue a PEIS that fully addresses all foreseeable impacts. DOE should place a moratorium on privatization until a credible EIS is issued and adequate time is provided for public comment and agency response.

Response
In addition to this WM PEIS, DOE funded a number of long-term planning efforts necessary to evaluate and improve DOE's Waste Management Program. The cost of these ancillary efforts (e.g., development of cost-estimating models and the Baseline Environmental Management Report to Congress have created misunderstandings about the actual cost of preparing the WM PEIS. The total cost for preparing the WM PEIS--from project initiation in 1990 to publication of the Final PEIS--was approximately $31 million. DOE firmly believes that the development of this WM PEIS is the necessary first step in the development of its comprehensive waste management strategy and that the benefits of the study warrant the expense.

DOE does not agree that it is necessary to revise and reissue the PEIS as a draft. DOE believes that the WM PEIS includes the major foreseeable impacts of the programmatic alternatives. The WM PEIS analysis evaluates human health risks, impacts to air quality, water resources, ecological resources, economic, social, environmental justice, land use, infrastructure, cultural resources, and cost impacts. Chapter 5 in Volume I of the WM PEIS describes the analysis methodologies. Chapters 6 through 10 in Volume I contain the analyses for the five waste types, and Chapter 11 in Volume I describes cumulative impacts.

Section 1.7.4 in Volume I has been added to discuss the issue of waste management privatization at DOE sites. The new language describes the potential for privatization of waste management activities, as long as they comply with applicable laws and other requirements, and qualitatively addresses the potential costs and environmental impacts of privatization. DOE does not believe a moratorium on privatization is necessary.

Comment (4052)
The Draft WM PEIS does not reflect DOE's apparently serious effort to formulate a national priority-setting policy through various panels and committees.

Response
The purpose of NEPA evaluations is to analyze impacts of proposed actions and alternatives, not to set priorities. The WM PEIS does reflect DOE's efforts to formulate national policies through various panels, committees, and study groups. Section 1.4.5 in Volume I of the WM PEIS describes consultations with other agencies, organizations, and Native American Tribes. This includes a description of consultations with the Environmental Management Advisory Board and Site-Specific Advisory Boards. In addition, Section 1.8.2 in Volume I describes related DOE actions and programs including the low-level mixed waste management DOE Disposal Workgroup, the nuclear material and waste dialogue team, and future-use project.

DOE will also consider budgets, schedules, national priorities, other studies, and the recommendations of advisory bodies such as the Environmental Management Advisory Board. DOE intends to integrate these various decision tools, including the WM PEIS, in the Record of Decision process. The various panels and committees have had the opportunity to comment on the Draft PEIS. Discussions with these panels and committees will also occur after publication of the Final PEIS.

Comment (4410)
There is no evidence of interagency consultation and cooperation in drafting the WM PEIS. In particular, because of its regulatory role at all DOE sites, EPA's early involvement is essential. The WM PEIS is not and will not be a credible document unless interagency consultation and cooperation is achieved early in the process.

Response
EPA and other agencies were involved in the early stages of drafting the WM PEIS. The WM PEIS Implementation Plan describes the WM PEIS scoping and the extent of EPA involvement in that process. Chapter 5 of the Implementation Plan states that at DOE's invitation, the U.S. Department of Health and Human Services agreed to be a cooperating agency on the PEIS within the scope of the agreement between DOE and the Agency for Toxic Substances and Disease Registry. NRC agreed to participate as a cooperating agency in a limited sense and directed its staff to monitor development of the PEIS technical information base and policy implications. EPA and DOE agreed on roles and responsibilities for technical coordination on issues of mutual concern. EPA helped DOE to define issues and concerns to address in the PEIS and provided information in areas in which EPA has regulatory authority or technical expertise. EPA reviewed the preliminary Draft PEIS, and participated in meetings involving review of the human health risk methodology. A list of consultations with other agencies and individuals is provided in Section 1.4.5 in Volume I of the WM PEIS. The Implementation Plan is available for review in the DOE public reading rooms listed in the Section 1.9 in Volume I.

11.1 Adequacy and Compliance with NEPA

Comment (3654)
The lack of analysis of the transuranic waste No Action Alternative, Regionalized Alternative 1, and Centralized Alternative for environmental restoration transuranic waste is unacceptable and does not meet the requirements of NEPA.

Response
DOE believes that the analysis of impacts for the various transuranic waste alternatives meets the NEPA requirements and CEQ implementing regulations and will provide support on where DOE should treat transuranic waste management. While the analysis of environmental restoration wastes is not within the scope of the WM PEIS, the PEIS does discuss how environmental restoration waste volumes for which responsibility transferred to the Waste Management Program could influence the comparison among waste management alternatives. Appendix B in Volume III of the WM PEIS discusses the potential influence of this transferred environmental restoration transuranic waste on the WM PEIS alternatives.

Comment (4408)
The WM PEIS violates required NEPA alternatives analysis by basing the entire PEIS transuranic waste (TRUW) discussion on the assumption that the future interim storage and/or permanent repository for TRUW will be the Waste Isolation Pilot Plant (WIPP) in New Mexico, despite the fact that WIPP is geologically unfeasible due to water intrusion, in addition to many other licensing problems. As a result, the WM PEIS does not provide a back-up plan if the site does not open, putting human and environmental safety at risk. DOE considered Monitored Retrievable Storage facilities other than WIPP in the Implementation Plan for the EIS for a Multi-Purpose Canister System for Management of Civilian and Naval Spent Nuclear Fuel. Shifting of funding and responsibility for the Multi-Purpose System to the Nuclear Navy does not relieve DOE of the responsibility to consider alternatives and significant impacts it can clearly foresee as alternatives to WIPP.

Response
DOE does not agree with the commentor. DOE believes the WM PEIS meets all NEPA and CEQ requirements. Section 1.5.3 in Volume I states that DOE is currently proposing to dispose of retrievably stored and newly generated TRUW at WIPP. The environmental impacts of developing WIPP were assessed in previous environmental impact statements. The impacts of disposal at WIPP are evaluated in the Draft WIPP SEIS-II, which was released in November 1996. The WM PEIS No Action Alternative evaluates the impacts of the first 20 years of long-term storage of TRUW if the opening of WIPP is delayed. The impacts of storage beyond 20 years are analyzed as part of the No Action Alternatives in the WIPP SEIS-II.

Section 2.2.3 in Volume I states that since 1970, DOE has stored all of its TRUW, including TRUW containing hazardous components that are subject to the Resource Conservation and Recovery Act (RCRA). DOE plans to dispose this retrievably stored TRUW at WIPP if acceptable performance can be demonstrated and regulatory requirements can be met. Several studies are underway to characterize and more fully understand the potential long-term behavior of the disposal of TRUW at WIPP. Based on the results of these studies and independent of the WM PEIS, DOE will determine whether to dispose of TRUW at WIPP and the extent to which TRUW must be treated before disposal. And, regardless of whether WIPP becomes a repository, DOE needs to identify the sites where TRUW would be treated and stored based on the WM PEIS analysis.

11.1 Adequacy and Compliance with NEPA

The former Multi-Purpose Canister IP and its successor document, the Evaluating Container Systems for the Management of Naval Spent Nuclear Fuel EIS, considered container systems and potential monitored retrievable storage facilities for the storage of spent nuclear fuel, not for TRUW.

Comment (4421)
Commentors stated that the WM PEIS is inadequate, and should be revised and reissued in draft for additional public comment. One commentor stated that the Draft WM PEIS misrepresents the impacts of DOE sites and actions, is incomplete, and could put people at risk if DOE were to use it to determine its waste management siting strategies. Another commentor stated that the WM PEIS needs another review due to numerous errors [example cited].

Response
DOE does not agree that the Draft WM PEIS misrepresented environmental impacts or was incomplete. Rather, DOE believes that the Draft WM PEIS met the requirements of NEPA and the CEQ regulations to support DOE waste management programmatic decisions. Therefore, it is not necessary to revise and reissue the Draft WM PEIS for public comment. DOE has made changes to the WM PEIS to correct errors and omissions identified by members of the public, DOE personnel, and contractor personnel. These changes are reflected in this Final WM PEIS. Section 1.7.2 in Volume I of the WM PEIS discusses the major changes made to the document.

The PEIS is one tool that DOE will use to decide how and where it will manage its radioactive and hazardous wastes in the future. Along with documents such as the Baseline Environmental Management Report, Site Treatment Plans, and other EISs (e.g., the WIPP SEIS-II), the PEIS provides decisionmakers with a national perspective to evaluate the potential impacts of various strategies. The PEIS identifies potential costs and environmental impacts of alternative configurations for waste management that DOE could implement for each type of waste. After deciding the overall strategy, which will identify sites for treatment, storage, and disposal facilities, DOE will perform site-specific NEPA reviews as appropriate.

Comment (4437)
Based on Site Environmental Reports and sources, exposure estimates at some DOE sites are hundreds of times higher than those presented in the Draft WM PEIS, and DOE and contractor management responsible for preparing the WM PEIS deliberately changed information as part of a premeditated cover-up. These activities affect DOE credibility and should be investigated.

Some of the most significant information that should have been included in the affected environment and/or cumulative impacts sections of the WM PEIS include:

- Radon exposure from FEMP and Argonne National Laboratory-East (ANL-E) (not covered in National Emission Standards for Hazard Air Pollutants);

- The high potential dose in game caught at the Savannah River Site (SRS) and Idaho National Engineering Laboratory (INEL), and fish affected by the West Valley Demonstration Project (WVDP) and SRS;

- Plutonium exposure detected by monitoring at Rocky Flats Environmental Technology Site (RFETS);

11.1 Adequacy and Compliance with NEPA

- Exposure to contaminated sediment, food, and direct radiation at Paducah;
- Exposure near the target of an accelerator at Los Alamos National Laboratory (LANL) and Lawrence Berkeley Laboratory (LBL);
- Multimedia exposure at Oak Ridge Reservation (ORR);
- Impacts from high-level waste treatment at WVDP;
- Presenting cumulative impact predicted fatalities over the alternative duration rather than an annual average.

Response
In addition to DOE's own investigation, EPA conducted an independent investigation of these allegations against DOE and its contractors (including META and Louis Berger and Associates, Inc.), and determined that there was no evidence of a cover-up or intentional misrepresentation of data.

The existing site contamination and multimedia maximally exposed individual exposure estimates described in the comment are presented in the WM PEIS Affected Environment Technical Report, which is available in the DOE public reading rooms listed in Volume I, Section 1.9, of the Final PEIS. Many of the exposure routes cited by the commentor were investigated during site-specific NEPA and CERCLA reviews, or might be investigated during future reviews.

DOE did not include this information in the applicable sections of Chapter 4, which discusses the affected environment, and Chapter 11, the cumulative impacts analysis in Volume I of the WM PEIS, because these pathways are not as relevant for the offsite public as airborne pathways, which are the most important routes of exposure for most members of the offsite populations living in the vicinity of the sites. The consumption of contaminated wildlife and other multimedia exposure scenarios are worst-case bounding estimates, which DOE can best address in site-specific analyses. These pathways would be relevant only for certain specialized populations (e.g., subsistence hunters and fishermen), and would require additional information or assumptions about the dietary habits of those populations. In addition, wildlife contamination data vary widely from year to year in site monitoring reports. DOE would maintain institutional control of the sites during the assumed 10-year waste treatment period. As a consequence, the offsite population should not be able to come in contact with hot-spots of contamination inside the site boundary.

11.2 Presentation

Comment (1)
Why does the Draft PEIS Summary document contain only 9 chapters when the Reader's Guide in the front of the Summary lists 12 chapters for Volume I?

Response
There is no direct correlation between chapter numbers in the Summary document and chapter numbers in Volume I. The Summary document is a separate document that highlights the most significant aspects and provides a broad overview of the WM PEIS. DOE added this explanation to the Final WM PEIS Summary document. Volume I, Section 1.3, describes the contents of Volumes I through V of the WM PEIS.

Comment (2)
Commentors suggested the following ways to make the WM PEIS more reader friendly:

- In the Summary document, define acronyms the first time they are used;
- Spell out acronyms in the margins every time they are used;
- Include a complete glossary of abbreviations in the Summary document;
- Remember who the audience is and write on a layperson level;
- Use plain English and avoid jargon.

Response
DOE made every effort to present complex technical information in a way that could be easily understood by the layperson. Technical terms are explained in the text and defined in the Glossary (see Volume I). Acronyms and abbreviations are spelled out when they are first used and listed in Volume I. DOE added a list of acronyms and abbreviations to the Final WM PEIS Summary document. DOE believes these features provide sufficient resources to readers of the Final WM PEIS and elected not to define terms in the margin every time they are used.

Comment (3)
Define "treatment" of wastes and "disposal" of radioactive wastes in the Summary document. Define "fines" at first use in the Summary document.

Response
The Summary document is intended to provide a broad overview of the WM PEIS. Definitions of terms (including those mentioned in the comment) are contained in the Glossary in Chapter 14 in Volume I.

Comment (6)
Compare a representative waste volume to something recognizable (for example, football fields).

Response
Section 1.4.1 of the Summary document includes a commonplace example of a representative volume of waste (100,000 cubic meters of waste would fill a seven-story building the size of a football field).

Comment (168)
The whole analysis section is fuzzy.

11.2 Presentation

Response
In preparing the Final WM PEIS, DOE made every effort to improve the clarity of the document, including the analysis.

Comment (519)
Will a separate WM PEIS User's Guide be available to the public?

Response
Although the subject of the WM PEIS is complex, the organization of the document is not. DOE does not believe that a separate User's Guide would be helpful. A short Reader's Guide is provided in the front of Volume I.

Comment (1687)
In Volume I, Section 1.5.2, the inset that details the quantities of waste has a small typed footnote that states, "Volumes do not include environmental restoration waste." Given the significance and magnitude of that small footnote, all similar references throughout the text should be printed in bold type to increase readers' awareness that a significant portion of waste generated over the next 20 years is not considered in this PEIS.

Response
In several places, the WM PEIS explicitly states that environmental restoration wastes are not included in the analysis. Therefore, DOE does not believe it is necessary to highlight the footnote. Volume I, Section 1.7.1, explains why environmental restoration wastes are not included in the PEIS analysis in detail.

Comment (1716)
Commentors identified typographical errors in the Draft WM PEIS.

Response
DOE corrected typographical errors identified by commentors.

Comment (1719)
There is not enough information in Section 4.4.13 about treatment technologies.

Response
Sections 4.4.1 through 4.4.17 in Volume I of the WM PEIS provide summary information about the affected environment at each of the 17 WM PEIS sites. Additional information about treatment technologies is in Sections 5.2.2, 6.2.2, 7.2.2, 8.2.2, and 10.2.2 in Volume I of the WM PEIS. Appendix H in Volume IV provides information on technology development.

Comment (2055)
Using the metric system to specify volumes is an internationally accepted practice. However, the WM PEIS would be more user friendly and comprehensible if the total volumes in summaries and chapter highlights were provided in equivalent gallons, as well as in cubic meters.

Response
The Final WM PEIS includes a table for converting waste volumes to both cubic feet and gallons. See the Summary document (Section 1.4.1) and Volume I (Section 1.5.1).

Comment (2347)
In Volume I, Section 10.8, of the Draft PEIS, last paragraph, first sentence, should the word affect actually be effect?

Response
Affect is used correctly.

Comment (2354)
A commentor commended DOE for its presentation of such a large study in only four volumes. The commentor stated that listing referenced technical reports and documents used for each chapter in Volume I was very helpful and that the pull-out chart at the end of each chapter presents clearly the alternatives and their relationships to the chapter topic and site involved. The commentor added that placing extensive background material (site data tables, methodologies, and future goals of DOE) in separate volumes enabled the reader to focus on the task.

Response
Thank you for commenting.

Comment (2410)
The Final WM PEIS should provide the names and addresses of the project leaders of site-specific EISs so that interested citizens can access drafts of them as they become available.

Response
Volume I, Section 1.9, of the Final WM PEIS contains a list of DOE public reading rooms where copies of some draft EISs can be found. Section 1.9 also provides phone numbers to call for additional information.

Comment (2543)
In Volume I, Table 9.4-7, use the word "Public" instead of "Normal Operations Population" to improve clarity. The footnotes for the table are incorrect; the asterisks are not correctly located in the table.

Response
DOE replaced *Normal Operations Population* with *Routing Operations Public* and corrected the errors in Volume I, Table 9.4-7, identified in this comment.

Comment (2545)
A commentor identified a sentence in Chapter 11 of the Draft WM PEIS and suggested that the sentence be edited to clarify its meaning.

Response
The sentence referred to in the comment appears in Section 11.2 of the Final WM PEIS. It is intended to explain how DOE selected information from other EISs for use in the WM PEIS cumulative impacts

analysis. DOE edited the sentence to clarify its meaning. It now reads "Where decisions have not been made regarding the preferred alternatives for a reasonably foreseeable action, the cumulative impacts analysis considers the range of impacts of those alternatives. Otherwise, only the impacts of the preferred alternative are included in the cumulative impacts analysis."

Comment (2551)
Provide a specific discussion of the significance of the tables in Volume II, Section 6.0.

Response
Section 1.1 in Volume II states that the tables list the impacts for each of the 17 major sites as a complement to the impact discussions in Chapters 6 through 10 in Volume I (see Table II-1.1). Section II.6 contains the INEL tables, which list the volume of each waste type in separate sections for low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. These tables list the impacts of managing radioactive and hazardous waste at INEL. Section 1.0 in Volume II specifically describes each table. The significance of the tables in Section II.6 is that they list impacts of managing radioactive and hazardous waste at INEL in a separate format.

Comment (2569)
The Summary document states that "Alpha radiation can be stopped by a sheet of paper and will not penetrate skin, but it is harmful if ingested or inhaled." This should be modified by substituting "material that emits alpha radiation" for "it."

Response
The sentence in the Summary document, Section 1.4.3, has been changed and now reads, "Alpha particles can be stopped by a sheet of paper and will not penetrate skin, but material that emits alpha particles is harmful if ingested or inhaled."

Comment (2620)
Volume I, Section 10.4.3. Insert the words "worst case" in the sentence: "Note that ... facility accidents were analyzed..."

Response
DOE did not make the requested change because the facility accident impact analyses cited in the comment are maximum consequence rather than worst case analyses. Section 10.4.3 in Volume I summarizes the accident scenarios with the estimated maximum consequences from among the range of accident scenarios analyzed. Appendices D (Volume III) and F (Volume IV) provide additional details about all of the hazardous waste facility accident scenarios evaluated in the WM PEIS. Sections 10.4.3.1 and 10.4.3.2 in Volume I have been revised to clarify that maximum consequence accidents, rather than worst-case accidents, were summarized in Section 10.4.3.

Comment (2665)
In Volume IV, Section E.16.1, it would be helpful to refer to where in the text the PLC, PAEC, and ICRC values are derived/explained.

Response
Section E.16.1 explains the use of PLC (potentially life-threatening concentration), PAEC (potentially adverse effects concentrations), and ICRC (increased cancer incidence effects) values in the WM PEIS

hazardous waste transportation analysis. Sections E.16.5.1, E.16.5.2, and E.16.5.3 describe the derivation of PLC, PAEC, and ICR values, respectively. In addition, the acronyms were added to the list of acronyms in Appendix E in Volume III of the WM PEIS and to the PEIS Glossary (Chapter 14, Volume I).

Comment (2682)
In Volume IV, Section F.2.2.1, please define the word "strongly" in the parenthetical statement, "(process chemical accidents that could not be *strongly* correlated with waste inventories or throughputs were not analyzed)." What impact does this restriction have on the development of source terms? Please define the words "sufficient" and "distinct" in the same paragraph, and the word "selected" in the following paragraph.

Response
DOE has deleted "strongly" from the referenced statement.

The word "sufficient" indicates that DOE did not develop accident source terms for sites with waste volumes so low that DOE would not construct fixed facilities for their treatment. The WM PEIS projects that DOE will treat small volumes of waste with portable treatment units, which could consist of one or more trailer-mounted treatment modules that would treat minimal quantities of waste (limit of 30 cubic meters per year per unit). Such units would be most suitable for the treatment of waste streams that were not generated on a regular basis. In this case, DOE did not perform an accident analysis due to the low inventory of material and the episodic operation of the treatment module. DOE based the source terms for the accident analysis on release classes, which take into account the waste type, treatment category, and accident stress. These release classes are "distinct" from each other, and this is what the term means.

The statement, "only selected waste management operations and treatment technologies were analyzed for source term development," refers to the review undertaken during the WM PEIS accident analysis to establish the technologies that might contribute significantly to the overall risk of waste treatment. For example, DOE chose incineration as a risk-dominant technology for options rather than a low-level mixed waste non-thermal option due to incineration extreme operating conditions (high temperature and pressure) and high dispersibility characteristics of the resulting radioactive ash product. Preliminary calculations indicated that the risks from accidents related to relatively benign technologies such as packaging and compaction would be lower than those for high-energy processes such as incineration and organic destruction.

Comment (2840)
In Volume I, Chapter 5, the WM PEIS cites "DOE 1991," but no such reference appears in the Chapter 5 list of references.

Response
DOE corrected the citation identified in the comment to "DOE, 1990."

Comment (2845)
Tables in Volume I, Section 3.4, and throughout the waste-type chapters, should define blank spaces.

11.2 Presentation

Response
DOE has added footnotes to the tables in Volume I, Section 3.4, to explain that the blank spaces indicate that DOE is not contemplating any waste management activity. Further, DOE has added footnotes to explain any blank spaces in the tables in the waste-type chapters.

Comment (2846)
The footnotes to Table 3.4-1 in Volume I should define "Number of Sites," "CH Non-Alpha Treat," and "Dispose."

Response
DOE believes Table 3.4-1 in Volume I of the WM PEIS is understandable as presented in the Draft PEIS and has not made the requested changes.

- The "Number of Sites" is determined by counting across the row the number of treatment or disposal sites.

- Low-level mixed waste is categorized as alpha or non-alpha waste, depending on whether the waste contains concentrations of alpha particles at or above 10 nanocuries per gram. As stated in the footnote to Table 3.4-1, there are typically two categories of low-level mixed waste: contact-handled (CH) and remote-handled (RH). The difference is the concentration of radioactive material in each category. RH waste typically requires additional shielding and containment. "CH" and "RH" are introduced and defined in Section 1.5 and the terms are listed and defined in the Glossary in Volume I. DOE added to the footnotes for Table 3.4-1 a description the two different kinds of CH low-level mixed waste (alpha and non-alpha).

- "Disposal" is defined in the Glossary.

Comment (2849)
In Volume I, Table 3.4-1, the "S" or the term Storage should be defined. Will material be stored at the site under which the "S" designation appears or elsewhere?

Response
The WM PEIS Glossary, which is in Volume I of the WM PEIS, defines "storage" as the collection and containment of waste or spent nuclear fuel (in such a manner as not to constitute disposal of the waste or spent nuclear fuel) for the purposes of awaiting treatment or disposal capacity (i.e., not short-term accumulation). The "S" in Table 3.4-1 in Volume I of the WM PEIS denotes indefinite onsite storage at that site under the No Action Alternative.

Comment (2852)
Under the Decentralized Alternative for BNL, the designation "TD" (for "Treatment to meet land disposal restrictions" and "Disposal") appears. However, it is not at all clear what is meant by these terms. Will treatment for land disposal occur on the BNL site or off the site? Will land disposal occur on the site or off the site? Will disposal occur on the site or off the site? The answers to these questions should be clearly stated in the PEIS.

Response
When the "TD" designation appears for a site, such as BNL, it means that the site is a candidate for these activities under that alternative. Wherever the PEIS identifies a site as a potential location for waste management activities, it refers to analysis of waste for onsite activities. Commercial treatment offsite is not precluded by this evaluation of onsite activities, but decisions to utilize commercial facilities would be made at the site level. Thus, the designation of "TD" for BNL under the low-level mixed waste Decentralized Alternative indicates that BNL is a candidate site for onsite treatment and disposal of its own low-level mixed waste. The WM PEIS Glossary, which is in Volume I, further amplifies this response. It defines "treatment" as "any method, technique, or process designed to change the physical or chemical character of the waste to render it less hazardous, safer to transport, store or dispose of, or reduced in volume." The Glossary defines "disposal" as "emplacement of waste in a manner that ensures protection of human health and the environment within prescribed limits for the foreseeable future with no intent of retrieval and that requires deliberate action to regain access to the waste." With regard to land disposal restrictions, the Resource Conservation and Recovery Act requires EPA to issue land disposal restrictions that require the use of the best demonstrated available technologies to treat certain hazardous waste and other waste containing certain hazardous components. The land disposal restrictions also prohibit the storage of waste that requires treatment, except to facilitate proper recovery, treatment, or disposal. DOE has revised the Glossary to include a definition of land disposal restrictions.

Comment (2872)
Volume III, Section B.3.3. The DOE-developed model, Automated Remedial Action Methodology is described in three sentences. No information is provided regarding data input to the model, mathematical solutions employed by the model, or where such information can be obtained to independently verify the model's output. Given that the Draft WM PEIS states DOE's intent to use this output to make "conclusions" regarding potential environmental restoration waste impacts (see Section B.3, Page B-3), a much more thorough description of how the model predicts waste volumes is warranted. It is not clear why DOE Headquarters estimates of INEL environmental restoration waste volumes were even necessary. It would seem that the field office should have more intimate knowledge of environmental restoration and decontamination and decommissioning sites at INEL and could provide a more detailed estimate of projected waste volumes.

Response
No information from, or reference to, Automated Remedial Action Methodology is contained in the Final WM PEIS. The model was not used because better information was available from the Baseline Environmental Management Report, as identified in Section B.5.

Comment (2903)
Figure 4-3 in Volume I should be drawn to scale.

Response
As noted in Figure 4-3, the map is not drawn to scale, nor are any of the maps in Section 4.4. DOE included these maps in Section 4.4 in Volume I of the WM PEIS to provide a general idea of the layout of each site. Therefore, DOE did not believe it was necessary to draw the maps to scale.

11.2 Presentation

Comment (2919)
To address the questions of centralized, regionalized, and local [decentralized] treatment, it would be helpful to have a table that lists the volume of each class of waste at each site, with an indication of the existence at each site of suitable treatment facilities, suitable permanent disposal facilities, and suitable offsite transport. This information should be included in Table 1.3-1 of the Summary document. A table of interstate shipping distances would also be useful.

Response
The WM PEIS Summary document is intended to give a general and broad overview of the basic content of the WM PEIS. The amount of information about waste volumes and site-specific suitability for treatment, disposal, and transportation could not readily be added to Table 1.3-1 without interfering with the clarity of the table. The information is, therefore, given in Sections 6.1, 7.1, 8.1, 9.1, and 10.1 in Volume I of the WM PEIS for each waste type.

Tables of intersite shipping distances are provided in Volume IV, Table E-2 for truck routes and Table E-3 for rail routes. However, these tables would be too long (4 pages) for inclusion in the WM PEIS Summary document.

Comment (2964)
In Volume I, Table 6.1-2, a footnote states that BNL does not have onsite wastewater or wastewater treatment. BNL has inadequate onsite wastewater treatment. The table should be modified to reflect this.

Response
Table 6.1-2 lists the capacities of existing and planned low-level mixed waste facilities at major sites considered in the WM PEIS analysis. Wastewater treatment is the most prevalent treatment capability for low-level mixed waste. The footnote indicates that BNL has no planned or current low-level mixed waste wastewater treatment capacity. The footnote is not referring to the infrastructure of BNL. As described in Section 2.15.6 in Volume II of the WM PEIS Affected Environment Technical Report, BNL has a 1-million-gallon per-day wastewater sewage treatment plant. The technical report is available in DOE public reading rooms listed in Volume I, Section 1.9, of the WM PEIS.

Comment (2967)
Volume I, Section 6.3.2, should make it clear that BNL is not proposed to receive any offsite waste for treatment or disposal.

Response
Table 6.3-2 shows that under the Decentralized Alternative, BNL would not receive any offsite low-level mixed waste for treatment or disposal.

Comment (2972)
Volume I, Section 6.3.3, should make it clear that BNL is shipping its low-level mixed waste to an offsite facility. Furthermore, it should be reemphasized that this is DOE's preferred alternative.

Response
Tables 6.3-3, 6.3-4, 6.3-5, and 6.3-6 show that, under all four Regionalized Alternatives, BNL low-level mixed waste would be shipped offsite. The preferred alternatives and the reasons they are

preferred are identified in Volume I, Section 3.7, of the Final WM PEIS. They are highlighted in the site profile for BNL that appears in the Summary document.

Comment (2991)
Several figures and tables in Chapter 7 list 16 disposal sites under the Decentralized Alternative. This contradicts Tables 7.4-4, 7.4-5, and 7.4-13, all of which show 15 sites.

Response
Under the Decentralized Alternative, disposal would occur at 16 sites. Although the 1992 Integrated Data Base, which was used for the Draft PEIS, does not report low-level waste data for BNL, BNL was considered a potential low-level waste management site for purposes of analysis. DOE has revised Tables 7.4-4, 7.4-5, and 7.4-13 to indicate 16 disposal sites. More recent data taken from the 1995 Integrated Data Base was used for the Final WM PEIS and confirms that there is low-level waste at BNL (see Table 7.1-1 in Volume I).

Comment (2993)
Table 7.4-1 shows no workers at BNL under the Decentralized Alternative. Other tables show that BNL will either dispose of low-level waste (e.g., Tables 3.4-2 and 7.3-2, Figure 7.3-2) or treat and dispose of low-level waste (e.g., Table 3.6-2). Also, Tables 7.4-7 and 7.4-9 indicate that none of the actions are applicable to BNL for any alternative. Please explain what this means.

Response
In the Draft WM PEIS, BNL did not have low-level waste based on the 1992 Integrated Data Base. Therefore, Table 7.4-1 did not show any estimates of BNL waste treatment worker populations.

In the Final WM PEIS, Chapter 7 (Volume I) was revised to incorporate low-level waste volumes from the 1995 Integrated Data Base, including BNL low-level waste (see Table 7.1-1). In addition, estimates of waste treatment worker populations at the site were added to Table 7.4-1. Consideration of updated low-level waste volumes for BNL also are included in Appendix I (Volume IV) in the Final WM PEIS, which addresses the issue of how updated waste projections affect WM PEIS conclusions.

Comment (3015)
Volume I, Section 5.2.1, indicates that DOE adjusted low-level mixed waste data for three sites; only two sites are identified. The third site should be identified and the adjustment noted in Table 4-2.

Response
DOE corrected Section 5.2.1 to indicate that low-level mixed waste data were adjusted for two sites.

Comment (3042)
Table 4-7 in Volume I is not described in the text of Section 4.3.7 in the Draft WM PEIS.

Response
Section 4.3.7 in Volume I of the WM PEIS was revised to add a reference to Table 4-7. Table 4.3-3 summarizes minority and low-income population data for the 50-mile zone of impact that surrounds each site.

11.2 Presentation

Comment (3057)
In Section 4.4.4, the Yakima Firing Range should be referred to as the Yakima Training Center.

Response
DOE made this correction.

Comment (3058)
The WM PEIS Affected Environment Technical Report, which is loosely cited in the WM PEIS, was not in the Lacey, Washington, DOE reading room.

Response
The citation in the Chapter 4 reference section was incorrect. The citation is correct in the Final WM PEIS. All technical reports were supplied to the DOE public reading rooms as announced in the *Federal Register* notice declaring the availability of the Draft WM PEIS. All technical reports have been reissued to the DOE public reading rooms, listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (3062)
The acronym ALOHA should not be used for a computer programmer's poison gas model. The use of this sacred Hawaiian greeting is akin to Shalom in Judeo-Christian culture.

Response
The computer model ALOHA (Aerial Locations of Hazardous Atmospheres) was not developed by DOE and DOE has no control over the model's name or the resulting acronym.

Comment (3285)
NTS is located in Nye County, not Las Vegas, as indicated in Section 4.4.8.

Response
The titles of Sections 4.4.1 through 4.4.17 in Volume I include the site and the closest large city, not the county in which the site is located. Some sites are located in more than one county. The text in Volume I, Section 4.4.8, notes that NTS is 65 miles northwest of Las Vegas. Also, the general public is more likely to recognize the name of a large city than the name of a county.

Comment (3368)
Volume III, Section D.2.6.1. The terms RfDs, RfCs, HEAST, and IRIS should be briefly explained here (as they are in Volume IV, Section E.16.5.2.1), or at least included in the list of abbreviations at the beginning of Appendix D.

Response
DOE added the terms RfD, and RfC to the abbreviation list, and HEAST, and IRIS to the acronym list for Appendix D.

Comment (3386)
Volume III, Section D.3.3.8.1, last paragraph, should include a reference to where in the text the source term is characterized.

11.2 Presentation

Regarding the specific example noted, Appendix B in Volume III contains a discussion of environmental restoration wastes. Environmental restoration is not within the scope of this programmatic study primarily because of its site-specific nature (see Section 1.7.1). Therefore, Appendix B of the document contains a qualitative discussion of the extent to which those environmental restoration waste volumes, for which responsibility could be transferred to the Waste Management Program, might affect the comparison among waste management alternatives. The approach used for the qualitative discussion of environmental restoration activities is not a full-fledged quantitative analysis.

DOE believes the alternatives analyzed meet NEPA requirements as discussed in Volume I, Chapter 3. The WM PEIS evaluates four broad categories of alternatives in order to make informed comparisons of programmatic management options: No Action Alternatives, under which the status quo would be maintained; Decentralized Alternatives under which waste would be managed at a large number of sites; Centralized Alternatives under which waste would be managed at one or two sites; and Regionalized Alternatives under which waste would be managed at an intermediate number of sites. DOE believes that the alternatives analyzed in this PEIS encompass a reasonable range of alternatives under NEPA, and that the potential impacts predicted of these alternatives provide a basis to select a waste management configuration from among the alternatives.

Comment (3538)
The series of maps at the end of Volume IV is overly simplified; waterways, small roads, and small villages that surround the DOE facilities should be included by making use of popular local maps, county maps, and satellite images.

Response
The maps provided in Appendix I in Volume IV of the Draft WM PEIS are now included in Section C.4.7.2.3 (Volume III). These are demographic maps prepared from 1990 census data. They are not road maps, but rather illustrate the distributions of minority and low-income populations in the census tracts around DOE sites. The detail suggested by the commentor was neither necessary nor appropriate in this context.

Comment (3550)
The document is too long. CEQ regulations state that an EIS should be no longer than 150 pages.

Response
NEPA and CEQ implementing regulations do not impose page limits in NEPA documents. Because of the complexity of programmatic waste management decisions and the degree of public interest during the scoping activities, DOE believes the detailed impacts evaluation and discussion in the PEIS and thus, its length, are warranted.

Comment (3610)
What is the meaning of the numbers (1000 to 5000) used in Volume I, Figure 8.2-3?

Response
The numbers in Figure 8.2-3 of the Draft WM PEIS indicated the categories of physical forms for the wastes. To avoid confusion, Figure 8.2-3 was changed in response to this comment. Words are now used in place of the numbers to identify the appropriate treatment train.

Response
The reference for the source term is identified in Appendix F in Volume IV and accompanying technical reports.

Comment (3408)
Volume III, page A-4, paragraph 4; and page A-5, paragraph 2: A reference is not provided for the Baseline Environmental Management Report or for the Risk Report.

Response
The Final WM PEIS includes references for the Baseline Environmental Management Report and the report *Risks and The Risk Debate: Searching for Common Ground, the First Step* in Appendix A.

Comment (3409)
Volume IV, Section E.5.1.2.1, last paragraph, states that the accident risk assessment uses site-specific and waste type-specific radiological and physical wastes. Site-specific is not appropriate for this assessment, because the actual population density was not used. The occurrence of the three population density zones might be route-specific, but they are not site-specific.

Response
The term "site-specific" in the text cited in the comment does not refer to the population density used in the analysis. The term is used to describe the characteristics of waste at a particular site (i.e., the radiological and physical waste characteristics of a particular waste at a particular site). Moreover, the next sentence states "the assessment uses route-specific information" for the transportation calculations.

Comment (3410)
In Volume IV, Section E.7.1.4, last paragraph, please change the word "unfavorable" to "stable."

Response
DOE made this change.

Comment (3527)
Although the Reader's Guide states otherwise, review of the appendices or technical reports should be considered necessary for a full understanding of the issues. For example, Appendix B in Volume III of the WM PEIS contains numerous assumptions limiting the scope of the WM PEIS to environmental effects for which economically practical and technically reasonable solutions are at hand (see Volume I, Section B.4-1, Table B.4-1), although such an approach contradicts the intentions of Congress for NEPA.

Response
Due to its programmatic nature, the WM PEIS is a complex study. It is organized to be useful to a broad range of interested parties. The Summary document serves readers who are interested in a broad overview of the WM PEIS. Volume I contains the main text of the document. The Site Data Tables (Volume II), appendices (Volumes III and IV), and technical reports support Volume I and assist readers who are interested in more detail. Thus, the WM PEIS attempts to accommodate readers with different levels of review knowledge and interest.

11.2 Presentation

Comment (3638)
With respect to Section 8.4.1, we do not understand the reasoning of population impacts and individual impacts.

Response
Population impacts are based on estimated exposures to all persons living within 80 kilometers (50 miles) of each site center or, for the larger sites, within 50 miles of an existing waste management facility on the site, who might be exposed to emissions from waste management activities according to wind patterns at each site. Individual impacts are based on the highest estimated exposures to a person located in the prevailing downwind direction from the activities.

Comment (3641)
Table 8.4-4 identifies the estimated number of cancer incidences and genetic effects program-wide for transuranic waste treatment. The discussion indicates that the mitigation of these emissions (americium-241 and plutonium-238) from thermal treatment of these radionuclides would be accomplished by exploring alternative treatment concepts or enhancing off-gas treatment systems. What is the meaning of "exploring" and how does it meet NEPA requirements.

Response
The wording in Section 8.4.1.2 has been changed to indicate that mitigation of emissions from thermal treatment of these radionuclides would be accomplished through application of alternative treatment methods when they become available.

Comment (3767)
The fact sheet for ANL-E has an inconsistency regarding the low-level waste decentralized and centralized options.

Response
Table 1 of the fact sheet for ANL-E indicated that the Decentralized Alternative for low-level waste would require 450 shipments of offsite waste to be transported to ANL-E for treatment and disposal, and that this would add 2% to the onsite volume of low-level waste that would be disposed of at ANL-E. This is consistent with the low-level waste Centralized Alternatives presented in the table, which state that 1,050 shipments would be required to ship *all* of ANL-E's low-level waste offsite for treatment and disposal. These shipments are further discussed in Volume IV, Appendix E.

Under the Decentralized Alternative, all ANL-E low-level waste (6,700 cubic meters) would be managed onsite (not shipped), and 450 shipments of low-level waste would be received from Ames (110 cubic meters) and Fermi (1,500 cubic meters) for treatment and disposal at ANL-E. Under the Centralized Alternatives all ANL-E low-level waste would be shipped offsite (1,050 shipments) to another DOE site for treatment and disposal, with no waste shipped to ANL-E from offsite. Therefore, although the Decentralized Alternative would result in more onsite impacts than the Centralized Alternatives, due to onsite waste treatment and disposal, offsite impacts would be larger under the Centralized Alternatives, due to the larger numbers of waste shipments for these alternatives. Note that impacts from low-level waste transport at ANL-E are predicted to be low for all alternatives.

Comment (3822)
The public needs to have more information on potential negative impacts.

11.2 Presentation

Response
The information presented in this PEIS is thought to be most relevant to decisions regarding management of wastes. Volume I of the WM PEIS summarizes the potential negative and positive impacts of the WM PEIS alternatives, and the WM PEIS appendices and technical reports on the impacts analysis and affected environment provide detailed information on potential negative impacts. When specific waste management facilities are proposed for specific locations, additional information on the potential impacts would be provided in site-specific NEPA reviews as necessary. In the PEIS process, DOE considered both positive and negative impacts from alternatives for waste management.

Comment (3875)
DOE needs to better educate the public about the use of the word "small." What is "extremely small"?

Response
DOE summarized the results of the WM PEIS analysis using general terminology concerning the level of human health risks or environmental impacts. In some cases the phrase "extremely small" was used to indicate a negligible level of risk or a minimal impact.

Comment (3917)
DOE needs to put radiation exposure into perspective and help the public to understand that everyone has radioactive material in them. Use analogies to everyday life.

Response
Section 4.3.1 in Volume I explains that all members of the public are exposed to background radiation, both natural and man-made, and that the PEIS analyzes the total effective dose equivalent above background radiation levels for site workers and for the maximally exposed individual members of the public. This discussion provides common examples of background radiation sources and describes the extent of this exposure.

Volume I, Section 5.4.1.4, of the Final WM PEIS includes an improved explanation of natural and man-made radioactive material and its presence in the human body and surrounding environment.

Comment (4463)
With regard to Section 7.1 and Table 7.1 in the Draft WM PEIS Summary document, there is no good scientific justification for reporting values such as the expected number of high-level waste canisters to five significant figures.

Response
For the Final WM PEIS, DOE rounded the high-level waste canister number estimates to the nearest 100 canisters.

Comment (4546)
Referencing population risks with an asterisk (*) on Table 6.4-5 in the Draft WM PEIS and stating in the footnote that impacts are greater than 0 and less than 0.5 is inadequate; at a minimum, the order of magnitude should be quantified.

Information on the order of magnitude of the uncertainties in the population risk numbers provided should also be provided in the Summary document. These risks should be quantified because they

impact the relative impacts of alternatives compared to each other and in terms of uncertainties in absolute risks.

Tables should specifically delineate the risks of trains versus trucks used for transportation, and risks from transportation separately for workers versus members of the general public.

Response
Health risks are presented for both populations of receptors and for maximally exposed individuals. The population risk tables list risk impacts as numbers of incidences of adverse health effects or potential fatalities in the population. For example, Table 6.4-5 lists the estimated *numbers* of cancer incidences and genetic effects for various receptor groups. For the offsite population, the analyses estimated less than one radiation cancer incidence for Regionalized Alternatives 2 through 4 and the Centralized Alternative. These values are *not* probabilities. The values all range from greater than zero to less than 0.5, so the order of magnitude is zero.

11.3 Scope

Comment (237)
DOE must conduct serious studies of the health, safety, environmental, and economic impacts of waste treatment, storage, and disposal activities.

Response
This WM PEIS is a serious study that examines the environmental impacts of managing DOE's radioactive and hazardous wastes across the nuclear weapons complex, including the impacts identified by the commentors. In the PEIS, DOE examines a range of broad waste management alternatives that could affect various environmental resources throughout the United States. The WM PEIS presents an approach for characterizing the affected resources at all potentially affected sites. The document also includes general and cumulative information on the affected environment that applies to all or some subset of the sites analyzed. This allows quantitative and qualitative comparisons of alternatives and DOE sites, which will help DOE decide on an overall waste management strategy. This programmatic study will be supplemented by detailed sitewide or project-level NEPA analyses, as necessary.

The evaluations in the WM PEIS will not be the only bases for decisions on waste management. Regulatory compliance, budgets, schedules, compliance with site agreements with States, and national priorities, as well as other DOE studies would be considered in reaching these decisions.

Comment (397)
The WM PEIS should include all wastes currently at Hanford (K-Basin spent fuel rods, environmental restoration wastes, Navy wastes such as the reactor cores), as well as all waste management wastes proposed to be brought to Hanford.

Response
The WM PEIS addresses all waste management wastes generated at the Hanford Site and those waste management wastes generated at other sites that might be sent to Hanford for treatment, storage, or disposal.

Section 1.8.1 in Volume I describes the WM PEIS's relationship to other NEPA documents and decisions. The K-Basin spent nuclear fuel is covered by a separate EIS, which was issued in March 1996. Spent fuel and naval wastes are addressed in the SNF/INEL EIS. DOE selected a regionalized approach for spent nuclear fuel storage and decided that Hanford production reactor fuel will remain at the Hanford Site (see the SNF/INEL EIS Record of Decision).

Environmental restoration waste that would be transferred to the Waste Management Program is included in the WM PEIS, and Appendix B provides a discussion of the extent to which it could affect the comparison among waste management alternatives. Cleanup activities generally deal with site-specific issues not appropriate for analysis in programmatic documents like the WM PEIS. Therefore, as previously stated, the WM PEIS considers environmental restoration wastes only in the context of how those wastes could affect the comparison among waste management alternatives. (See Appendix B in Volume III.) Site-specific analysis under RCRA or CERCLA cleanup actions will address impacts from environmental restoration at Hanford.

Naval Submarine reactor compartments are disposed of with the cores (spent fuel) removed. As already discussed, spent fuel is addressed in the SNF/INEL EIS. The remainder of the reactor

compartments are not included in the WM PEIS, because their disposal is covered by the SNF/INEL EIS.

Comment (398)
The WM PEIS does not clearly explain why a number of waste types are not considered in the document. Examples are environmental restoration wastes, spent nuclear fuel, and plutonium stored at the Hanford Site. In addition, DOE needs to explain if the spent nuclear fuel being transported to INEL by the Navy is addressed in the document.

Response
Volume I, Section 1.5.6, identifies waste types not considered in the WM PEIS and explains why they were not considered. Section 1.7.1 explains the WM PEIS scope change, which resulted in exclusion of environmental restoration wastes from the analysis. Spent nuclear fuel managed by the Navy and at the Hanford Site is addressed in the SNF/INEL EIS; plutonium stored at the Hanford Site is addressed in DOE studies including the Storage and Disposition of Fissile Materials PEIS, Stockpile Stewardship and Management PEIS, and Hanford Plutonium Finishing Plant Complex EIS. Spent nuclear fuel and plutonium are not considered wastes.

Comment (1109)
DOE should explain how the PEIS addresses high-level wastes and spent nuclear fuel from commercial and foreign sources.

Response
The WM PEIS does not evaluate high-level waste and spent nuclear fuel from commercial or foreign sources. DOE evaluated the spent nuclear fuel from foreign research reactors in the Foreign Spent Nuclear Fuel EIS, and will evaluate commercial spent fuel in the Yucca Mountain Repository EIS. As stated in Volume I, Section 1.7.3, this WM PEIS does analyze the environmental impacts of longer term storage of treated DOE high-level waste in the event there is a delay in the construction and operation of a geologic repository.

Comment (1112)
DOE should clarify if the PEIS looks only at DOE wastes or if it considers wastes from outside DOE.

Response
The WM PEIS analysis of programmatic waste management alternatives does not include commercially generated wastes. See Volume I, Section 1.1, for a description of the wastes analyzed in the WM PEIS. Section 1.1 in the Summary document and Section 1.5.6 in Volume I were revised to indicate that DOE generally is not responsible for the management of commercially generated radioactive wastes and that, therefore, the WM PEIS does not analyze management of such wastes. DOE is responsible for commercially generated greater-than-Class-C low-level waste and is in the process of developing strategies for doing so. Once formulated, they will be addressed in separate NEPA reviews.

DOE is also responsible for some wastes from outside DOE, such as low-level mixed waste and low-level waste from the Navy nuclear propulsion program. These include wastes generated at Bettis Atomic Power Laboratory, Charleston Naval Shipyard, Knolls Atomic Power Laboratory, Mare Island Naval Shipyard, Norfolk Naval Shipyard, Pearl Harbor Naval Shipyard, Portsmouth Naval Shipyard,

and Puget Sound Naval Shipyard. These wastes are included in the waste volumes listed in Sections 6.1.2 and 7.1.2 in Volume I of the WM PEIS.

Comment (1116)
DOE should explain what special nuclear materials (SNM) are in the SNM inventory, and if they are included in the decisions of the WM PEIS.

Response
The impacts of storage and disposition of SNM, which are not considered waste, are not within the scope of the WM PEIS, except where those impacts are cumulative with impacts from waste management activities (see Chapter 11). The WM PEIS was changed to provide a definition of SNM (see Glossary) and describe why SNM is not within the scope of the WM PEIS (see Section 1.5.6).

The impacts of the management of some DOE SNM are evaluated in the Storage and Disposition of Weapons Usable Fissile Materials PEIS and the Disposition of Surplus Highly Enriched Uranium EIS.

Comment (1527)
DOE is proceeding with the mixed waste management facility at LLNL before completion of the WM PEIS and without the benefit of a NEPA-required facility-specific EIS. DOE is moving forward with the project on the basis of an environmental assessment backed by unjustified data concluding that no significant environmental impacts would result from the mixed waste management facility which is moving forward exempt from RCRA permitting requirements and in the absence of public review or an environmental impact report under the California Environmental Quality Act.

Response
Based on the Final Environmental Assessment for the Mixed Waste Management Facility (MWMF) at LLNL, DOE issued a Finding of No Significant Impact on September 21, 1995, for the construction and operation of the MWMF. Bench scale testing was performed for developing and evaluating treatment technologies, not for treating waste. Subsequent to the bench scale testing, the MWMF project was canceled.

Comment (1529)
It is unclear if, under the WM PEIS, Site 300 and LLNL will ultimately accept civilian radioactive waste.

Response
Civilian radioactive wastes are outside the scope of this PEIS. Therefore, the management of this waste is not analyzed in the WM PEIS and decisions on this type of waste will not be made on the basis of the WM PEIS. However, waste disposal compacts are being developed, which address commercial radioactive waste disposal.

Comment (1755)
WIPP should have been evaluated in the PEIS.

Response
As described in Volume I, Section 1.1, of the WM PEIS, DOE intends to identify sites for treatment and storage for transuranic waste. For purposes of this analysis, DOE assumes that WIPP will operate

as a transuranic waste disposal facility. As described in Section 1.5.3, the WM PEIS does not evaluate transuranic waste disposal impacts. Potential long-term impacts of transuranic waste disposal at WIPP are addressed in the WIPP SEIS-II, which will be used to inform DOE's decision on whether to dispose of transuranic waste at WIPP. The WM PEIS does analyze transuranic waste treatment impacts at WIPP under the Centralized Alternative. Volume I, Chapter 8, details the associated potential impacts from this alternative.

Comment (1864)
The Draft WM PEIS is technically flawed because it fails to fully address property value issues.

Response
DOE believes that it would be too speculative to analyze the economic impacts of potential negative perceptions. In general, the environmental impacts, including changes in economic conditions, associated with waste management under all alternatives considered in the WM PEIS would be small. Thus, there is no reason to believe that waste management activities at any candidate site would have a negative effect on long-term housing demand or property values.

Comment (2164)
The PEIS is required by law to disclose and consider in one document (1) all waste and nuclear materials that might come to the Hanford Site or any other site; (2) all wastes and nuclear material on the site that require treatment, storage, and disposal; (3) storage, treatment and disposal alternatives for all the waste that comes to or might be at Hanford and their interrelated or cumulative impacts; (4) cumulative transportation and site-related impacts if all potential wastes and materials that might be sent to Hanford were shipped through the region, as in the case of spent nuclear fuel from foreign research reactors; and (5) all decontamination and decommissioning, and environmental restoration wastes at Hanford.

Response
NEPA does not require DOE to consolidate the analyses of all its programs into a single NEPA document. Some nuclear materials, such as spent nuclear fuel and special nuclear material, are not wastes and, therefore, are outside the scope of the WM PEIS. The impacts of spent nuclear fuel management are analyzed in the SNF/INEL EIS and the Foreign Research Reactor Spent Nuclear Fuel EIS. As described in Appendix B in Volume III, wastes generated by environmental restoration and decontamination and decommissioning activities are outside the scope of the WM PEIS because remediation decisions are site-specific in nature and must reflect site-specific conditions. However, the WM PEIS cumulative impacts analysis (see Chapter 11 in Volume I) considers the impacts of the preferred alternatives identified in the SNF/INEL EIS and the Foreign Research Reactor Spent Nuclear Fuel EIS, as well as other DOE EISs and programs, including transportation and other activities. Section 11.6 discusses the combined and cumulative impacts specific to Hanford. In addition, the Hanford Remedial Action EIS covers the impacts of all environmental restoration activities at Hanford.

The WM PEIS includes a reasonable siting and management alternatives for DOE's radioactive and hazardous wastes Department-wide, including Hanford. Hanford waste volumes are included in the WM PEIS.

11.3 Scope

Comment (2174)
A commentor stated that the following waste types are left out of the WM PEIS: "SNF, transuranic if you don't open WIPP, HLW if you don't open Yucca Mountain...; hazardous waste, plutonium, plutonium residues, and scraps and solutions are left out."

Response
DOE has not left these materials out, but rather has discussed them thoroughly in this or other NEPA documents, as follows:

The treatment and storage of transuranic waste, storage of treated high-level waste, and the treatment hazardous waste are analyzed in the WM PEIS.

Spent nuclear fuel is not considered a waste. The SNF/INEL EIS evaluates DOE spent fuel management at the programmatic level, just as this PEIS evaluates the DOE Waste Management Program. In addition, the Foreign Research Reactor Spent Nuclear Fuel EIS, evaluates alternatives for the management of reactor fuel irradiated in foreign reactors.

For all action alternatives, DOE assumes that WIPP would become operational for disposal of transuranic waste. Under the No Action Alternative, the impacts of continued storage of transuranic waste at the generator sites without disposal at WIPP are analyzed. Further, as described in Volume I, Section 1.8.1, of the Final WM PEIS, DOE has prepared the WIPP SEIS-II to evaluate environmental impacts from transuranic waste disposal at WIPP. As part of the WIPP SEIS-II, the No Action Alternatives evaluate the continued management of transuranic waste at generator sites and the decommissioning or other disposition of the WIPP facility. These alternatives analyze environmental impacts if DOE decides not to use this facility for transuranic waste disposal.

If DOE is unable to open a high-level waste repository at Yucca Mountain, it would have to reevaluate its long-term plans for high-level waste disposal. The WM PEIS does not analyze the environmental impacts of disposal at Yucca Mountain or alternative locations for a geologic repository. It does, however, analyze the impacts of longer term storage of treated high-level waste if DOE has to delay the construction and operation of a national geologic repository. Impacts from the construction, operation, and closure of a geologic repository would be examined in the Yucca Mountain Repository EIS.

The Stockpile Stewardship and Management PEIS, the Fissile Materials PEIS, and the Surplus Highly Enriched Uranium EIS contain thorough discussions of the other materials listed in the comment, which are considered special nuclear materials. Special nuclear material was not analyzed in the WM PEIS because it is not considered waste, as explained in Section 1.5.6 in Volume I of the PEIS.

Comment (2261)
The WM PEIS does not include very important wastes, including several tons of plutonium not in the weapons stockpile that have been declared surplus. Several tons of plutonium that are indeed waste (scrap plutonium that is in the ductwork of some of the facilities). It is incumbent on DOE to bring the entire waste pie to the table. DOE is doling out little bits of this pie to different parts of the country in a very, very complicated manner that is impossible for the public to understand. "This might not be the type of coverup that we have seen so blatantly in the history of the Department, but is a coverup nonetheless."

Response
DOE is committed to providing as much information as possible to the public so it can receive informed comments and public input. There is no coverup of information, but rather an open and honest attempt to address a number of complex issues, some related and others not related to DOE's Waste Management Program.

The DOE Waste Management Program is separate and distinct from other programs, and DOE believes that it is appropriate to analyze it in this programmatic NEPA document. This WM PEIS is complex; it covers five major types of radioactive and hazardous waste. It does not include some wastes that DOE believes are not ready for the decisionmaking process. It also does not include some other materials (e.g., spent nuclear fuel and plutonium) because they are not wastes and/or have been the subject of other DOE EISs. Volume I, Section 1.8.1, describes these other EISs and their relationship to the WM PEIS. DOE has, to the extent possible, included the impacts identified in these other EISs in the WM PEIS cumulative impacts analysis (Volume I, Chapter 11).

The SNF/INEL EIS evaluates DOE spent nuclear fuel management at the programmatic level, just as this PEIS evaluates the DOE Waste Management Program. In addition, the Foreign Research Reactor Spent Nuclear Fuel EIS evaluates alternatives for the management of reactor fuel irradiated in foreign reactors. DOE believes that these extensive documents cover their subjects thoroughly and completely.

The Stockpile Stewardship and Management PEIS and the Storage and Disposition of Weapons-Usable Fissile Materials PEIS offer thorough discussions of DOE's projected plans for plutonium. The impacts associated with the alternatives analyzed in these EISs were considered in the WM PEIS cumulative impacts analysis.

Comment (2263)
Deputy Assistant Secretary Grumbly made a commitment in Seattle in the early part of October 1995 to include all of the relevant materials in the WM PEIS. His commitment was clear, and he made it in the presence of Governor Lowery. This process tonight [the Richland, Washington, public hearing] does not meet that commitment, and we are challenging DOE to live up to its promises.

Response
DOE believes that the WM PEIS includes all relevant materials pertinent to the proposed action to improve the management of its radioactive and hazardous wastes. The WM PEIS is DOE's national and programmatic planning tool to achieve this objective. The Waste Management Program is separate and discrete from other DOE programs, and as such is appropriately analyzed in this programmatic NEPA document. Section 1.5 in Volume I of the WM PEIS defines and discusses each of the waste types considered. For wastes and materials that are not managed by the Waste Management Program and, thus, are not evaluated in the WM PEIS, cumulative impacts are considered to the extent possible (see Chapter 11). When the Department makes decisions on this and other programs, Under-Secretary Grumbly and DOE are committed to integrated decisionmaking regarding the future of the DOE complex. Equity is one of several criteria for decisionmaking as described in Section 1.7.3 in Volume I of the WM PEIS.

In accordance with NEPA and the CEQ implementing regulations, DOE released the Draft WM PEIS for public comment. Public hearings such as the one in Richland provided an opportunity for members of the public to discuss and comment on any part of the WM PEIS, and issues relating to the materials included

in the WM PEIS. The public comment period and hearings met the requirements for public participation under NEPA.

Comment (2403)
The PEIS should make it clear that there is no intent for long-term disposal of transuranic and high-level wastes at SRS. The section should also be clear on the risks that might drive disposal at the various DOE sites (other than WIPP and Nevada). Contingency planning should be discussed for the unplanned disposal. The analysis should also include impacts of long-term storage or disposal should the high-level waste repository be found to be unacceptable.

Response
The WM PEIS evaluates the disposal of only two waste types--low-level waste and low-level mixed waste. Sections 6.4.1.6 and 7.4.1.5, respectively, discuss the screening-level analyses that DOE used to estimate risk, and the results of the analyses including descriptions of the radionuclides that would drive the risks.

The WM PEIS does not analyze the disposal of transuranic or high-level waste at any DOE site. The WIPP SEIS-II addresses the disposal of transuranic waste, and future NEPA analyses on the potential geological repository will address the disposal of high-level waste.

For analytical purposes only, the WM PEIS assumes that vitrified high-level waste will eventually be accepted for disposal at a geologic repository at the potential location of Yucca Mountain, Nevada, and that transuranic waste will be disposed of at WIPP.

Comment (2409)
Some alternatives in the WM PEIS consider shipping WVDP high-level waste to SRS for interim storage. Include a discussion of the consequences of actions needed at SRS should this WVDP waste not be suitable for disposal.

Response
The scope of the WM PEIS does not include the issue of high-level waste treatment and disposal. Only storage of vitrified high-level waste is within the scope of the WM PEIS. Some high-level waste alternatives include shipment of WVDP vitrified high-level waste to SRS for storage. Waste would not be shipped to SRS until it is vitrified.

Chapter 9 in Volume I of the WM PEIS includes an analysis of the impacts of long-term storage of vitrified high-level waste, should capacity in a high-level waste repository not be available as anticipated. As described in Chapter 9, the impacts of long-term storage would be minor.

Comment (2412)
This PEIS, which will help guide DOE waste management for the next 20 years, does not consider high-level waste treatment, greater-than-Class-C and special-case waste management, environmental restoration wastes, tank remediation at Hanford, or the possible resumption of some activities (like fuel reprocessing) that could or will affect waste management. These activities will likely have significant impacts, but those impacts are segmented from the impacts of the activities considered in this PEIS. Such segmentation seriously undermines the usefulness of this document to decisionmakers.

Response

The WM PEIS considers critical issues that are related to waste treatment, storage, and disposal on a broad, programmatic level. However, as mentioned in this comment, DOE has excluded some activities from evaluation in the PEIS. In addition to explanations in the following paragraphs, Volume I, Chapter 1, explains DOE's reasons for excluding these waste activities. Impact estimates from activities that DOE excluded from evaluation in the PEIS are included, if available, in the cumulative impacts analysis in Chapter 11. For example, the cumulative impacts analysis includes the effects of high-level waste treatment.

The PEIS does not include greater-than-Class-C wastes or special-case wastes, as explained in Volume I, Section 1.5.6. DOE will perform NEPA reviews for management of these wastes as it develops proposals for their treatment, storage, and disposal.

The Hanford Tank Waste Remediation System EIS analyzes tank waste remediation at Hanford. It was prepared partly to fulfill DOE's commitment in the 1988 Record of Decision for the Hanford Defense Waste EIS to supplement the analysis. A description of the Tank Waste Remediation EIS and its relationship to the WM PEIS is presented in Section 1.8.1 in Volume I. The impacts of the actions analyzed in that EIS are included in the WM PEIS cumulative impacts analysis (Chapter 11).

DOE originally intended the WM PEIS to perform a programmatic analysis of the impacts associated with both the Waste Management Program and environmental restoration activities. In 1995, however, DOE determined that programmatic decisionmaking would not be possible for the Environmental Restoration Program. DOE believes that local conditions and the concerns of local stakeholders are the appropriate drivers for site-specific cleanup decisions. Additionally, DOE recognizes that the current information available about environmental restoration wastes is not sufficient for meaningful impact analysis.

After review and approval by the DOE Environmental Management Advisory Board, DOE published a *Federal Register* announcement that stated DOE's intent to remove the Environmental Restoration Program from the scope of the PEIS and to rename the document. This rescoping announcement solicited public comments for DOE consideration. Appendix A in Volume III of the WM PEIS summarizes the comments received and DOE responses to them, and outlines the means for public involvement in DOE environmental restoration planning and decisionmaking.

Although the WM PEIS will not lead to decisions on the Environmental Restoration Program, it does consider the subset of environmental restoration wastes that will be transferred to the Waste Management Program (see Appendix B). The PEIS analysis indicates that the sites and facilities selected for waste management activities are a minimum set that are needed regardless of environmental restoration transferred waste. However, future environmental restoration activities might affect necessary onsite capacity or might result in additional waste being transported to another site that was selected for treatment, storage, or disposal. As information about these wastes becomes available, additional environmental analyses would lead to appropriate decisions.

Fuel reprocessing is not a waste management activity and, therefore, was not included in the WM PEIS analysis. Moreover, DOE generally has ceased reprocessing of spent nuclear fuel because recycling of plutonium and uranium for weapons production is no longer a priority.

11.3 Scope

Comment (2718)
The EIS analysis may be simplified to the extent of focusing on the obscure. The EIS analyzes only the impacts of storing vitrified high-level waste. The overwhelming environmental risk associated with these wastes is caused by storing the high-level waste as liquid. INEL will be storing non-vitrified high-level waste for the next 30 years. DOE should consider addressing the question of expedience in solidifying high-level waste? DOE should explain whether estimated low-level waste and/or transuranic waste to be generated from high-level waste processing is included in projected inventories.

Response
DOE's high-level waste solidification program is one of the top priorities of the Office of Environmental Management. The storage and vitrification of high-level waste has been reviewed by DOE in the SRS DWPF EIS, WVDP EIS, SNF/INEL PEIS, and the Hanford Tank Waste Remediation EIS. High-level waste vitrification facilities have been constructed at WVDP and SRS. Operations began at the SRS Defense Waste Processing Facility on March 12, 1996, and at WVDP on July 2, 1996. Vitrification processes high-level waste into a solid form that is not readily dispersible into air or leachable into groundwater or surface water. High-level waste at INEL is stored in an inert calcined form that does not pose the threat posed by storage of liquid high-level waste. Where these NEPA reviews identify high-level waste treatment impacts that add to the impacts identified in the WM PEIS, those impacts have been included in the cumulative impacts analysis in Chapter 11 in Volume I of the WM PEIS.

Low-level waste and transuranic waste generated by high-level waste treatment and stabilization are not included in projected inventories. More information on the DOE High-Level Waste Program is provided in Section 9.1 in Volume I of the WM PEIS.

Comment (3617)
The WM PEIS needs to capture and quantify the human health risks, environmental impacts, and costs.

Response
The WM PEIS documents DOE's analysis of the human health risks, environmental impacts, and costs of alternatives to manage low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. When commentors have indicated specifically where the analysis was deficient or incorrect, DOE has made appropriate corrections and modifications. These changes are summarized in Volume I.

Comment (3689)
High-level wastes from commercial reactors that will become DOE's responsibility have been excluded from the WM PEIS. These wastes are also expected to go to the Yucca Mountain repository. The potential cumulative impacts of managing all high-level waste have not been addressed; therefore, the analysis is incomplete and not in compliance with NEPA. The commercial high-level waste is also an issue that will and has affected Native Nations. DOE's objective of sighting interim storage (monitored retrievable storage) on Native lands is highly contentious, if not despicable, creating great tensions and divisions within the Native Nations that have been approached. What is particularly important to understand about the potential monitored retrievable storage sites is that there is no reason to believe they would be temporary.

Response
Commercial nuclear reactors generate spent nuclear fuel, not high-level waste. Spent nuclear fuel is not a waste, and thus, outside the scope of the WM PEIS. Disposal of high-level waste and spent nuclear fuel at Yucca Mountain will be the subject of a separate NEPA review. Storage of spent nuclear fuel in a monitored retrievable storage facility is outside the scope of the WM PEIS.

Comment (3766)
When handled properly, hazardous waste is no threat to workers or the public. It is disposed of commercially at licensed facilities. Including hazardous waste in this study diverts the public from the real issues. DOE needs to put the hazardous waste issues to bed.

Response
The WM PEIS focuses on mixed radioactive and hazardous waste in the analysis of mixed low-level waste and transuranic waste, as well as the analysis of hazardous waste that does not contain radioactive elements. The management decision for purely hazardous waste was limited to examining whether more onsite treatment of organic wastes should occur, versus continued reliance on commercial facilities, considering that sites are also being evaluated for organic destruction facilities to treat mixed low-level waste and transuranic waste. This analysis allows DOE to consider multiple uses for its organic destruction facilities, and provides the public a more complete picture of the impacts of possible DOE activities. DOE did not evaluate disposal alternatives for hazardous waste, leaving such decisions to site-specific processes. Omission of hazardous waste in the WM PEIS would have represented a gap in DOE's analysis of alternatives for radioactive and hazardous waste that would have rendered the analysis incomplete.

Comment (4018)
The WM PEIS omits nearly 600,000 metric tons of depleted uranium currently in the DOE waste inventory. Disposition and disposal of depleted uranium is a clearly foreseeable significant Federal action with direct and indirect impacts to both human health and the natural environment, and is a most serious omission. Disposition and disposal of depleted uranium should be fully addressed and the WM PEIS should be reissued.

Response
DOE does not consider depleted uranium [primarily in the form of depleted uranium hexafluoride (DUF_6)] a waste. However, as stated in Section 1.8.1 in Volume I of the WM PEIS, which discusses the relationship of other NEPA reviews to the WM PEIS, the Long-Term Management of Depleted Uranium Hexafluoride EIS will evaluate alternative strategies for long-term management of DOE-owned DUF_6 currently stored at the K-25 Site in Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio.

Comment (4020)
Referencing the SNF/INEL PEIS in the WM PEIS does not adequately address disposition of spent nuclear fuel. The dangers of increasing high-level liquid wastes should be fully addressed in the WM PEIS. The material should not be made, sold, or transported.

Response
U.S. Government-owned and foreign reactor spent nuclear fuel are addressed in separate NEPA reviews, which are identified in Section 1.8.1 in Volume I of the WM PEIS. Section 1.8.1 provides

11.3 Scope

brief discussions of the relationship of these documents to the WM PEIS, and the PEIS considers impacts from other programs on the waste management complex. For example, Section 9.4.4 in Volume I discusses the potential reprocessing of foreign research reactor spent nuclear fuel at SRS, and the high-level waste resulting from that activity. Also, Chapter 11 in Volume I of the PEIS includes the results of the SNF/INEL EIS and the Foreign Research Reactor Spent Fuel EIS in assessing cumulative impacts.

DOE assumes the comment concerns high-level liquid wastes generated during reprocessing of spent nuclear fuel and irradiated targets in nuclear defense, research, and production activities. The analysis of high-level waste management in the PEIS pertains to the interim storage of vitrified high-level waste in canisters only. Management involving storage of liquid high-level waste was not considered in the WM PEIS, as discussed in Section 9.1.1 in Volume I. Management of liquid high-level waste would occur onsite and, therefore, has or will be addressed in site-specific NEPA analyses.

Comment (4025)
Treatment of high-level waste and the direct and indirect impacts of this clearly foreseeable agency action upon human health and the environment have been omitted [from the WM PEIS]. DOE should include high-level waste treatment in a programmatic EIS.

Response
The decision to vitrify high-level waste is explained in Section 9.1. Thus the treatment of high-level waste is not within the scope of the EIS. The NEPA documents that analyze current treatment of high-level waste at Hanford, INEL, SRS and WVDP are identified in Sections 9.1.2.1, 9.1.2.2, 9.1.2.3, and 9.1.2.4, respectively. The effects of high-level waste treatment are contained in Chapter 11, Cumulative Impacts. Since decisions about treatment of high-level waste were made or were being studied during the development of the WM PEIS, the treatment decisions were not included in the WM PEIS. The WM PEIS analyzes only the impacts of storing vitrified high-level waste.

Comment (4027)
The WM PEIS does not consider buried transuranic waste even though it constitutes the most urgent and serious of transuranic waste problems. DOE should include buried transuranic waste in the WM PEIS, not merely reference the Environmental Restoration PEIS.

Response
Buried (pre-1970) transuranic waste is considered environmental restoration waste. Appendix B in Volume III of the WM PEIS discusses how those environmental restoration wastes for which responsibility could be transferred to the Waste Management Program could influence the comparison among waste management alternatives. Note that DOE is not preparing an Environmental Restoration PEIS.

Comment (4140)
The WM PEIS was supposed to be a comprehensive document. It should include all waste in the complex, including plutonium, impacts of civilian reactor fuel, and impacts of importing foreign spent fuel and naval wastes.

11.3 Scope

Response
NEPA and CEQ implementing regulations do not require DOE to consolidate all its programs into a single NEPA document. Volume I, Section 1.5.6 of the WM PEIS identifies waste types not considered in the PEIS and explains why they were not considered. Spent nuclear fuel is addressed in the SNF/INEL PEIS and the Foreign Research Reactor Spent Nuclear Fuel plutonium stored at Hanford is addressed in two ongoing DOE programmatic studies that address storage and disposition of fissile materials and stockpile stewardship and management. However, the WM PEIS cumulative impacts analysis (see Chapter 11) includes estimates of impacts from other programs including domestic and foreign research reactor spent nuclear fuel, plutonium, and high-level waste treatment. The impacts of civilian reactor fuel will be analyzed in the Yucca Mountain Repository EIS.

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

Comment (133)
Clarify how the WM PEIS fits into the overall DOE complex-wide issues and comprehensive planning, and its relationship to the Baseline Environmental Management Report (BEMR), the Federal Facility Compliance Act (FFCAct) and Site Treatment Plans, and the Risk Report. Explain how decisions on various wastes, and in documents such as the WM PEIS, Site Treatment Plans, BEMR, and EISs for other projects will be integrated at both a higher and lower level, that is, at a system-wide and a sitewide level. Clarify where and when such integration will occur. DOE should explain the separate system, if any, for managing environmental restoration and environmental management wastes.

Response
The WM PEIS is a nationwide study to help DOE develop a strategy to manage five waste types (low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste) in the nuclear weapons complex. The WM PEIS is one tool DOE will use in deciding how and where it will manage its radioactive and hazardous wastes. DOE needs to ensure safe and efficient management of these wastes and to comply with all applicable Federal and State laws to protect public health and safety.

The WM PEIS identifies the potential cost and environmental impacts of alternative waste management scenarios that could be implemented for each type of DOE waste. After selecting the overall strategy that identifies where DOE will locate waste management facilities, DOE would conduct site-specific NEPA reviews, as necessary, before building any waste management facilities or transporting waste.

Along with other studies such as BEMR, FFCAct STPs, and other EISs, the WM PEIS provides decisionmakers with a national perspective to compare impacts of various strategies. Section 1.8.2 in Volume I of the WM PEIS discusses the other actions and programs taken into account in the PEIS. DOE has updated Section 1.8.1 to include new information and additional relevant EISs.

BEMR is a DOE report required by Congress to specify all activities and projects within the Environmental Management Program. The most current BEMR, submitted in June 1996, was based on a broad range of assumptions regarding the outcome of various decisionmaking processes that will determine the ultimate disposition of DOE facilities and sites and, thus, the scope and pace of the program. One of the key assumptions was related to the location of sites for waste management facilities. BEMR used *current* plans and agreements to define where wastes could be treated and disposed of. The WM PEIS, however, examined alternative configurations in addition to the one which DOE is now using to develop the BEMR cost estimates.

The FFCAct waives the sovereign immunity of DOE by allowing States and EPA to impose penalties for noncompliance with RCRA and requires DOE to develop plans for developing treatment capacity for treating the hazardous components of radioactive wastes (i.e., mixed wastes) subject to RCRA requirements. Pursuant to the FFCAct, STPs are developed by DOE with involvement by the States and EPA. The preparation of the WM PEIS has been accomplished in parallel with the process for development of the STPs.

The Risk Report, which was prepared in 1995, relates to the prioritization of DOE environmental restoration and waste management activities. It used information from many sources, including the WM PEIS. The Risk Report evaluated risk to workers, to the public, and to the environment from all

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

Environmental Management Program activities, not just cleanup. The Final WM PEIS describes the Risk Report in Section 1.8.2 in Volume I.

DOE's Environmental Management Program includes the Waste Management and Environmental Restoration Programs. The Environmental Restoration Program encompasses remedial actions and decontamination and decommissioning. Section 1.8.2 of the WM PEIS includes a description of the Environmental Restoration Program. The waste generated from environmental restoration activities is not analyzed in the WM PEIS because of the site-specific nature of these activities. However, Appendix B of the WM PEIS presents estimated volumes of environmental restoration wastes that could come into the waste management complex and discusses how environmental restoration activities could influence the Waste Management Program.

DOE has for several years explored alternatives for public participation in decisionmaking and policy development for waste management and environmental restoration. Such alternatives vary, depending on the nature of the activity to be discussed or the pending decision. For example, public participation in DOE activities regarding environmental restoration frequently occurs at the site level, because these activities typically concern site-specific cleanup actions. In such cases, DOE uses a variety of methods to provide the public with opportunities for dialogue, including general public meetings and forums and participation in site advisory boards. Recent efforts to enhance public participation in decisionmaking include the National Dialogue and Environmental Management Ten Year Plan discussed in Section 1.8.2 in Volume I of the WM PEIS. Additionally, Appendix A in Volume III outlines the means for public involvement in planning and decisionmaking for DOE's environmental restoration activities.

Comment (153)
The assumption made for Hanford that defense waste will be treated, stored, and disposed of in accordance with the Hanford Defense Waste EIS is wrong.

Response
The commentor is correct. The management strategy in the Hanford Defense Waste EIS has been superseded by the Hanford Tri-Party Agreement. The Hanford Defense Waste EIS, however, is used in Chapter 9 (Volume I) of the WM PEIS only as a source of estimates of volumes of high-level waste at Hanford and for defining the No Action Alternative. DOE acknowledges the role of the Tri-Party Agreement in waste management actions at Hanford and discusses the Tri-Party Agreement in Section 9.3.5.

Comment (160)
FEMP's existing Records of Decision, Consent Agreements, and Site Treatment Plans, especially the 10-year accelerated remediation plan, should not be impacted by the WM PEIS.

Response
The preparation of the WM PEIS was accomplished in parallel with the development of the Site Treatment Plans. DOE assumes the commentor is referring to CERCLA Records of Decision. Existing Records of Decision and agreements will be considered in programmatic waste management decisionmaking. DOE does not anticipate that its programmatic waste management decisions would impede cleanup plans at FEMP. However, it is possible that some site-specific decisions will need to be revisited as a result of the decisions stemming from the WM PEIS. DOE recognizes that specific procedures, including consultation

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with stakeholders and regulatory authorities, would need to be followed before previous site-specific decisions could be altered to conform to programmatic strategies.

Comment (489)
The WM PEIS needs to include a discussion of waste inventories associated with weapons dismantlement materials and highly enriched uranium disposition.

Response
Section 1.8.1 of the Final WM PEIS discusses related NEPA documents, such as those which analyze weapons-usable fissile materials including the Stockpile Stewardship and Management PEIS and the Storage and Disposition of Weapons-Usable Fissile Materials PEIS, and highly enriched uranium in the Disposition of Surplus Highly Enriched Uranium EIS. The total amount of weapons-usable plutonium and highly enriched uranium considered for disposition, as wastes or for reuse, is approximately 250 metric tons, an amount that is small in comparison to other DOE wastes. Wastes resulting from those actions under DOE initiatives would be treated, stored, and disposed of in accordance with the decisions based on the WM PEIS. In addition, the Pantex Plant Sitewide EIS identifies wastes generated from various levels of weapons dismantlement activities.

Comment (508)
What environmental documentation would determine how waste destined for the WIPP in New Mexico would have to be treated to qualify for disposal at that facility? What is the schedule for completing the WIPP Disposal Phase Supplemental EIS (WIPP SEIS-II)?

Response
The Draft WIPP SEIS-II was issued for public review in November 1996. The Record of Decision is scheduled to be issued in June 1997. As described in Volume I, Section 1.8.1 of the WM PEIS, the WIPP SEIS-II will be used to inform DOE's decision on the minimum level of treatment needed to meet the waste acceptance criteria for transuranic waste disposal at WIPP.

Comment (509)
DOE needs to explain how the WM PEIS relates to other EISs on such issues as transportation and cultural resources.

Response
Section 1.8 in Volume I of the WM PEIS describes the relationship of this PEIS to other actions and programs, including other EISs. Sitewide or project-level NEPA documents are generally more precise than programmatic NEPA documents with regard to detailed site parameters, including transportation and cultural resources.

Chapter 11 in Volume I describes cumulative impacts, including impacts described in other EISs. Some impacts that were addressed in the individual waste-type chapters of the WM PEIS were not considered in the cumulative impacts analysis for various reasons. For example, impacts to cultural resources were not combined because they depend on location-specific factors and mitigation developed during implementation, which are not addressed in this programmatic EIS. DOE updated Section 1.8 (formerly Section 1.7.4) and Chapter 11 of the WM PEIS to include new information and additional relevant EISs.

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Comment (1103)
DOE should clearly explain the importance of the WM PEIS to activities at the FEMP.

Response
The WM PEIS is directly relevant to the low-level mixed waste activities at FEMP because it evaluates the effects of the waste management facilities required to treat and dispose of the site's low-level mixed waste volumes. Chapter 6 in Volume I of the WM PEIS describes the impacts of the alternatives of managing low-level mixed waste at FEMP. FEMP was also included as a candidate site for management of low-level waste. However, since all onsite low-level waste at FEMP is currently considered to be environmental restoration waste, it was not evaluated. Some offsite low-level waste was evaluated for treatment at FEMP under Regionalized Alternative 2, as described in Chapter 7 (Volume I).

Because the WM PEIS does not address environmental restoration actions and decisions, it is not as relevant to such activities at FEMP. The cumulative effects that could occur from the implementation of waste management activities and environmental restoration activities are discussed in Chapter 11 in Volume I; however, radiological effects of environmental restoration activities at FEMP are not included in the cumulative analysis because of differences in analytical approaches. The analyses of environmental restoration activities report health effects as Incidental Lifetime Cancer Risk (ILCR). ILCR includes risks from radionuclide and chemical exposure. Therefore, ILCRs cannot be added directly to the radiological dose and latent cancer fatality risk parameters used in the WM PEIS cumulative impacts section. The PEIS also discusses the relationship of environmental restoration waste volumes projected to be transferred to the Waste Management Program and how that transferred waste could affect the comparison among waste management alternatives (see Appendix B, Volume III).

Comment (1138)
Several commentors stated that preparing a separate PEIS on waste management is segmentation. Commentors stated that there should be a comprehensive analysis of production, waste management, and environmental restoration in one PEIS, but that DOE has continued to proliferate PEIS's to prevent such a comprehensive analysis. Rather than having one comprehensive PEIS or even the two that DOE announced in 1990, DOE now has seven PEISs--Spent Fuel, Foreign Research Reactor Nuclear Fuel, Tritium, Stockpile Stewardship and Management, Fissile Materials, Highly Enriched Uranium, and Waste Management--and still no PEIS for environmental restoration. One commentor stated that all activities with the potential to release radionuclides and hazardous chemicals should be analyzed together to calculate the total dose of all combined releases.

Response
NEPA and CEQ implementing regulations recognize that separate NEPA reviews are justified for an agency's programs due to timing or the need for specificity or in-depth analyses. By preparing separate environmental impact analyses on a number of extremely complex subjects, DOE has not ignored a comprehensive analysis (as suggested in the comment), but rather has developed a more in-depth body of information by preparing a number of PEISs. Moreover, the cumulative impacts analysis in this WM PEIS (Volume I, Chapter 11) includes the impacts of the preferred alternatives in the NEPA analyses prepared for other DOE programs, allowing DOE to evaluate the impacts of DOE's operations as a whole.

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Preparing separate EISs on separate but related programs does not avoid the necessity for coordination among the programs to ensure integrated decisions and consistent presentation of information. DOE, therefore, has made every effort to ensure that the WM PEIS is generally consistent with other related EISs, including those cited in the comment. Section 1.8 in Volume I of the WM PEIS discusses these related EISs, as well as other DOE programs, and their relationship to the WM PEIS.

DOE reviews every proposal to prepare a NEPA document to determine if the decision is sound and in compliance with CEQ regulations and guidelines on segmentation and interim actions. Any decision to prepare a NEPA document, including those listed by the commentor, must comply with those criteria. DOE believes that the preparation of one environmental impact statement on all DOE activities (operations, environmental restoration, and waste management) would necessarily be so broad that it would result in an essentially meaningless and unmanageable analysis. DOE is committed, as a matter of policy, to prepare sitewide EISs for most of its large, multi-facility sites. DOE believes that sitewide analyses result in a meaningful assessment of all of DOE activities at a particular location.

Section 1.7.1 in Volume I of the WM PEIS describes the DOE rationale for not including environmental restoration impacts in the PEIS. DOE determined that its original intention to include both environmental restoration and waste management was not appropriate, primarily because environmental restoration decisions tend to be site-specific and, therefore, do not lend themselves to programmatic decisions.

The WM PEIS does contain information on the anticipated waste volumes generated as a result of restoration activities and a qualitative discussion of the extent to which those environmental restoration waste volumes, for which responsibility could be transferred to the Waste Management Program, could affect the comparison among waste management alternatives. See Appendix B in Volume III, and Sections 6.15, 7.15, and 8.15 in Volume I.

The impacts of environmental restoration activities will be evaluated in separate site-specific environmental analyses prepared in support of the RCRA corrective action and CERCLA remedial action processes.

Comment (1517)
The PEIS is a wholesale segmentation of environmental review because waste remediation is being considered separately from waste management.

Response
Section 1.7.1 in Volume I of the WM PEIS describes DOE's rationale for not including environmental restoration impacts in the PEIS. DOE determined that its original intention to include both environmental restoration and waste management was not appropriate, primarily because environmental restoration decisions are site-specific and, therefore, do not lend themselves to programmatic decisions.

The WM PEIS focuses on waste management alternatives. It does not analyze environmental restoration alternatives, but it does contain information on the anticipated waste volumes generated as a result of restoration activities and a qualitative discussion of the extent to which such volumes could affect the comparison among waste management alternatives. See Appendix B in Volume III.

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Chapter 11 in Volume I describes the cumulative impacts for each site from a number of different programs. To the extent possible, Chapter 11 considers environmental restoration and existing operations.

Comment (1611)
DOE needs to correct the inconsistencies between documents such as the Baseline Environmental Management Report, the NTS EIS, and the WM PEIS. For example, the number of waste shipments and amount of waste analyzed for NTS differ greatly from document to document. Conflicting information can damage DOE's credibility.

Response
The WM PEIS evaluates programmatic alternatives concerning DOE's management of five waste types in the nuclear weapons complex. As such, it must address waste amounts in a more general way than individual site projects or programs. Volume I, Section 1.8, explains the relationship between the WM PEIS and the other documents cited by the commentor.

Inconsistencies in waste data among documents arise for several reasons. Waste inventories change over time as the waste is treated or disposed of and as new waste is generated. Furthermore, characterization of the waste can result in reclassification to a different waste type. For example, waste assumed to be transuranic waste might be found to actually be low-level waste upon more thorough testing. Waste generation estimates could change as estimates of future work and technologies change. Accordingly, waste data reported in documents produced at different times might be somewhat different.

In addition, the time periods analyzed in other documents might be different, resulting in different totals being reported. For example, the WM PEIS analysis covers 20 years in order to better compare a wide variety of treatment and disposal alternatives. The Baseline Environmental Management Report was a report mandated by Congress that was required to consider all waste generated throughout the life of the waste management complex.

Comment (1614)
There is a need for a national level of dialogue on low-level waste disposal, which is being ignored by the segmented approaches of the various DOE EISs.

Response
DOE recognizes the need to develop an effective decisionmaking process to integrate waste management and radioactive materials disposition. In 1995, DOE began a "National Dialogue" on radioactive waste and materials dispositions through discussions with interested States, site-specific advisory boards, and their forums on these issues. This process is described in Volume I, Section 1.8.2.

In addition, DOE has completed a comprehensive Department-wide review of its management of low-level waste and the radioactive component of low-level mixed waste, which includes evaluation of low-level waste disposal. The Final Complex-Wide Review Report, available in DOE public reading rooms, was published April 30, 1996, and will be used in conjunction with the WM PEIS to make decisions on low-level waste management. The complex-wide review is further described in Section 1.8.2 in Volume I of the WM PEIS. DOE public reading rooms are listed in Section 1.9 in Volume I of the Final WM PEIS.

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Comment (1662)
Discrepancies identified in current environmental documents related to the shipment and disposal of low-level waste contribute to an incoherent proposal from DOE. Shipping volumes are up to five times higher than volumes reported in the NTS EIS. A comprehensive response to the WM PEIS is not possible without resolution of these discrepancies.

Response
Discrepancies in the shipment numbers exist due to the 20-year analysis period assumed by the WM PEIS as compared to 10 years for the NTS EIS, and shipments based on weight (most shipments were estimated to be weight- rather than volume-limited) in the WM PEIS versus volume, as in the NTS EIS. The WM PEIS results are valid for programmatic decisionmaking because the same assumptions were used for all alternatives and the relative potential risks provide the necessary information to evaluate programmatic alternatives.

During the preparation of the WM PEIS, DOE reviewed other NEPA documents, including the NTS EIS, to ensure that these documents present information that is as consistent as possible. DOE acknowledges that some estimated values in the WM PEIS might be higher than comparable values presented in site-specific NEPA documents. DOE believes that the use of these higher, more conservative values is acceptable because they include the potential impacts of the actions discussed in the lower tier evaluations and provide programmatic flexibility to accommodate frequently changing inventory projections.

Comment (1667)
The NTS EIS reported relatively low total risks, and the percentage of health effects due to the radiological nature of the cargo are a small percentage of the total risk. In the WM PEIS, the total number of predicted health effects and the percentage of health effects due to low-level waste radiation are potentially significant.

Response
The primary differences in estimated routine exposures between the WM PEIS and the NTS EIS are due to shielding considerations and the assumed values for the external dose rates from low-level waste shipments. As discussed in Section E.6.2.2 in Volume IV, the PEIS used an external dose rate of 1 millirem per hour at 1 meter for the low-level waste shipments. This estimate, which is based on historic DOE low-level waste shipments, is appropriate for the Department-wide programmatic nature of the WM PEIS. The NTS EIS based its estimated external dose rates on site inventories and assumed shipment configurations, resulting in some dose rates that were as much as two orders of magnitude less than 1 millirem per hour at 1 meter. In addition, the PEIS took no credit for potential shielding between the waste package and the crew or the public, in order to be conservative by tending to overestimate doses. On the other hand, the NTS EIS factored in mitigation measures in order to keep radiation exposure as low as reasonably achievable, thereby reducing the estimated exposure doses to the crew and public.

Accordingly, estimated health effects from radiological exposure during the routine transportation of low-level waste are higher in the WM PEIS than in the NTS EIS. At the same time, estimated nonradiological fatalities from physical trauma are roughly equivalent on a per kilometer basis. Therefore, the percentage of estimated radiological health effects (potential fatalities) is higher in the WM PEIS low-level waste transportation assessment than in the NTS EIS.

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DOE reviewed other NEPA documents, including the NTS EIS, to ensure that, to the extent possible, those documents present consistent information. However, some of the values used in the WM PEIS might be higher than some used in project-level or sitewide EISs. In most cases, this is acceptable because the PEIS estimates tend to overestimate the impacts of the site-specific analyses. Two Centralized Alternatives in the WM PEIS propose that the NTS dispose of all low-level waste within the complex. Disposing of these large volumes of low-level waste would result in higher risks than those reported in NTS site-specific document.

Comment (1690)
Referring to Volume I, Section 1.7.4, a commentor asked whether portions of the Baseline Environmental Management Report (BEMR) relating to the opening dates of key facilities (e.g., WIPP, Yucca Mountain, etc.) were used in the WM PEIS or was an independent analysis of the openings performed by the PEIS?

Response
The BEMR analysis was not directly used in determining the opening dates for the national geologic repository and WIPP. Volume I of the 1996 BEMR indicates that the BEMR analysis assumed that high-level waste would be accepted by the national geologic repository beginning in 2016, with WIPP accepting waste in 1998. For the high-level waste repository, the BEMR and WM PEIS analysis differ. It was assumed in the WM PEIS that the national geologic repository would start accepting high-level waste in 2015. As stated above, the BEMR analysis assumes a delay to 2016 for the national geologic repository. The potential impacts of delaying opening of the high-level waste national geologic repository were evaluated in the WM PEIS for Centralized Alternative 2. The potential impacts of the first 20 years of longer term storage of transuranic waste at the treatment sites, assuming a delayed opening of WIPP, are analyzed in the WM PEIS under the transuranic waste No Action Alternative. The impacts of storage beyond 20 years are analyzed as part of the No Action Alternatives in the WIPP SEIS-II.

Comment (2147)
One commentor asked when the U.S. agreement on the receipt of European spent fuel would expire.

Response
DOE analyzed foreign research reactor fuel in the Foreign Research Reactor Spent Nuclear Fuel EIS. The Record of Decision was issued in May 1996. This agreement allows for acceptance of spent nuclear fuel from 1996 to 2009.

Comment (2189)
DOE is already implementing alternatives at PGDP that are a part of the decisionmaking process associated with the WM PEIS. This violates CEQ regulations under limitation of actions. Vitrifying waste limits the alternatives available to the site for transuranic waste treatment.

Response
DOE is preparing some site-specific NEPA documents on waste management facilities in parallel with the preparation of the WM PEIS to expedite compliance with site-specific agreements, the Federal Facility Compliance Act, and its responsibilities under NEPA. For example, PGDP has several agreements with the Commonwealth of Kentucky and EPA Region IV that require PGDP to treat and

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dispose of its RCRA and Toxic Substances Control Act waste within 1 year. Prior to a startup of the vitrification project, PGDP will have conducted a NEPA review.

The WM PEIS will not be used to select waste management technologies and, therefore, does not analyze alternative technologies. Any technologies used in the WM PEIS analyses were used as representative technologies only, for the purpose of comparing potential impacts of waste management activities across sites. Therefore, the implementation of a specific technology, such as waste vitrification, at a site prior to the completion of the WM PEIS would not limit the WM PEIS alternatives.

Any actions undertaken by DOE at PGDP before the Final WM PEIS is issued will have complied with the limitations on action during the development of a programmatic EIS set forth in 40 CFR 1506(c). However, once decisions are made resulting from the WM PEIS, prior sitewide or project-level decisions may be reevaluated to ensure consistency with the subsequent programmatic decisions. More detail on the relationship of the WM PEIS to other NEPA documents is provided in Section 1.8.1 in Volume I of the WM PEIS.

Comment (2244)
There is a chart in the WM PEIS that lists EISs and related material. Clarify how these documents relate to the PEIS, impact the PEIS, and explain how these EISs interact.

Response
Section 1.8.1 in Volume I of the Final WM PEIS provides a comprehensive description of other EISs that are related to the WM PEIS, including a discussion of how they relate to or impact the PEIS. Chapter 11 in Volume I contains a summary of cumulative impacts at each of the 17 sites, including the impacts identified in other related studies.

Comment (2245)
The WM PEIS should clarify if DOE will conduct site-specific NEPA studies before waste management alternatives are implemented.

Response
Volume I, Section 1.7.3, states that DOE will use the analyses presented in the PEIS to decide on a programmatic or strategic approach to managing its waste. DOE intends to select a configuration of DOE sites for waste management activities on the basis of the WM PEIS and other factors. The level of analysis in the WM PEIS is appropriate for making broad programmatic decisions on what DOE sites should be used for waste management. At the programmatic level, however, it is not possible to take into account special requirements for particular waste streams, different technologies that are or may be available to manage particular wastes, or site-specific environmental considerations such as the presence of culturally important resources or endangered species at a specific location on a site. DOE will rely upon other NEPA reviews, primarily ones that evaluate particular locations on sites or projects (sitewide or project-level reviews), for these analyses. Thus, decisions regarding specific locations or technologies for waste management facilities at DOE sites or the waste management technologies to be used will be made on the basis of sitewide or project-level NEPA reviews.

In addition, Section 1.8 and Chapter 11, discuss project-level and site-specific NEPA documents which consider waste management facilities in parallel with the preparation of the WM PEIS.

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Comment (2255)
The WM PEIS used data that was generated for the Baseline Environmental Management Report (BEMR), which was never subjected to public reviews. Using the waste volume information from that report as a basis for this PEIS might be inappropriate. Furthermore, WM PEIS Appendix B notes that the environmental restoration waste volumes expected to come into the Waste Management Program do not appear in the published volumes of BEMR, but were provided from internal BEMR working documents. If DOE is going to continue to use BEMR-generated information, that material should be released for public comment so that we can make certain that we all agree that the assumptions are correct.

Response
It would be impractical to submit all source information for public review and approval. To be consistent, it was appropriate to use the environmental restoration waste data from BEMR. The Final WM PEIS includes environmental restoration waste data used for the 1996 BEMR (see Appendix B in Volume III). These are the latest available data and have been approved by the sites and by the DOE Environmental Restoration Program.

Comment (2264)
In Section 1.7.4 in Volume I of the PEIS, there is a fairly comprehensive list of relevant NEPA processes and other EISs. Listing these EISs is not sufficient. The entire pie should be put on the table so that everyone in this country has an opportunity to evaluate what the risks are, determine what the capabilities are in their particular part of the country for dealing with these risks, and equitably distribute the risks, once and for all. The piecemeal approach is a coverup for DOE's problems, and the public around Hanford will not stand for it.

Response
DOE is committed to providing as much information as possible to the public so the Department can receive informed comments and public input. There is no coverup of information, but rather an open and honest attempt to address a number of complex issues, some related and others not related to DOE's Waste Management Program. By preparing separate EISs on a number of complex subjects, DOE has not prevented a comprehensive analysis, as suggested in the comment, but rather has developed a more in-depth body of information.

The DOE Waste Management Program is separate and distinct from other programs, and DOE believes that it is appropriate to analyze it in this separate programmatic NEPA document. The WM PEIS is complex; it covers five major types of radioactive and hazardous waste. It does not include some wastes that DOE believes are not ready for the decisionmaking process, and other materials (e.g., spent nuclear fuel) because they are not wastes. However, DOE has, to the extent possible, included the impacts of these in the cumulative impact analysis in Volume I, Chapter 11.

DOE has revised Chapter 11 in the Final WM PEIS to provide a more comprehensive evaluation of other DOE actions that could affect the sites, including the Hanford Site.

DOE must select alternatives to meet the urgent national priority for safe and efficient waste management. While residents might perceive that one approach, such as Decentralization, offers particular benefits or damage to a community or region, DOE must base its final decision on the diverse national needs and issues that affect many sites and regions. DOE has revised its list of

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decision factors in Section 1.7.3 in Volume I to include equity. DOE will favor alternatives that tend to distribute waste management facilities in a manner that is equitable.

Comment (2301)
DOE must organize the timing and review of its WM PEIS and other related documents, to permit review, response, and interaction time for local review groups, etc., with those making the recommendations.

Response
DOE has provided a variety of opportunities for reviews by local groups over the past 6 years of this PEIS process, including the 5-month public review for the Draft WM PEIS. See Section 1.7.2 in Volume I of the Final WM PEIS, which describes public involvement and review for this PEIS. The timing of reviews of NEPA documents is determined by the NEPA requirements of individual programs. NEPA does not preclude holding simultaneous reviews of a number of independent NEPA documents. Volume I, Chapter 11, does provide information on the consequences of multiple actions for each site, to the extent that such information is available.

Comment (2318)
The WM PEIS should include the values of the Hanford Future Site Uses Working Group, values from the Tank Waste Remediation System Rebaselining Task Force, and comments and discussions from the public.

Response
The decision criteria and factors to be used in the cited reports contain valuable stakeholder Tribal Nation input and values and were considered in the selection of WM PEIS preferred alternatives (see Section 1.7.3 in Volume I). Input from the general public has occurred during the public scoping period, early in the development of the PEIS, and during the public comment period on the Draft WM PEIS.

Comment (2425)
The WM PEIS mentions that because of Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2, a DOE complex-wide review of low-level waste management is under way. It should also note that DNFSB's intent is to upgrade DOE low-level waste management, bringing it more in line with commercial and international standards.

Response
DOE has expanded the discussion of DNFSB Recommendation 94-2 in Volume I, Section 1.8.2, to more fully inform readers of the nature of the DNFSB concerns and DOE's actions to address those concerns.

Comment (2428)
Volume I, Chapter 1, discusses other actions under way and also quotes from 40 CFR 1506.1(c) regarding the taking of actions that might prejudice a NEPA decision. With all the other activities taking place in the DOE complex, how can they not bias this PEIS?

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Response
40 CFR 1506.1(c) does not restrict the performance of NEPA analyses or the issuance of EISs. This regulation prohibits agencies from taking other major Federal actions (i.e., the implementation of a Record of Decision) that would prejudice the ultimate decision on an EIS. An interim action prejudices the ultimate decision on the program when it tends to determine subsequent development or limit alternatives. DOE will review the implementation of each DOE Record of Decision to ensure there is no prejudice to the WM PEIS decisions, as noted in Volume I, Section 1.8.1. DOE evaluates every action it takes to ensure compliance with 40 CFR 1506.1(c) before it implements that action.

Comment (2571)
It is unclear how tiering works. The WM PEIS Summary document states that decisions regarding the actual location of waste management facilities at particular DOE sites will not be made on the basis of this PEIS, but rather will be the subject of site-specific NEPA documents. Then what is the purpose of this EIS? A site-specific waste management EIS has already been done for INEL and for SRS. How does the PEIS integrate the decisions made in these documents?

Response
The WM PEIS is a nationwide study to help DOE develop a strategy to manage five waste types (low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste) in the DOE complex. The WM PEIS is one tool DOE will use in deciding how and where it will manage its radioactive and hazardous wastes. DOE needs to ensure safe and efficient management of these wastes and to comply with all applicable Federal and State laws to protect public health and safety.

As described in Section 1.8.1 in Volume I of the Final WM PEIS, three levels or "tiers" of NEPA documentation may be prepared: programmatic, sitewide, and project-level. Programmatic documents, such as the WM PEIS, inform decisions on broad agency actions, such as the adoption of future proposed plans, programs, and strategies. The second-tier, sitewide NEPA documents, allow DOE to consider changes in the overall operation of a site, including mission changes, and provide a current environmental baseline for the site, both to support and to simplify project-level NEPA documents. The third-tier, project-level NEPA documents, evaluate the impacts of a specific project proposed for a specific location on a site, and are intended to identify and evaluate alternatives on how the facility should be sited, constructed, and operated. Sitewide NEPA documents, which evaluate projects that could be implemented in the near-term at a site, would also include project-level NEPA reviews if sufficient information is available to allow the proposed to be adequately analyzed.

Comment (2591)
How does the Final Tritium Supply EIS affect the cumulative impacts analysis?

Response
DOE published the Final Tritium Supply and Recycling PEIS in October 1995. It analyzes alternatives associated with new tritium production and recycling of tritium recovered from nuclear weapons retired from service. The Record of Decision based on the Tritium Supply and Recycling PEIS included two courses of action, either tritium production in a commercial reactor or development of an accelerator at SRS. The Tritium Supply and Recycling PEIS and its Record of Decision are included in the WM PEIS cumulative impacts analysis presented in Chapter 11 in Volume I. Table 11.17-2, the "Other Actions" column, includes impacts from the Tritium Supply and Recycling PEIS for SRS.

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Comment (2689)
Preferred alternatives selected by DOE do not appear to be contrary to the Nuclear Waste Agreement negotiated by the State of Idaho with DOE. This should be confirmed and documented in the WM PEIS for each preferred alternative.

Response
The WM PEIS is DOE's NEPA review for its Waste Management Program. NEPA requires Federal agencies to include a discussion of reasonable alternatives to the proposed action in an EIS. An agency must provide sufficient information for each alternative to allow reviewers to evaluate the comparative merits of those alternatives.

While the WM PEIS is a national and programmatic study to assist DOE in formulating and implementing a strategy for its Waste Management Program, actual programmatic decisions will be announced in Records of Decision. The decisions will be based on this WM PEIS, regulatory compliance, compliance with site agreements with States, national priorities, budgets, schedules, and other DOE studies. Thus, the decision process will include consideration of the Nuclear Waste Agreement.

Comment (2710)
The WM PEIS does not consider binding Records of Decision are in place at some sites that eliminate some alternatives considered in the WM PEIS.

Response
As discussed in Volume I, Section 3.2, the CEQ regulations implementing NEPA require Federal agencies to include a discussion of reasonable alternatives and provide sufficient information for each alternative, even if alternatives are not within the agency's jurisdiction (e.g., in conflict with current law), so that reviewers can evaluate the comparative merits of those alternatives. Sections 1.7.3 and 3.5 in Volume I discuss the methodology for identifying alternatives.

DOE will use the analyses presented in the WM PEIS to decide on a programmatic or strategic approach to managing its waste. DOE intends to select a configuration of DOE sites for waste management activities on the basis of the WM PEIS and other factors. DOE will rely upon other NEPA reviews, primarily ones that evaluate particular locations on sites or projects (sitewide or project-level reviews), for decisions regarding specific locations or technologies for waste management facilities at DOE sites or the waste management technologies to be used.

In addition to preparing sitewide or project-level NEPA reviews, DOE would also rely upon reviews that have already been completed. Existing sitewide and project-level NEPA analyses will be reviewed to determine whether modifications are needed to implement the decisions based on evaluations in the WM PEIS.

Comment (3034)
Table 1.7-1 overlooks the Hanford Remedial Action EIS and the Fissile Materials and Pantex EISs, which include options affecting the Hanford Site.

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Response
Section 1.8.1 in Volume I of the Final WM PEIS includes a more comprehensive discussion of related NEPA documents, including those mentioned by the commentors.

Comment (3169)
A commentor is concerned that the WM PEIS used the Baseline Environmental Management Report as its source for estimated waste volumes and urges DOE to work with individual sites to verify and validate these estimates, as well as other identified assumptions.

Response
The estimates of waste volumes used in the 1996 Baseline Environmental Management Report were actually taken from baseline reports originally generated by each site to support the WM PEIS and program planning efforts. As described in WM PEIS Appendix B (Volume III) and Sections 6.15, 7.15, 8.15, and 10.15 (Volume I), environmental restoration waste volumes were updated for the Final WM PEIS based on the database used for the 1996 Baseline Environmental Management Report, which was the best information available when the Final WM PEIS was prepared. The environmental restoration waste volumes at certain sites have substantially increased based on the updated data. The WM PEIS contains a qualitative discussion on the potential transfer of some environmental restoration wastes to Waste management Program responsibility. Much of the environmental restoration waste is likely to be managed in place or in environmental restoration facilities. Environmental restoration waste management decisions will be made on a site-by-site basis.

Comment (3174)
It is essential that DOE submit the risk analysis in the Hanford Remedial Action EIS, the Tank Waste Remediation System EIS, and the WM PEIS to independent technical peer review and then through a second review by Federal, State, Tribal agencies and departments before publication of final EISs and Records of Decision. The public and regulators cannot assess the technical adequacy of the risk analyses in these EISs in a 30 to 60 day comment period.

Response
The issues analyzed in the Hanford Remedial Action and Tank Waste Remediation System EISs are outside the scope of the WM PEIS, which is a national and programmatic study on DOE's Waste Management Program. The WM PEIS risk analysis used state-of-the-art models and conservative assumptions. The health risk methods were subjected to peer review by EPA and others before being used in the WM PEIS. Moreover, DOE provided a 150-day public comment period to allow for detailed review.

Comment (3276)
Storage alternatives for high-level waste are not sufficiently analyzed. While the WM PEIS states that high-level waste treatment and disposal are not within the range of decisions to be considered under this PEIS, treatment and disposal are integral parts of a comprehensive waste management policy. Assuming the existence of and then analyzing a single disposal alternative, Yucca Mountain in this case, is contrary to the intent of NEPA.

Response
The treatment of high-level waste is not within the scope of the WM PEIS, as explained in Volume I, Section 9.1.1. However, impacts related to high-level waste treatment, where known, have been added

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

to the revised cumulative impacts analysis sections of Chapter 11 for the Hanford Site, INEL, SRS, and WVDP. These estimates of potential risks from recent site-specific NEPA analyses (e.g., Hanford Tank Waste Remediation System and WVDP Completion and Closure EISs) are based on additional detailed site-specific information.

Impacts from transportation of high-level waste are included in the cumulative impacts analysis in Volume I, Section 11.20 of the WM PEIS. Impacts from high-level waste disposal at Yucca Mountain are not included in the cumulative impacts section for NTS because the Yucca Mountain Repository EIS is just getting under way. If the high-level waste repository is not established at Yucca Mountain, DOE would have to reevaluate long-term plans for disposition of high-level waste. The WM PEIS does not analyze environmental impacts of disposal at Yucca Mountain or alternative locations for a geologic repository. However, the WM PEIS does analyze the environmental impacts of the longer term storage of treated high-level waste in the event that the construction and operation of a national geologic repository is delayed. Impacts from the construction, operation, and closure of a geologic repository would be examined in the Yucca Mountain Repository EIS.

Comment (3553)
It is not clear how the WM PEIS will tier down to site-specific EISs for waste management. DOE seems to be equally perplexed with the information presented--only three preferred alternatives are tentatively identified.

Response
The WM PEIS is a nationwide study to help DOE develop a strategy to manage five waste types (low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste) in the DOE complex. The WM PEIS is one tool DOE will use in deciding how and where it will manage its radioactive and hazardous wastes. DOE needs to ensure safe and efficient management of these wastes and to comply with all applicable Federal and State laws to protect public health and safety.

As described in Section 1.8.1 in Volume I of the Final WM PEIS, three levels or "tiers" of NEPA documentation may be prepared: programmatic, sitewide, and project-level. Programmatic documents, such as the WM PEIS, inform decisions on broad agency actions, such as the adoption of future proposed plans, programs, and strategies. The second-tier, sitewide NEPA documents, allow DOE to consider changes in the overall operation of a site, including mission changes, and provide a current environmental baseline for the site, both to support and to simplify project-level NEPA documents. The third-tier, project-level NEPA documents, evaluate the impacts of a specific project proposed for a specific location on a site, and are intended to identify and evaluate alternatives on how the facility should be sited, constructed, and operated. Sitewide NEPA documents, which evaluate projects that could be implemented in the near-term at a site, would also include project-level NEPA reviews if sufficient information is available to allow the proposed to be adequately analyzed.

NEPA and CEQ implementing regulations require the Federal agency to identify preferred alternatives, if known, in the Draft EIS, and to identify preferred alternatives in the Final EIS unless another law prohibits the expression of such a preference. In accordance with the law, the Final WM PEIS identifies a preferred alternative for each waste type. DOE identifies its preferred waste management alternatives and the reasons they are preferred in Section 3.7 of the Final PEIS.

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

Comment (3680)
It is the taxpayers who have paid trillions of dollars for research to find a safe method of high-level waste disposal. After 50 years of assumptions that a safe method would be chosen, none has been found. It is time to take a hard look at the reality of the situation. Segmenting or narrowing the scope of managing nuclear materials as well as divorcing past contamination and clean-up from the total management scheme, only minimizes a problem that is global in its presence and implications. DOE alone cannot undertake the requisite hard look and analysis. In the least, every facet of the Federal Government needs to cooperate and discuss the problem. Most importantly, the public, including Native Nations, must be co-equals in this discussion.

Response
By preparing separate environmental impact analyses for a number of extremely complex subjects, DOE has not minimized the various issues surrounding nuclear materials and waste management, but rather has developed a more in-depth body of information. Moreover, the cumulative impacts analysis in this WM PEIS (Volume I, Chapter 11) includes the impacts for the preferred alternatives analyzed in other DOE NEPA documents, and the impacts of other DOE programs. This allows consideration of impacts from DOE operations as a whole.

DOE has and will continue to comply with the NEPA requirements for consulting with other Federal agencies, Native Nations, and State and local agencies with jurisdiction by law or special expertise with regard to the proposed actions analyzed in DOE NEPA documents.

Comment (3690)
Commentors asked whether there is another EIS on the vitrification of high-level waste (HLW) and stated that the exclusion of HLW treatment from the PEIS is an example of segmentation and, thus, a violation of NEPA. In evaluating the intensity of a proposed action to determine its significance, the CEQ regulations at Section 1508.27(7) tell agencies to consider whether "the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance cannot be avoided by determining an action temporary or by breaking it down in to small component parts."

Response
The decision to vitrify HLW is explained in Volume I, Section 9.1. DOE does consider HLW vitrification to be significant and, has already prepared EISs to evaluate the environmental impacts of alternatives for HLW management. Section 1.8.1 identifies several site-specific DOE EISs that analyze the treatment of HLW. As stated in Volume I, Section 2.1, the WM PEIS analyzes only storage of treated (vitrified) HLW canisters until a geologic repository is available. However, the impacts of treating high-level waste are considered in the WM PEIS cumulative impacts analysis in Chapter 11. In this way, the cumulative impacts of treatment and storage of HLW are evaluated.

NEPA and CEQ implementing regulations recognize that separate NEPA reviews are justified for an agency's programs due to timing or the need for specificity or in-depth analyses. By preparing separate environmental impact analyses on a number of extremely complex subjects, DOE has not ignored a comprehensive analysis, but rather has developed a more in-depth body of information by preparing a number of PEISs. Moreover, the cumulative impacts analysis in this WM PEIS (Volume I, Chapter 11) includes the impacts of the preferred alternatives in the NEPA analyses prepared for other DOE programs, allowing DOE to evaluate the impacts of DOE's operations as a whole.

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

The ability to prepare separate EISs on separate but related programs does not avoid the necessity for coordination among the programs to ensure integrated decisions and consistent presentation of information. DOE, therefore, has made every effort to ensure that the WM PEIS is generally consistent with other related EISs, including those cited in the comment. Section 1.8 in Volume I of the WM PEIS discusses these related EISs, as well as other DOE programs, and their relationship to the WM PEIS.

DOE reviews every proposal to prepare a NEPA document to determine if the decision is sound and in compliance with CEQ regulations and guidelines on segmentation and interim actions. Any decision to prepare a NEPA document, including those listed by the commentor, must comply with those criteria. DOE believes that the preparation of one environmental impact statement on all DOE activities (operations, environmental restoration, and waste management) would necessarily be so broad that it would result in an essentially meaningless and unmanageable analysis. DOE is committed, as a matter of policy, to prepare sitewide EISs for most of its large, multi-facility sites. DOE believes that sitewide analyses result in a meaningful assessment of all of DOE activities at a particular location.

Impacts related to HLW treatment, where known, have been added to the revised cumulative impacts analysis sections of Chapter 11 for the Hanford Site, INEL, SRS, and WVDP. These estimates of potential risks from recent project-level and sitewide NEPA analyses are based on additional detailed site-specific information.

Comment (3750)
DOE should include the following in consideration of public values and principles: full disclosure (in one EIS, with a full public review) of all wastes that might be moved from other sites through the Northwest for "treatment" or burial; full disclosure of all projected environmental restoration waste, weapons plant decontamination waste, and plutonium wastes already at Hanford, along with all the other wastes that DOE might ship for treatment or burial; and the cumulative health impacts, cumulative environmental impacts, and the effect on Hanford cleanup schedules from importing all the wastes that DOE is likely to consider for treatment or burial at Hanford.

Response
DOE is committed to considering public values and input. DOE believes that integrating additional non-waste management wastes and materials into one NEPA review will not promote understanding or efficient and timely decisionmaking. Section 1.8.1 in Volume I describes the analyses contained in the other DOE EISs that affect the Hanford Site, including the issues identified in the comment. DOE revised Chapter 11 of the WM PEIS to provide a more comprehensive evaluation of the impacts of other DOE actions combined with waste management activities on individual sites, including Hanford. The Hanford Remedial Action EIS, described in Section 1.8.1 in Volume I, analyzes the impacts of environmental restoration wastes. However, Appendix B in Volume III of the WM PEIS discusses how environmental restoration wastes transferred to the Waste Management Program could influence WM PEIS alternatives and impacts analyses.

Comment (3759)
The WM PEIS fails to integrate impacts from DOE's proposals to ship plutonium (which DOE refuses to call waste, thus allowing it to escape regulations), to Hanford. Proposals include: (1) using Hanford to make it into reactor fuel; (2) burning the plutonium reactor fuel at the Washington Public Power Supply System, WNP-2 commercial power reactor, or other reactors; and (3) glassifying (vitrifying)

the plutonium along with Hanford's high-level nuclear waste, so that it cannot be reused in weapons and can be disposed of.

Response
This PEIS addresses only five waste types, as defined in Volume I, Section 1.5, and analyzed in Chapters 6, 7, 8, 9, and 10. The impacts from the plutonium vitrification process are covered in the Hanford Plutonium Finishing Plant Complex EIS and the impacts of DOE's proposals for long-term disposition of its plutonium are analyzed in the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS. Both of these EISs are identified in Section 1.8.1 in Volume I of the PEIS, which provides an overview of related NEPA reviews. Chapter 11 in Volume I of the PEIS analyzes the specific cumulative impacts for other actions at a given site.

Comment (3925)
The WM PEIS should fully address spent nuclear fuel disposition and not merely reference the SNF EIS.

Response
The management of spent nuclear fuel is outside the scope of the WM PEIS. In April 1995, DOE issued the SNF/INEL EIS, which evaluated alternatives for managing existing and reasonably foreseeable inventories of spent nuclear fuel through the year 2035, therefore, there is no need to repeat the analysis. DOE, in its Record of Decision (ROD), decided to regionalize spent nuclear fuel management by fuel type at three sites--the Hanford Site, INEL, and SRS--pending disposal in a geologic repository. Volume 2 of the SNF/INEL EIS, in addition to evaluating programmatic spent nuclear fuel alternatives, evaluates sitewide alternatives for environmental restoration and waste management programs at INEL. In the SNF/INEL EIS ROD, DOE decided to implement the preferred alternative, for INEL as evaluated in the Final EIS. Section 1.8.1 describes Volumes I and II of the SNF/INEL EIS.

The cumulative impacts analysis of the waste management alternatives in Chapter 11 in Volume I of the WM PEIS includes the environmental impacts resulting from the decision on spent nuclear fuel management and on the implementation of the preferred alternative at INEL.

Comment (4028)
Some DOE sites, such as LLNL, are already committing significant resources to new waste management facilities, which will have the effect of "locking in" a particular alternative described in the WM PEIS, even though programmatic environmental review is far from complete.

Response
Facilities being constructed at LLNL and other DOE sites have been the subject of site-specific NEPA documentation. They are being constructed to meet particular needs at those sites. The WM PEIS accounted for existing and approved facilities at DOE sites in determining the alternatives to be addressed and in the No Action Alternative analyses. Note that the mixed waste management facility demonstration project at LLNL has been canceled.

NEPA and CEQ implementing regulations recognize that separate NEPA reviews are justified for an agency's programs due to timing or the need for specificity or in-depth analyses. By preparing separate environmental impact analyses on a number of extremely complex subjects, DOE has not ignored a

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

comprehensive analysis, but rather has developed a more in-depth body of information by preparing a number of PEISs. Moreover, the cumulative impacts analysis in this WM PEIS (Volume I, Chapter 11) includes the impacts of the preferred alternatives in the NEPA analyses prepared for other DOE programs, allowing DOE to evaluate the impacts of DOE's operations as a whole.

The ability to prepare separate EISs on separate but related programs does not avoid the necessity for coordination among the programs to ensure integrated decisions and consistent presentation of information. DOE, therefore, has made every effort to ensure that the WM PEIS is generally consistent with other related EISs, including those cited in the comment. Section 1.8 in Volume I of the WM PEIS discusses these related EISs, as well as other DOE programs, and their relationship to the WM PEIS.

DOE reviews every proposal to prepare a NEPA document to determine if the decision is sound and in compliance with CEQ regulations and guidelines on segmentation and interim actions. Any decision to prepare a NEPA document, including those listed by the commentor, must comply with those criteria. DOE believes that the preparation of one environmental impact statement on all DOE activities (operations, environmental restoration, and waste management) would necessarily be so broad that it would result in an essentially meaningless and unmanageable analysis. DOE is committed, as a matter of policy, to prepare sitewide EISs for most of its large, multi-facility sites. DOE believes that sitewide analyses result in a meaningful assessment of all of DOE activities at a particular location.

Comment (4037)
The WM PEIS exemplifies that the principal role of DOE's Waste Management Program, as it is presently configured, is to serve as the handmaiden of DOE's nuclear weapons program. While noting that much of the infrastructure requirements of the proposed action are to service waste streams generated by the Stockpile Stewardship and Management Program, the Draft WM PEIS already indicates that more wastes will be generated from ongoing Science Based Stockpile Stewardship and related actions than from site remediation and cleanup activities, although the programmatic NEPA document for Science Based Stockpile Stewardship has not yet been published.

Response
The Final Stockpile Stewardship and Management PEIS was published in November 1996. Impacts of the Stockpile Stewardship and Management Program are considered in the WM PEIS cumulative impacts analysis presented in Chapter 11 in Volume I. As described in Appendix B (Volume III) and Sections 6.15, 7.15, and 8.15 (Volume I), the total volume of environmental restoration waste is larger than waste management; however, much of the environmental restoration waste is likely to be managed in place or in environmental restoration facilities.

Comment (4051)
The WM PEIS working assumption of a fully funded and robust Stockpile Stewardship and Management Program removes from the scope of the document the significant policy alternative of waste minimization through the conversion or scaling back of nuclear programs. By separating defense programs and waste management, any consideration of waste management impacts is limited to a narrow range of alternatives: to transport or not to transport, and where to maintain or construct DOE waste management facilities. If the National Ignition Facility (NIF), Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, or new prototype plutonium fabrication plants are not constructed, what will be the likely impact on waste management actions?

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

Response
Decisions on whether to construct and operate facilities such as NIF and DARHT are made, in part, on the basis of NEPA documents prepared for those proposed actions. The need for agency action is addressed in those NEPA documents. The purpose of the WM PEIS is to help develop a strategy to deal with the wastes generated by those and other past and present DOE actions.

Alternatives for the Stockpile Stewardship and Management Program are evaluated in the PEIS on that subject identified in Volume I, Section 1.8.1, of the WM PEIS. The WM PEIS contains 20-year projections of waste volumes for the various alternatives that reflect planning for facilities, including NIF, DARHT, or a new plutonium fabrication plant. If these facilities are not built, there would be less waste generated.

DOE does not consider a shutdown of its nuclear weapons programs to be a reasonable alternative at this time. Based on the best available information at the time of the analysis on future waste generation, DOE assumed that current waste generation rates would continue for the next 20 years. Volume I, Section 1.8.2, describes DOE programs and actions that will generate waste analyzed in the PEIS.

Comment (4339)
If DOE revises the WM PEIS sections on cumulative impacts and relationships with other EISs to more fully account for other programs, the document will provide an adequate basis for selecting conceptual approaches to treat, store, or dispose of the five waste types. However, the WM PEIS is not adequate to select sites within a conceptual alternative because data are old or inaccurate, analytic methods are too generic, and cumulative effects are not accounted for on a site-by-site basis. Decisions about the configuration of sites should be supported by a second level of NEPA review.

Response
DOE believes that the Final WM PEIS is an adequate basis not only to support decisions about strategies for dealing with each waste type, but also to support decisions about sites chosen to manage each waste type. In the PEIS, DOE has attempted not only to examine in an integrated fashion the impacts of Department-wide waste management decisions for each waste type in the nuclear weapons complex, but also the cumulative impacts for all the waste facilities at a given site.

While the PEIS identifies preferred alternatives in accordance with NEPA and the CEQ regulations, actual programmatic decisions on configurations will be announced in Records of Decision. The "second level of NEPA review" referenced in the comment will occur before DOE decides on the location of a waste management facility at a programmatic site.

In moving from the draft to the final document and incorporating public comments, DOE has made extensive revisions pertaining to relationships with other EISs (see Section 1.8.1 in Volume I) and cumulative impacts, including on a site-by-site basis (see Chapter 11 in Volume I). Regarding the data used in the analysis, the Final PEIS includes updated waste volumes for low-level waste, low-level mixed waste, and transuranic waste, and analyzes how newly available data might impact the analyses of alternatives in the WM PEIS (see Appendix I in Volume IV).

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

Comment (4403)
The WM PEIS unacceptably excludes high-level waste of U.S. commercial nuclear programs that is and will become the total responsibility of DOE to manage and dispose of under the Nuclear Waste Policy Act of 1982. DOE must include a fully integrated analysis of the potential impacts and risks to humans and the environment from the management and disposal of commercial nuclear wastes in a new WM PEIS. The WM PEIS's reference to an EIS on commercial spent nuclear fuel management is not adequate.

Response
The WM PEIS was prepared to help DOE develop a Department-wide waste management strategy. The PEIS addresses, in a programmatic manner, most of the radioactive wastes produced over the past years by national defense activities at DOE facilities. The PEIS does not address radioactive wastes produced by commercial activities; DOE does not have the authority or responsibility for making decisions on such wastes.

DOE has sought public input at various stages in the WM PEIS process so that the PEIS could seriously address the issues of DOE wastes. Spent nuclear fuel is not classified as a waste and, thus, is not included in the WM PEIS as a waste type. Other EISs dealing with spent nuclear fuel management are discussed in Volume I, Section 1.8.1. In addition, issues relating to the characterization of the candidate geologic repository at Yucca Mountain are outside the scope of the WM PEIS, but would be addressed in the Yucca Mountain Repository EIS.

Comment (4407)
The WM PEIS violates NEPA by basing the analysis of high-level wastes on the assumption that the future permanent repository will be at Yucca Mountain, despite the fact that Yucca Mountain is geologically unfeasible due to seismic activity, and despite serious misgivings concerning the actual licensing and opening of the repository. Secretary O'Leary has indicated a 50% chance of Yucca Mountain actually being licensed. DOE calculations have indicated that Yucca Mountain cannot meet the dose limits for a subsistence farm scenario. DOE must address the known problems concerning the site and the "non-possibility" of Yucca Mountain as a final repository in a credible PEIS.

Response
Section 1.8.1 in Volume I describes the relationship between the WM PEIS and the EIS for a potential geologic repository at Yucca Mountain. Section 9.1.1 in Volume I indicates that the impacts of disposing of high-level waste in a repository are not within the scope of the WM PEIS, but will be analyzed in a subsequent DOE NEPA document relating to a geologic repository. Because the Yucca Mountain site is the only candidate repository site being studied at present, DOE assumed the existence of a geologic repository there for purposes of analyzing the impacts of transporting the high-level waste to a potential disposal facility. The WM PEIS Centralized Alternative examines long-term storage of vitrified high-level waste at Hanford should a geologic repository not open as expected.

Comment (4464)
Will a supplemental NEPA document be prepared for alternative high-level waste disposal sites to Yucca Mountain, or for leaving the waste onsite for an extended period in retrievable storage until acceptable permanent storage sites are identified and finalized? DOE should include in the WM PEIS the alternatives advocated in *High Level Dollars, Low Level Sense*, a book commissioned by the State of Nevada. Also, what criteria would trigger the need for supplemental or additional NEPA

11.5 Cost of Preparation

Response

From project initiation in 1990 to publication of the Final WM PEIS in 1996, the cost of the study itself was approximately $31 million. The $59 million figure mentioned by several commentors includes ancillary efforts that support other DOE activities in addition to the WM PEIS. In fact, DOE used results of early efforts for several purposes to increase the utility of tax dollars already spent. For example, the cost-estimating models used in the PEIS were also used in producing the Baseline Environmental Management Report to Congress, which has been updated using those same models. The waste inventories set up for the PEIS analyses continue to be updated and used in many ways. The models to predict risk and potential environmental impacts can be used for other environmental studies at the national and local level and for transportation planning, just to name a few examples. These valuable planning and analytic tools have continuing, direct applicability to a multitude of other DOE efforts.

Further, the cost of the WM PEIS project should be viewed within the context of the overall Waste Management Program. The PEIS will be an important basis for determining the best long-range waste management strategies. The cost of the PEIS is only a small fraction of the cost per year to safely and responsibly manage the country's radioactive and hazardous wastes over the next 20 years. This up-front planning effort will result in big returns in the future. For example, the WM PEIS fulfills requirements under NEPA to conduct environmental reviews before making decisions on improving the existing waste management configuration. Moreover, it provides technical information that should help streamline future NEPA reviews that would be required prior to specific decisions about facilities, facility locations or sites, and waste management technologies.

One of NEPA's major objectives is to inform the public of proposed Federal actions and provide opportunities for public input to those decisions. From its inception, the WM PEIS project has devoted a substantial amount of time and effort to obtaining public comment on the scope and content of the study, to carefully considering the comments received, and to making appropriate changes in response to public input. As a result, the WM PEIS project has demonstrated DOE's commitment to meeting both the spirit and letter of NEPA requirements and DOE's commitment to openness with the public.

11.6 Other

Comment (425)
A special commission should be dedicated to revise and coordinate this project.

Response
An independent oversight advisory committee provided advice to the preparers of the WM PEIS. In January 1992, DOE chartered the Environmental Restoration and Waste Management Advisory Committee to advise DOE's Assistant Secretary for Environmental Management on both the substance of and the process for the WM PEIS, from the perspective of affected groups and State, local and Tribal Governments. The members of this Committee were selected from universities; trade organizations; Federal, State, and local government agencies; Native American organizations and groups; environmental groups; and other interested parties. There has been a significant exchange of information on this WM PEIS with the Committee. In addition, site advisory boards have also provided comments on the scope and content of this WM PEIS. The same will hold true for DOE's decisionmaking process for DOE's Waste Management Program.

Comment (1632)
DOE should provide a centralized database of WM PEIS data that can be accessed by State and local governments.

Response
The WM PEIS draws on a variety of sources, all of which are referenced and either readily available in public libraries or available to the public in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS. Hard copies and/or microfiche have been distributed to DOE reading rooms across the Nation. Therefore, anyone can access the technical documentation identified in the WM PEIS.

Comment (1648)
DOE should explain to Congress that NEPA is fundamentally flawed and needs to be revised.

Response
DOE believes that implementing NEPA has led to greater protection of human health and environment. The public involvement process required by NEPA has enhanced DOE decisionmaking. Please send specific recommendations on how NEPA can be improved to the President's Council on Environmental Quality, 722 Jackson Place, NW, Washington, D.C. 20006.

Comment (1877)
Referring to an error in the DOE letter that announced the extension of the Draft WM PEIS public comment period (February 19, 1995, instead of February 19, 1996), the commentor stated, "As always the DOE is regressing."

Response
DOE apologizes for this typographical error.

Comment (2149)
DOE should have a legal review of the WM PEIS to ensure that it is very clear.

Response
DOE's Office of General Counsel was involved in the development of the Notice of Intent and scoping meetings in 1990 and reviewed the Draft and Final WM PEIS prior to issuance.

Comment (2160)
What was the prior involvement of contractors on this project and are any of them new?

Response
DOE prepared the Draft and Final WM PEIS. Several National laboratories and contractors assisted DOE at some point, and to varying degrees, during the preparation of these documents. They are Argonne National Laboratory (the primary technical support organization during preparation of the Final WM PEIS); Idaho National Engineering Laboratory; Los Alamos National Laboratory; Oak Ridge National Laboratory; Pacific Northwest Laboratory; META/Berger (the primary technical support organization during preparation of the Draft WM PEIS, META/Berger are the prime and subcontractor firms, respectively, Maria Elena Torrano Associates--META--and Louis A. Berger and Associates); Brown & Root Environmental; Science Applications International Corporation; Lamb Associates, Inc. Significant individual contributions are listed in Volume I, Chapter 13, of the Final WM PEIS.

Comment (4001)
A commentor noted that the Bureau of National Affairs *Environment Reporter* announced an addendum to the Draft WM PEIS.

Response
The statement in the Bureau of National Affairs (BNA) *Environment Reporter*, February 16, 1996, that there had been an amendment to the Draft WM PEIS was incorrect. BNA referenced an EPA *Federal Register* notice acknowledging an amendment to DOE's Notice of Availability for the Draft WM PEIS. The amendment notified the public that DOE extended the public comment period for the Draft PEIS by an additional 60 days, from the initial 90-day period. There was no addendum to the Draft PEIS, and BNA was notified of this error. BNA subsequently published a correction.

Comment (4068)
Can DOE do a PEIS on its mission?

Response
This WM PEIS was prepared in compliance with NEPA and CEQ implementing regulations requiring agencies to prepare an EIS for every "major Federal action significantly affecting the quality of the human environment." The overall agency mission does not amount to an action, whereas DOE's proposal to manage the five waste types does constitute an action. Section 2.2 in Volume I of the WM PEIS describes the purpose and need for DOE action; Section 1.8 discusses the WM PEIS relationship to other DOE actions and programs.

Comment (4413)
The articles published in the February 15 and 16, 1996, *USA Today*, which describe the Draft WM PEIS as flawed, incomplete, and irrelevant, should be considered as comments on the Draft WM PEIS.

11.6 Other

Response
The articles published in the *USA Today* were not submitted to DOE as comments and, therefore, were not considered in this comment response document.

On March 1, 1996, Richard J. Guimond, the Principal Deputy Assistant Secretary of Energy for Environmental Management, responded to the Editor of *USA Today* on these articles. Mr. Guimond's response refuted the *USA Today* characterization of the WM PEIS and stated that the study provides a solid foundation for DOE's future strategy to transport, store, treat, and dispose of radioactive and hazardous waste from nuclear weapons production and nuclear research.

12. Public Involvement

Comment (152)
Several commentors suggested that DOE needed to conduct a more comprehensive public outreach program for the potential actions evaluated in the WM PEIS. Although some people indicated that they believe DOE is listening and addressing comments "honestly and collaboratively," others felt that greater efforts needed to be made to involve communities, as well as State and local governments, in decisionmaking; to provide educational information regarding waste management activities and facilities, as well as pertinent laws and regulations; and to consider public input on issues such as equity, site-selection criteria, transportation of waste, disposal configuration, and overall waste management goals. Some commentors suggested that additional public hearings should be held once DOE selects its preferred alternatives. Others suggested that DOE conduct a "National Dialogue" on waste management to facilitate the discussion of intersite issues and that such a dialogue should be convened between the advisory boards representing citizens living near DOE nuclear weapons plants to discuss what wastes the citizens are willing to keep on the sites or receive from other sites. Several commentors indicated that more time is needed to build stronger agency-community working relationships.

Response
Open dialogue and cooperation with the public is essential to determining the most appropriate method(s) for managing DOE's current and future wastes. DOE is committed to meaningful public involvement in its waste management decisions. DOE has a variety of public outreach programs in place to facilitate public participation at both the national and local level. Specifically in conjunction with the WM PEIS, DOE held 23 scoping meetings, 6 regional workshops on the PEIS Implementation Plan, and 2 public workshops on the risk assessment methodology; published 3 newsletters and 20 fact sheets; produced 2 videos; provided periodic briefings for the Environmental Management Advisory Board and several Site-Specific Advisory Boards; and most recently, conducted 13 public hearings on the Draft WM PEIS. The Draft WM PEIS public comment period was held open for 150 days in response to requests from the public. Sections 1.7.1 and 1.7.2 in Volume I of the WM PEIS describe public involvement related to the WM PEIS.

Aided by an extensive public scoping process, DOE developed the waste management alternatives and selected the major sites for analysis as potential candidates for waste treatment, storage, or disposal functions. Section 1.6 in Volume I provides an overview of the waste management sites covered in the PEIS and Section 3.5 in Volume I describes the methodology used by DOE for identifying alternatives.

After the Final WM PEIS is published, the decision process will begin. DOE does not expect that all waste management decisions will be made at one time for all waste types. Rather, DOE expects that the PEIS will result in separate Records of Decision by waste type to be issued in a staggered fashion starting in calendar year 1997. Section 1.7.3 in Volume I has been revised to explain the process for making waste management decisions subsequent to issuance of the Final PEIS.

DOE will use all relevant information, in addition to the WM PEIS, necessary for making responsible waste management decisions. DOE agrees that public input to the decision process will be worthwhile. Forthright dialogue with the public on the important issues regarding the management of the Nation's nuclear waste is important to DOE as well as to the potentially affected communities.

DOE has not only specifically sought comments on the Draft WM PEIS from State and local officials and the general public through the NEPA process, DOE is sponsoring a "National Dialogue" initiative

12. Public Involvement

to provide a forum to communicate with interested members of the general public, State and Tribal Governments, and representatives from the site-specific citizens advisory boards to discuss potential national decisions on waste management and on the intersite management and disposition of other nuclear materials. This initiative is discussed in Section 1.8.2 in Volume I of the Final WM PEIS.

DOE is considering how best to sustain and strengthen that initiative to provide additional avenues for public input to its decisionmaking processes. The ensuing public dialogue will specifically include input to the development of waste management decisions on a national scale, and will include the example topics identified in the comments as they are relevant to waste management decisions and of concern to public participants.

Comment (2151)
BNL needs to have an open channel to DOE Headquarters to help to nail down the Brookhaven National Laboratory (BNL) cleanup and waste management issues, such as a civic board, which should be looking at these issues within 6 months.

Response
DOE is committed to public involvement and welcomes input on how to improve this process. BNL is assisting the community with the formulation of a community forum. This group is open to the public and will provide an opportunity for people to voice their concerns and identify issues regarding BNL. For more information, please call the BNL Public Affairs Office.

Comment (2187)
The public needed to be better informed about how many volumes [books] were included in the entire Draft WM PEIS document.

Response
DOE recognizes that there was some confusion because the "Readers' Guide" in the Draft WM PEIS Summary document erroneously stated that the document consisted of two (rather than four) volumes. The Final PEIS consists of five volumes, as noted in the Final WM PEIS Readers Guide, and has been distributed in whole sets to those who requested it. As was done with the Draft, the Final WM PEIS Summary document also is distributed separately, based on requests.

Comment (2310)
Commentors questioned the absence of a Site-Specific Advisory Board (SSAB) and health studies at the Portsmouth Plant. Commentors also expressed concern over the effectiveness of SSABs and Citizen Advisory Boards (CABs), commenting that CABs do not adequately represent the public, might be distracted by multiple issues, and could describe issues more creatively to the public.

Response
SSABs have been established at a number of DOE sites to provide a mechanism for members of the community to contribute to site-specific policy and technical decisions on waste management and environmental restoration decisions. The SSAB is only one component of the public participation efforts that occur at the DOE sites. Each SSAB defines its own membership and/or charter and works with DOE to set its own agenda and define the issues that are important to the local communities. Health studies are conducted at certain DOE sites if warranted by specific circumstances at those sites.

Not every site has an SSAB; some are established, others are forming, and others do not have a board. Some of the SSABs submitted comments and recommendations to DOE on the WM PEIS.

The Portsmouth Plant does have a stakeholders group and meetings and workshops are routinely held with DOE site personnel.

Comment (2334)
DOE should release to the media and the general public performance summaries of actual emissions data as measured by continuous monitoring systems at Oak Ridge National Laboratory (ORNL); numbers like 99.99% removal of toxics in contaminated feeds are not as convincing as actual hard data.

Response
The management of current ongoing site operations is not within the scope of the WM PEIS. However, many other sources of data, such as annual reports, are available on request from local DOE offices. DOE encourages interested citizens to contact their site for more detailed operational information. In addition, when sites for waste management facilities are selected and any required environmental reviews are undertaken, site-specific questions such as emissions control monitoring will be addressed.

Comment (2402)
The Savannah River Site (SRS) Citizen's Advisory Board (CAB) has worked to discover, and has what appears to be, a developing consensus about what matters to people who live near SRS; but the CAB has real difficulty in relating these citizen priorities to the alternatives developed in the WM PEIS. One definition of the failure to communicate is this: When the public cannot see clearly how its values will play out in DOE alternatives even after the public knows what it cares about, and after it has been given thousands of pages that claim to explain what DOE plans to do, affects what the public cares about. The Draft WM PEIS fails the SRS CAB in too many ways. Since the data in the draft is now widely available to the interested public, DOE should take the time to develop a more useful final document, including independent scientific peer review, that addresses the issues of scope and communication that we have addressed here.

Response
The initial scope of the WM PEIS was defined in 1990, prior to the establishment of many of the DOE advisory boards. DOE conducted a series of public hearings across the Nation that were announced in the *Federal Register* and advertised through newspapers, on the radio, and at press meetings. DOE's WM PEIS public participation activities exceeded the requirements of NEPA. The priorities developed by the SRS CAB were considered in developing the Final WM PEIS, along with other comments collected during the public comment period, which extended from September 22, 1995, through February 19, 1996. DOE made substantial changes to the WM PEIS based on comments received on the Draft WM PEIS (see the summary of changes in Volume I). This comment-response document, which was developed as part of the WM PEIS pursuant to NEPA requirements, also identifies where changes were made to the PEIS based on public input. Where requested changes could not be made, this document explains why. The rationales for incorporating or not incorporating suggested changes show that DOE carefully considered all input and made suggested changes to the extent possible.

12. Public Involvement

In developing the WM PEIS, DOE consulted with EPA, and has obtained the comments of other Federal, Tribal, State, and local agencies with jurisdiction by law, or special expertise, as required by the CEQ regulations.

The WM PEIS analysis will not be the only basis for ultimately making waste management decisions; budgets, schedules, and national priorities, as well as other DOE studies, will be considered in developing Records of Decision.

Comment (2687)
DOE has no idea how to clean up our existing waste problems, since you are asking for suggestions from private citizens.

Response
The WM PEIS was presented to the public in draft form, not because DOE does not have any ideas or plans to manage its waste, but rather, to provide the public an opportunity to comment on those plans prior to DOE making its decisions. DOE currently faces the challenge of safely and efficiently managing over 2 million cubic meters of radioactive and hazardous waste from its past, present, and future activities at 54 sites across the United States. To provide a national, programmatic basis for comparing alternative waste management configurations, the Draft WM PEIS analyzes the health, environmental, and socioeconomic impacts of multiple alternatives for the treatment, storage, and disposal of five waste types: hazardous waste, high-level radioactive waste, transuranic waste, low-level radioactive waste, and mixed low-level waste (radioactive and hazardous components). DOE's preferred alternatives for managing each waste type and the reasons they are preferred are identified in Volume I, Section 3.7.

Comment (3297)
DOE should work in partnership with local governments to ensure that they are well informed and given support to be able to educate and respond to public stakeholders.

Response
DOE has public affairs and community involvement personnel available to work with public officials. DOE is committed to public education and involvement at all its sites, and believes that active participation by its local governments, regulators, and the general public can lead to reasonable, effective, decisions.

Comment (3308)
Local governments should be kept informed of any analyses addressing the factors [other than those listed in Section 1.8] that will be considered in making final decisions among alternatives.

Response
Local governments and other interested parties are kept informed of the decision process through the Site-Specific Advisory Boards and Public Affairs Offices at each DOE site. Volume I, Section 1.7.3, describes the WM PEIS decision factors and criteria, which DOE used to identify the preferred alternatives. Further dialogue will be undertaken between the Final WM PEIS and the issuance of the Records of Decision.

Comment (3886)
The public and DOE need to look for other alternatives. The public expects DOE to listen and heed the mandate of the people. Citizens must use all avenues to keep control of the DOE decision, such as controlling the project on a local level, knowing the laws, reading all material available, and using local media and Congressional involvement to help sway the decision.

Response
DOE welcomes the level of interest in its waste management decisions, and has considered all comments offered during the public comment period in finalizing the WM PEIS. A well-informed and involved citizenry can provide valuable insight into what DOE should consider in its decisionmaking. However, DOE is, by law, responsible for making decisions such as those outlined in the WM PEIS, and is held accountable by the public and regulators for safely implementing those decisions.

Comment (4054)
DOE's failure to respond to the requests of residents and officials to hold a hearing in Livermore (in addition to the one held in Tracy), which is a community that will be directly impacted by the WM PEIS preferred alternative for low-level mixed wastes, adds another reason why the WM PEIS should be revised and reissued before proceeding to a final document and Records of Decision.

Response
Although NEPA regulations only require one public hearing to be held, DOE conducted a series of public hearings all across the Nation that were announced in the *Federal Register* and advertised through newspapers, radio stations, press meetings, etc. Meeting summaries were made available at the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The Tracy, California, hearing location was chosen because of its proximity to Site 300, which is considered in the WM PEIS as an alternative disposal site.

Comment (4412)
DOE should place a moratorium not only on privatization of DOE facilities and environmental remediation, but on the production of all nuclear weapons materials until a credible WM PEIS is issued. Public participation is a crucial and vital aspect of an accurate, efficient, and acceptable nuclear and hazardous waste management analysis under the NEPA process where DOE must make every effort to include public participation to the fullest extent.

Response
DOE is committed to public involvement. Sections 1.7.1 and 1.7.2 in Volume I of the WM PEIS describe public involvement related to this WM PEIS. Section 1.7.4 has been added to Volume I of the WM PEIS for a discussion of the issue of waste management privatization at DOE sites. As stated in Section 1.7.4, the impacts associated with DOE waste management facilities are expected to be representative of the impacts of private facilities on DOE sites. Although DOE identified preferred alternatives in the WM PEIS, decisions on privatization are site-specific in nature, and would be addressed in site-specific documents.

Environmental remediation activities are considered in the WM PEIS only to the extent that waste generated would enter the waste management system. More detail is provided in Appendix B in Volume III of the WM PEIS. Environmental remediation activities are implemented based on

site-specific studies, technical evaluations, and discussions with regulatory authorities and the public. Nuclear weapons material production issues are being evaluated by other NEPA reviews addressing stockpile stewardship and management, the disposition of fissile materials, tritium supply and recycling, and the production of highly enriched uranium. These NEPA documents are described in Section 1.8.1 in Volume I of the WM PEIS. Where these documents identify impacts that add to the impacts identified in the WM PEIS, these impacts have been included in the analysis of cumulative impacts in Chapter 11 in Volume I of the WM PEIS. The other studies, along with the WM PEIS analysis of environmental impacts from waste management activities, will help to focus DOE decisions.

Comment (4427)
DOE should evaluate programmatic alternatives for the consolidation of administration, environmental oversight, and environmental policymaking between the waste management and environmental restoration programs, and alternatives for the role of the public in overall strategic decisionmaking.

Response
DOE originally intended to perform a programmatic analysis of the impacts associated with both environmental restoration (ER), and waste management, but changed the scope of the WM PEIS in January 1995. Volume I, Section 1.7.1, explains why the WM PEIS does not include ER alternatives. In summary, after collecting data and doing some preliminary analyses, DOE determined that, because ER decisions should reflect the particular conditions at each site, as well as the involvement of state regulators and local stakeholders, addressing them at a programmatic level would be inappropriate.

DOE has for several years explored alternatives for public participation in decisionmaking and policy development for waste management and ER. Such alternatives vary, depending on the nature of the activity to be discussed or the pending decision. For example, public participation in DOE activities regarding ER frequently occurs at the site level, because these activities typically concern site-specific cleanup actions. In such cases, DOE uses a variety of methods to provide the public with opportunities for dialogue, including general public meetings and forums and participation in site advisory boards. Recent efforts to enhance public participation in decisionmaking include the National Dialogue and Environmental Management Ten Year Plan discussed in Section 1.8.2 in Volume I of the WM PEIS. Additionally, Appendix A in Volume III outlines the means for public involvement in planning and decisionmaking for DOE's ER activities.

Potential decisions on issues such as those addressed in developing the WM PEIS have involved national-level as well as site-specific opportunities for public involvement. For example, the decision to remove ER alternatives from the WM PEIS analysis was discussed with and reviewed by DOE's Environmental Management Advisory Board from a national perspective.

The extensive series of public hearings held on the Draft PEIS tended to consider local concerns about sites' potential roles in the national Waste Management Program. During the public comment period on the draft, public input was sought on the criteria for national decisionmaking, the selection of preferred alternatives, and specific issues important to individual sites.

In all such cases, the objective is to employ alternatives for informing the public and seeking public input that best reflect the type of activity under consideration, whether it involves a national decisionmaking process or a site-specific action. Other examples of alternatives that have been pursued to achieve this objective include extensive public disclosure of previously classified material on past

DOE activities; major reports to the Congress, States, and the general public such as the Baseline Environmental Management Report; regular news briefs released to the national media; and community meetings on local DOE activities.

12.1 WM PEIS Scoping Process

Comment (3172)
When DOE re-scoped the WM PEIS to remove environmental restoration waste, site specific advisory boards were in operation. There is no record that DOE brought this re-scoping to any site boards for comment.

Response
The Environmental Management Advisory Board reviewed this change in the focus or scope of the WM PEIS in its meeting on July 15, 1994. In a *Federal Register* notice issued in January 1995, DOE asked for public comments on its proposal to modify the scope of the WM PEIS (60 FR 4607, January 24, 1995). See Volume I, Section 1.7.1, of the WM PEIS for an explanation of the WM PEIS scope. Appendix A in Volume III of the WM PEIS contains a summary of the comments received in response to the proposed change in scope and DOE's responses to those comments. DOE also provided information to the public about the PEIS scope change through its site personnel and regular public communication channels.

12.2 Draft WM PEIS Public Comment Process and Hearings

Comment (206)
Several commentors stated that DOE's notification of times, dates and locations of the public hearings on the Draft WM PEIS was inadequate. Poor attendance at some hearings was attributed to lack of wide notification. More specifically, some individuals raised concerns regarding DOE's general notification to the residents around the potentially affected sites about its waste management plans and wanted to know what efforts DOE had made to inform local communities about the WM PEIS, decisions being considered in the WM PEIS, and their potential implications. A few people suggested that DOE's inadequate notification reflected an intention on DOE's part to deliberately keep information from the public and wanted to be assured that the WM PEIS was being reviewed by someone with "impeccable credentials."

Some of the suggestions for improving publicity included more extensive individual mailings, and greater use of radio and cable TV to announce the meetings. One commentor suggested that DOE consider publishing articles regularly in local newspapers to keep stakeholders informed and engaged; another suggested that postcards be used to inform the public of major document scope changes, such as the decision to eliminate an analysis of environmental restoration activities from the WM PEIS.

Response
In compliance with the NEPA public participation requirements, the WM PEIS public hearings were announced in the *Federal Register*. In addition, DOE advertised through newspapers, radio stations, and press briefings. DOE also used a variety of other methods at the sites to provide information to the public about the WM PEIS and the hearings, including briefings at other meetings related to the site such as Site-Specific Advisory Board meetings or other project meetings and information fairs. In the months prior to the release of the Draft WM PEIS, three newsletters were sent to everyone on the WM PEIS mailing list to update them on the status of the document; this list included individuals who had attended scoping meetings or provided scoping comments, as well as others expressing an interest in the WM PEIS. The first page of the Summary contained a letter to citizens that lists a toll-free information number. Notification and schedules of the hearings were available through this service.

A short video was made available at meetings and other public forums that announced the pending release of the WM PEIS. The video, as well as the WM PEIS itself, includes information on potential decisions and the decisionmaking process.

DOE did receive comments from individuals with "impeccable credentials," including the Site-Specific Advisory Boards, the Environmental Management Advisory Board, and individual technical experts. DOE in no way made any effort to keep information from the public; DOE fully complied with NEPA and CEQ requirements. DOE sought comments from other Federal and State agencies with jurisdiction by law or special expertise, including EPA. The comments from these agencies were objective and were not only welcome, but many resulted in substantive technical and other changes to the WM PEIS that helped improve the final document.

Suggestions from the public on how to improve communication about progress related to the WM PEIS, such as subsequent decisionmaking processes, are also welcome and are being used to enhance DOE's public involvement efforts. For example, specific suggestions about the use of postcards resulted in a mailer sent to all persons receiving the Draft WM PEIS to determine continued interest in receiving the final document. Further, DOE is considering ways of obtaining public input to

12.2 Draft WM PEIS Public Comment Process and Hearings

future waste management decisions, and suggestions received on the Draft WM PEIS that can help achieve this objective will continue to be factored into the evolving processes.

Sections 1.7.1 and 1.7.2 in Volume I of the WM PEIS contains a discussion of DOE's public participation process. Documents related to the WM PEIS are available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (254)
Several commentors requested additional opportunities for public comment on the WM PEIS. There were some requests for additional hearings, but most of the requests were for an extension of 1 to 6 months of the public comment period.

Response
A 90-day public comment period for the Draft WM PEIS was scheduled from September 22 until December 21, 1995. In response to requests from the public, DOE extended this comment period through February 19, 1996. Thus, DOE provided a 150-day comment period, 105 days more than required by NEPA. During this time, DOE conducted 13 public hearings across the nation and received comments from many interested parties including local officials, environmental groups, community representatives and individual citizens. In response to the requests for an additional hearing at ANL-E, DOE held an informational meeting with stakeholders (December 14, 1995), and a second hearing with afternoon and evening sessions (January 24, 1996).

Comment (363)
Two individuals notified DOE that they failed in their attempts to preregister for public hearings using the Center for Environmental Management Information 800 number.

Response
DOE found that in both cases, personnel errors caused the problems. DOE regrets any inconvenience experienced by the commentors and appreciates their feedback on the preregistration process. DOE offered the toll-free preregistration opportunity to facilitate the hearing process. However, preregistration was not required. During the course of each hearing, everyone who wished to speak was given an opportunity to do so.

Comment (365)
An attendee at the Richland, Washington, public hearing complained that because preregistered speakers were taken first, followed by speakers from five different sites in rotation, many members of the public had to wait hours for the opportunity to speak. The commentor left without having an opportunity to speak. Another commentor stated that people who attend public hearings should be entitled to speak and should not have to compete with each other for limited time because they are all compressed into one hearing in one evening.

Response
The videoconference format allowed members of the public from five communities near the Hanford Site to hear each other's comments and to hear discussion and responses from technical experts in Washington, DC. During all public hearings on the WM PEIS, DOE emphasized that the hearing would remain open until all participants who wished to speak, preregistered or not, would have an opportunity to do so. DOE did not attempt to limit the number of people allowed to attend the

11.5 Cost of Preparation

Comment (56)
DOE is wasting "trillions" of tax dollars by producing "Final Environmental Impact Statements" that do not contain solutions. Persons "working on the problem" are not inclined to find a solution to managing wastes because they view their work as "a lucrative gravy train."

Response
The total costs of all of DOE's NEPA documents would not approach "trillions" of dollars. The costs represent a fraction of the costs needed to properly manage the programs and are consistent with the level of effort required. Moreover, DOE must comply with the law, in this case NEPA. NEPA requires Federal agencies to consider the potential environmental consequences related to their proposed actions before they can be taken and to prepare detailed statements on environmental impacts, alternatives to the proposed action, and measures to avoid or minimize adverse impacts. CEQ regulations and DOE's own regulations (10 CFR 1021) provide specific guidance for the preparation of NEPA documents.

NEPA provides for the preparation of programmatic EISs that serve as a basis for broad decisions and help avoid the development of redundant studies that, in turn, might drive costs up. As a programmatic review, the WM PEIS will serve as a basis for decisions involving national strategies for waste management. Sitewide or project-level NEPA reviews concerning facility locations or technology selection will build on technical information presented in the WM PEIS. This hierarchy promotes efficiency in targeting the areas ready for action and in maximizing the use of available technical data.

Comment (1524)
It will be interesting to compare the cost of the Stockpile Stewardship and Management PEIS to the cost of this WM PEIS.

Response
The total cost of producing the WM PEIS--from project initiation in 1990 to publication of the Final PEIS--was approximately $31 million. The cost of the Stockpile Stewardship and Management PEIS is estimated at $10 million. Both documents are broad and complex, and the costs of developing these studies are commensurate with the level of effort required to meet the letter and spirit of NEPA, CEQ, and DOE requirements.

Comment (2157)
How much did it cost to prepare the WM PEIS?

Response
The total cost of producing the WM PEIS--from project initiation in 1990 to publication of the final study in 1996--was approximately $31 million.

Comment (3780)
DOE needs to consider how the tax dollars are being used on this project, and how those dollars could be better spent, including spending the money on cleanup. In the Final WM PEIS, DOE needs to explain how all the money for preliminary studies, etc., was targeted for this study. The PEIS was originally supposed to cost $8 million and 6 years later has cost $59 million because META wants to rip off the taxpayers instead of finding a solution to the waste management problem.

11.4 Segmentation/Relationship and Consistency with Other DOE Documents and Programs

documents? What would be the significance of high-level waste acceptance rates at the candidate geologic repository of other than the 800 canisters per year DOE assessed in the Draft WM PEIS?

Response

The impacts from disposing of high-level waste in a repository are not within the scope of the WM PEIS, but DOE will analyze them in the Yucca Mountain Repository EIS, which is described in Section 1.8.1 in Volume I. Under the Nuclear Waste Policy Act, DOE will dispose of high-level waste at a geologic repository, and Yucca Mountain in Nevada is the only site currently being studied for suitability to house the repository. DOE assumes that acceptance of its high-level waste at this facility would begin in 2015. However, for this PEIS, DOE has analyzed high-level waste canister storage requirements in case the repository opens after 2015.

Section 9.3 of the Final WM PEIS states that for each of the five high-level waste alternatives, DOE assumed that the candidate geologic repository would begin accepting DOE-managed high-level waste in year 2015 at the rate of 800 canisters per year. The acceptance rate at the repository will determine the duration of glass canister storage, so an acceptance rate of 400 canisters per year would double the duration of current storage of glass canisters. DOE based the value of 800 canisters per year on the latest available data for the projected acceptance rate for the high-level waste geologic repository. A reduced acceptance rate would cause effects to continue at the sites for a longer period, while reducing transportation effects on an annual basis. A higher rate would shorten the duration of effects at the sites and increase annual transportation effects. DOE estimated the effects of longer-term storage of high-level waste for Centralized Alternative 2.

hearings; on the contrary, all those wishing to attend were encouraged to do so, and the resulting mix of views was welcome. As a courtesy, preregistered speakers were called in the order in which they registered. The hearing did remain open until everyone who indicated a desire to speak had done so. The benefits of allowing multiple communities to hear each others' concerns made it necessary to allow sufficient time for all speakers to participate in an orderly manner. DOE regrets the inconvenience to the commentors and appreciates the written feedback they provided.

Comment (1484)
Some commentors liked the public hearing videoconference format. Others criticized the format for the following reasons: They thought it limited dialogue; the methods for recording comments were not acceptable; comments should have been attributed to commentors; and hearings were not independently facilitated. Some doubted the format saved money.

Response
DOE appreciates both the favorable and critical comments on the teleconference hearing format and will apply them to improving future hearings. The hearings were held to obtain public comments on the Draft WM PEIS for consideration in development of the Final WM PEIS, and to provide for some discussion as time permitted. The videoconference format used for hearings on the Draft WM PEIS offered an opportunity for more people to participate, which helped to expand the dialogue. This includes dialogue among members of the public who could be affected by DOE's proposed actions, as well as a number of DOE officials and technical experts preparing the WM PEIS analyses. On the other hand, DOE recognizes that the benefit of opening a discussion to a large number of people should be balanced with the need for patience and cooperation on the part of all involved so that everyone who indicates a desire to speak will have the opportunity to do so.

The format used did not limit DOE's ability to record the meeting. Rather, it provided a highly accurate method of documenting the session in the form of audio- and videotapes. The notes taken during the hearing and the hearing summary placed in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS have been used as supplements to capturing public comments offered in the hearings and in developing appropriate responses to public comments on the Draft WM PEIS. Further, whenever a verbatim record and/or individual attribution was requested, audiotapes were used to read the individual's statement into the hearing summary.

Although some of the hearing facilitators work in some connection for DOE or have done so in the past, all were experienced in conducting sessions of this nature. The hearing format was not structured as an "arm's length" negotiation session requiring an unbiased arbitrator. Rather, it was structured as a true dialogue in which DOE officials and technical personnel could directly hear the public's perspectives and enter into a discussion in which the public's perspectives could be properly understood to facilitate development of appropriate changes to the Draft WM PEIS.

The hearing did save money by allowing a maximum number of involved DOE officials and technical experts to hear public comments first-hand, while avoiding unnecessary travel costs. Recognizing that personal contact is also desirable and thought to be important to some individuals, DOE provided at least one individual from its Headquarters WM PEIS Team at all hearings for onsite participation, as well as DOE officials from the sites who are knowledgeable about local DOE programs and public issues.

12.2 Draft WM PEIS Public Comment Process and Hearings

Comment (1567)
The video shown at the beginning of the hearing was informative; however, it was not honest. *DOE was involved in a number of activities*. The PEIS was forced by a lawsuit.

Response
As acknowledged in the beginning of the videotape, DOE has, in the past, undertaken waste management activities primarily at the sites where the waste was generated so that a minimum of waste was moved between sites. However, this may or may not be the best strategy for future management of DOE waste. And, while it is true that the preparation of the WM PEIS was initiated in response to a lawsuit, that does not in any way diminish its value or DOE's intent to use the analysis and results presented in the PEIS to help make decisions regarding the treatment, storage, and disposal of waste. These analyses will help DOE to understand the potential environmental impacts, human health risks, and costs of various waste management strategies. Furthermore, DOE believes that choosing the right balance among these and other factors should be based on good science, safety, common sense, and public values.

Comment (1576)
The teleconference hearing was not a consensus process because it did not include all of the public at all of the sites simultaneously; DOE should have held all the hearings at the same time to get a true national consensus.

Response
The WM PEIS public hearings, like all others held under the process for implementing NEPA, were not designed or intended to form a "consensus" process, but to provide for the expression of diverse viewpoints where they exist. The hearings were held to obtain public input on the Draft PEIS that would be considered and factored into the Final WM PEIS, as appropriate. The format used for the WM PEIS hearings was also developed to provide experts to answer the public's questions and provide a discussion forum to promote a clear understanding of the public comments conveyed.

In contrast to the commentor's preference for a single national forum, some commentors felt that holding simultaneous hearings involving multiple sites is unwieldy. DOE's approach was to balance the need to open the hearings to as many individuals as possible, while keeping the participation orderly and focused. To this end, hearings were held in all potentially affected regions of the country. Through this mechanism and through subsequent public involvement opportunities, differences in regional or other perspectives can be considered in the national decision process supported by the WM PEIS.

Recent efforts to enhance public participation in decisionmaking include the National Dialogue discussed in Volume I, Section 1.8.2, of the WM PEIS.

Comment (2217)
When I arrived at this hearing I was given a form to provide written comments. I made the effort to come down here, I don't need to write down a bunch of stuff and send it to you.

Response
Comment forms were provided to meeting attendees as a convenience for those who wished to hear the proceedings but preferred to offer written rather than oral comments. The forms could be used to

submit written comments at the hearing or to send written comments to DOE after the hearing. There was no requirement to write comments. Everyone who wished to provide oral comments at hearings was given an opportunity to do so. All oral comments were recorded.

Comment (2218)
I don't trust DOE to summarize the comments I give at public hearings.

Response
Comments given at public hearings on the WM PEIS were recorded verbatim for members of the public who requested this service. Comments from all public hearings were documented and placed in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS in early February 1996. Thus, hearing summary comments and verbatim comments (when requested by individuals) were available for commentor review before the end of the public comment period and publication of the Final PEIS.

Comment (3186)
We believe the concerns we raised in our testimony at the November 9, 1995 hearing have not been addressed. The issues in that testimony should be addressed in the Final EIS.

Response
DOE considered all comments received during the public comment period in preparing the Final WM PEIS. This includes all comments received during the public meetings on the Draft WM PEIS.

Comment (3334)
Public involvement for this WM PEIS was deficient because (1) there were no public hearings, which tainted the process and indicated a breach of trust; and (2) it was not fair to have public hearings "on some line" that most Americans could not access "(e.g., like asking that these comments be postmarked by February 19, Presidents Day, when most PO's are closed)."

Response
Thirteen public hearings were held during the public comment period, which ran from September 22 until February 19, 1996. Recognizing that February 19, 1996, was a holiday, DOE accepted comments postmarked on February 20, 1996.

Although NEPA regulations only require one public hearing to be held, DOE conducted these public hearings all across the Nation and utilized the video conference format to allow for a greater involvement of DOE managers and program staff and to reduce costs. The hearings were announced in the *Federal Register* and advertised in newspapers, on radio stations, at press meetings, and via other local announcements. Meeting summaries were made available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

DOE has conformed to the CEQ regulations concerned with public involvement in the NEPA process. Persons wishing to participate in the hearings were encouraged to attend. The videoconference format actually allowed the public at two or more locations to hear each other's comments, which enhanced understanding of the issues.

12.2 Draft WM PEIS Public Comment Process and Hearings

Comment (3774)
This public hearing format was different from other hearings. DOE should not require speakers to sign up to speak at the meeting.

Response
Many DOE public hearings offer preregistration to ensure early opportunities to speak and to allow DOE to provide adequately sized facilities for the hearing. However, sign-up was not required in order to speak up at the public meeting. Preregistration was conducted to facilitate the organization of the meeting, and was supplemented by sign-up at the hearing location.

Comment (3797)
DOE needs to ensure that public involvement in the meetings such as these include notifying Argonne National Laboratory-East (ANL-E) workers.

Response
DOE notified the public of its public hearings through the typical avenues, including a *Federal Register* notice, radio and newspaper announcements, and, in some cases, information mailed to those on the site mailing list. In the future, DOE will work closely with the ANL-E management to provide adequate notification to the ANL-E workers.

Comment (3914)
DOE needs to be more responsive to the questions asked at hearings. "Yes" or "no" answers and fewer technical terms would be helpful.

Response
The WM PEIS public hearings, which were conducted all across the Nation, served several purposes. They were intended as a public forum to submit oral comments on the PEIS, and to facilitate a direct and open dialogue between the attendees and DOE. Thus, DOE had an opportunity to listen to and collect public comments, clarify issues and respond to questions, and interact with the public to make the WM PEIS the best document possible.

Waste management planning involves complex technical and other types of issues; therefore, DOE cannot always avoid using technical terms and cannot always give "yes" or "no" responses to questions. In addition, there are questions that cannot be answered with a 100% certainty, especially when dealing with predictions. DOE strives to explain technical terms and encourages hearing participants to ask for clarifications when they need them.

Comment (4568)
DOE should provide the meeting (public hearing) records to the public before the public makes written comments on the PEIS.

Response
The public hearings were held as one of two primary avenues for obtaining public comments on the Draft WM PEIS; the other was a 5-month comment period during which written comments could be submitted. These two avenues were provided simultaneously and one was not contingent on the other. The number of hearings and length of time allowed for public input were well beyond the requirements of NEPA and its implementing regulations. DOE is strongly committed to informing the public of its

proposed actions and highly receptive to public input on the NEPA reviews of those actions. To this end, DOE believes it is essential to keep the public's attention and comments focused on the NEPA document itself, in this case the WM PEIS, rather than on the public hearing record. That record is available for information in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

Comment (4571)
Notice for the Hanford public hearing was abysmal. The notices did not identify proposals to ship vast quantities of waste to the Northwest or the resulting potential human health risks. Legal notices are not designed to reasonably reach the affected population.

Response
Flyers were distributed to approximately 5,000 people who are on Hanford's distribution list of most interested citizens and stakeholders. These flyers clearly identified the alternatives that would send waste to Hanford. A display advertisement was run in the Tri-City Herald, which did state that certain alternatives, if selected, would send waste to Hanford. The DOE video on the WM PEIS was aired approximately 12 times on Northwest Public Television. This video clearly defined the alternatives that could send waste to Hanford. Radio advertisements and editorials were also used to inform the public of the public hearings. DOE, therefore, believes satisfactory notice was given.

12.2 Draft WM PEIS Public Comment Process and Hearings

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13. Waste Management Programmatic Decisionmaking

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(No comments were received for this section)

13.1 Decision Criteria

Comment (158)
PEIS criteria for selecting preferred alternatives and issuing Records of Decision should include the impact the decisions would have on the environmental restoration activities at each site, including the Records of Decision, Consent Agreements, and Site Treatment Plans already in place.

Response
The WM PEIS is a programmatic document that addresses future configurations for selected waste management facilities. The factors and criteria used to select PEIS preferred alternatives are identified in Volume I, Section 1.7.3, and include favoring alternatives that comply with all applicable regulatory requirements, DOE Orders, and commitments made through the FFCAct process or Department agreements with states and other regulators. DOE's preferred alternatives and the reasons they are preferred are identified in Section 3.7. DOE will consider all available information, including site-specific environmental restoration concerns, when making decisions.

Comment (552)
The regulatory risk decision criterion should focus not only on more stringent future statutes, but also on the possibility of less stringent requirements. The regulatory risk assessment should be tied closely with the implementation flexibility decision criterion.

Response
DOE agrees with this comment, and has (1) included the possibility of less stringent future statutes in the WM PEIS regulatory risk decision criterion and will (2) use the regulatory risk and implementation flexibility criteria in concert with the other decision criteria and factors to guide decisions on waste management.

In the context of this PEIS, regulatory risk addresses how the preference for an alternative might be affected by regulatory and statutory changes, regardless of whether the change is toward more or less stringent requirements. Selecting more costly alternatives could result in needless expenditures if less stringent regulations were to go into effect. Conversely, selecting less costly alternatives could save money in the short term, but could also introduce delays and "backfitting" costs if more stringent statutes and regulations were to go into effect.

DOE modified Section 1.6 of the WM PEIS Summary document and Section 1.7.3 in Volume I, which discuss the regulatory risk criterion.

Comment (1525)
Economic issues are important, but not at the expense of human health and environmental risk. DOE needs to consider environmental values and human health.

Response
Volume I, Section 1.7.3, describes the decision criteria and factors DOE has used and will use to select waste management alternatives. The waste management alternatives in the WM PEIS could affect a number of environmental resources, among them human health and safety, socioeconomic conditions, ecological resources, and more. DOE has evaluated the impacts of its programmatic alternatives on these areas. These evaluations are part of DOE's decisionmaking process.

13.1 Decision Criteria

Comment (1535)
DOE needs to state clearly the factors and criteria it will use in selecting a waste management alternative, and how these factors will be ranked. The public should have input to the selection and ranking of these criteria. The decision criteria should be weighted toward feasibility, costs, and ways of mitigating impacts.

Response
The WM PEIS lists and discusses the criteria used to select a preferred alternative for each waste type in Section 1.7.3. These criteria are not ranked in terms of importance, which provides DOE with maximum flexibility in the decisionmaking process. The public has had an opportunity to provide input to the selection and use of the decisionmaking criteria used in the PEIS during the public comment period on the draft document. Cost and ways of mitigating impacts are two of the criteria used to select a preferred alternative. Feasibility plays a central role both in defining alternatives to consider, and in selecting a preferred alternative.

DOE's ultimate decision on how to manage each waste type examined in the WM PEIS will follow the issuing of the Final PEIS and will be outlined in published Record(s) of Decision. In making these decisions, DOE will consider the criteria examined in the WM PEIS, as well as other factors such as budgets, schedules, and national priorities.

Comment (1541)
The WM PEIS lists the decisionmaking factors and criteria. DOE needs to tell the public how it will rank these factors. There needs to be public involvement in the assumptions used for ranking and weighting.

Response
DOE solicited public comments on the criteria it proposed for decisionmaking, which are described in Volume I, Section 1.7.3, of the WM PEIS; this volume describes those comments. During the public meetings on the Draft WM PEIS, DOE specifically asked the public four main questions:

- Is the document technically adequate?
- What values should DOE consider in making these decisions?
- What alternatives does the public prefer or oppose?
- Is the proposed process for making these decisions reasonable?

The WM PEIS lists and discusses the criteria used to select a preferred alternative for each waste type in Section 1.7.3. These criteria are not ranked in terms of importance, which provides DOE with maximum flexibility in the decisionmaking process. The public has had an opportunity to provide input to the selection and use of the decisionmaking criteria used in the PEIS during the public comment period on the draft document.

The first step in the development of waste management decisions is the identification of the preferred alternatives for each waste type (see Volume I, Section 3.7). This identification does not mean that DOE has made final decisions.

DOE's ultimate decision on how to manage each waste type examined in the WM PEIS will follow the issuing of the Final PEIS and will be outlined in published Record(s) of Decision. In making these

decisions, DOE will consider the criteria examined in the WM PEIS, as well as other factors such as budgets, schedules, and National priorities.

Comment (1542)
DOE might rate cost factors higher than the public would.

Response
Volume I, Section 1.7.3, describes the decision criteria and factors DOE has used and will use to select waste management alternatives. Human health and environmental risks are two important decision criteria. However, DOE has not weighted or ranked its decision criteria because DOE decisionmakers will take other factors such as budget, schedules, and national priorities into account in arriving at waste management decisions.

Comment (1545)
Risk analysis is being debated by the public. Attaching numeric and dollar values to human life is a big problem. DOE needs to consider whether risk analysis is an appropriate criterion for screening alternatives.

Response
DOE believes that health risk is an appropriate criterion on which to base its waste management decisions. However, DOE is not attempting to put dollar values on human life. In the WM PEIS, the risk analyses are evaluations of the potential risks from each alternative considered. These risks include cancer incidences and deaths from radiological or chemical sources from accidents and normal operations as well as trauma deaths from accidents. These impacts are measured for waste management workers, other onsite workers, and the general public. In addition, the PEIS evaluates the impacts to the maximally exposed individual (generally a member of a farm family located at the boundary of the facility) and to an intruder who drills into a disposal site after institutional control of the site ends. These risk calculations do not include a monetary value for human life.

Comment (1547)
Decisionmaking criteria do not address economic impacts to the communities.

Response
DOE included economic dislocation as a decision criterion in Section 1.7.3; therefore, DOE will consider alternatives that tend to minimize economic dislocation, including job losses. Furthermore, the WM PEIS provides an analysis of economic impacts. The economic impacts analyzed include (1) changes in regional and national employment, (2) changes in personal incomes at the national and regional levels, (3) changes in national economic output, and (4) changes in job-years at the national level.

Comment (1605)
The PEIS should weight the factors of the analysis and discuss them in terms of what is good for the nation and the public.

Response
The WM PEIS is DOE's national programmatic study leading to the decisions to be made on the safe and efficient management of its radioactive and hazardous wastes, which will benefit the Nation and the

public. During the comment period on the Draft WM PEIS, DOE solicited public input on the decision criteria and factors for the siting and management alternatives to help identify the preferred alternatives in the Final WM PEIS; Section 1.7.3 in Volume I describes these criteria.

In addition to the environmental (including human health) impacts and costs addressed in the WM PEIS, DOE decisionmakers will take other factors such as budgets, schedules, and national priorities into account in arriving at waste management decisions. For this reason, the WM PEIS is not the appropriate forum to determine ranking criteria or to weight factors of analysis.

Comment (1633)
The PEIS should consider the community context for siting decisions and discuss the effects of the alternatives on local government resources (including costs), because local governments are responsible for public safety and will bear many of the costs of these actions.

Response
DOE agrees that impacts on the community around a site are important. The WM PEIS considers many potential community impacts, including health risk to the offsite population; economic impacts to the region of influence around the site, including regional income and employment; population changes to the region and their likelihood to cause changes to community size, stability, diversity, identity, and provision of necessary services; and potentially disproportionately high and adverse impacts on minority or low-income populations around each site (environmental justice).

Comment (1634)
The decision criteria should be weighted toward the feasibility, costs, and ways of mitigating impacts.

Response
During the comment period for the Draft WM PEIS, DOE emphasized its interest in public opinion on the decision criteria. DOE considered those comments and refined the list of decision criteria presented in Volume I, Section 1.7.3, of the Final WM PEIS. DOE will continue to use these criteria and other decisionmaking principles during the decisionmaking process as it did in choosing the preferred alternatives.

Comment (1668)
Criteria that DOE should consider in selecting preferred alternatives and making final decisions include:

- The concept that cost and risk are major parameters for decisionmaking in the absence of extreme or unknown hazards that require high priority regardless of cost.

- Relative to low-level waste, it is apparent that transportation is the dominant source of public risk and that treatment and disposal are dominant for worker risks. It is also apparent that development of disposal facilities is expensive relative to transportation. This presents decisionmakers with the dilemma of trading off dollar savings for potential increases in public and worker risks.

- Many Nevadans are opposed to the disposal of these wastes in our State regardless of cost and risk issues. What additional and ongoing opportunities do you plan to provide to listen to this

13.1 Decision Criteria

viewpoint, expand local oversight authority, and manage wastes on a national scale to minimize or eliminate the need for waste disposal in Nevada?

Response
The decisionmaking process following publication of the Final WM PEIS will certainly include cost and risk considerations, but it will also consider a number of other important factors, including those described in Section 1.7.3 in Volume I. The decisionmakers will be faced with many trade-offs. Thoughtful consideration of these many factors is a part of the decision process. In some cases the decision can be made easier since mitigation measures can be used to reduce the impacts of the selected alternative. The decision process will result in Records of Decision issued subsequent to this PEIS. They will identify DOE's strategy for the management of wastes on a national scale.

DOE is developing additional opportunities for a public National Dialogue during the decisionmaking process. This initiative is discussed in Section 1.8.2 in Volume I of the Final WM PEIS. To this end, all potentially affected states, including Nevada, are being provided with the same opportunities for input. The potential for expansion of local oversight authority is a site-specific issue that could be considered during sitewide or project-level NEPA reviews. This issue is outside the scope of the WM PEIS.

One of the major decisions to be made as a result of the WM PEIS is whether to manage wastes in a decentralized, regionalized, or centralized configuration. Therefore, DOE is considering the "national scale" configuration of its waste management facilities in the WM PEIS.

Comment (1772)
The WM PEIS includes regulatory compliance as a criterion DOE "may use" to screen, evaluate, and narrow the current alternatives for each waste type. The wording should be changed to "shall use" and the PEIS should list all State and Federal regulations for clarification.

Response
Section 1.6 in the Summary document and Section 1.7.3 in Volume I of the Final WM PEIS were revised to state that DOE will use the listed factors and criteria to make decisions. However, DOE remains open to public input to further develop principles for making decisions.

Section 1.4 in Volume I of the WM PEIS identifies the major Federal laws and requirements that might apply to the programmatic alternatives for waste management. As noted in Section 1.4, there may be other State and local measures, applicable to the Waste Management Program; however, these additional requirements will be addressed in sitewide and project-level NEPA reviews.

Comment (2304)
Minimize transportation. With many of your plans, transportation across this country would be phenomenal and the risks to public health and safety would be beyond belief.

Response
Transportation requirements are considered a factor in examining different programmatic siting and management alternatives. Included in the analysis is whether transportation should be minimized by DOE. DOE will have to balance the number of shipments with potential environmental risks, safety consequences, public concerns, mission needs, and costs. DOE's preferred alternatives and the reasons

they are preferred are identified in Section 3.7 in Volume I of the WM PEIS. Programmatic decisions will be announced in Records of Decision after the Final WM PEIS is published.

Comment (2966)
It is not clear how conflicting comments dealing with site preferences will be resolved in the DOE decision process.

Response
The decision criteria and factors described in Volume I, Section 1.7.3, were used in selecting preferred alternatives. To the extent possible, DOE incorporated stakeholder preferences along with its needs in the WM PEIS decisionmaking process. The Final WM PEIS considered public comments on the Draft WM PEIS in developing the preferred alternatives identified in Section 3.7.

The WM PEIS will inform DOE decisionmakers by providing an analysis of the environmental and human health impacts of the alternatives. However, the PEIS will not be the only basis for making decisions, especially in the event of conflicting opinions about site preferences. DOE will consider budgets, schedules, national priorities, and other DOE studies in making these decisions.

Comment (2974)
DOE should consider the following criteria in selecting preferred alternatives and making final decisions: Are cost estimates based on DOE-owned or privately owned and operated facilities?

Response
Waste management costs, especially those for construction, can vary by region, season, and vendor. Moreover, there are many offsite waste management facilities operated by private companies. It would be difficult to determine which facilities DOE would use, how much waste they would receive, and what types of waste they would receive. In order to ensure consistency in the WM PEIS analysis, DOE based the costs for the conceptual treatment, storage, and disposal facilities identified in the PEIS on experience gained during the construction of its own facilities. Therefore, the relative costs of the respective alternatives is a valid discriminator among alternatives. Chapters 6 through 10 (Volume I) and Appendix C (Volume III) of the PEIS provide details of the cost analyses. DOE project managers will minimize actual expenditures after the development of specific facility plans. DOE encourages commercial participation in its Waste Management Program. Section 1.7.4 in Volume I addresses use of privatized or commercial facilities to manage DOE waste. Cost would be one factor DOE would consider in deciding whether to commercialize or privatize specific waste management operations.

Comment (2975)
DOE should consider the following criteria in selecting preferred alternatives and making final decisions: Cost estimates for transportation should include funding for emergency response training and equipment for State and local officials.

Response
The costs to train emergency responders are not included in the WM PEIS. Since there are over two million radioactive materials shipments in the United States by public and private entities each year, most State HAZMAT emergency responders are already trained to respond to hazardous waste, low-level waste, and low-level mixed waste transportation incidents. DOE is working with the States to train emergency responders for future WIPP transuranic waste shipments. Future training of State emergency

13.1 Decision Criteria

responders for high-level waste is also planned. DOE will work with the States to develop transportation plans that will determine the needs of State emergency responders prior to waste shipment where required.

Because of existing State emergency response training for hazardous waste, low-level waste, and low-level mixed waste, DOE expects emergency response training and equipment costs to be small compared to shipping costs and, therefore, has not included these costs in the WM PEIS cost estimates.

Comment (2985)
Site geology and proximity of offsite population should be primary factors in making disposal (and treatment) decisions.

Response
Site geology and offsite population are factors that influence human health risk and other environmental impacts. Volume I, Section 1.7.3, was revised to indicate that human health risks depend on factors such as the population surrounding the sites and the hydrogeology of disposal sites. DOE did not attempt to quantitatively estimate risks to offsite populations from disposal because any credible analysis would require knowing specific locations for each disposal unit. However, DOE did analyze the vulnerability of the populations at the 16 potential disposal sites to risks from disposal based on site factors such as population, site size, and hydrology. The sites relative risk vulnerability grouping was used to compare the disposal alternatives. See Section 5.4.1.2.3 in Volume I of the WM PEIS.

Comment (2992)
In its decision process, DOE should consider impacts on the existing workforce, particularly in options that rely on the private sector.

Response
DOE does consider the impacts of its actions on the existing workforce in terms of economic dislocation. These impacts were added as a decision criterion, as explained in Section 1.7.3 of the WM PEIS. Chapters 6 through 10 of the PEIS discuss the economic and population (including worker) impacts from the alternatives for each waste type.

Comment (3028)
When the analysis highlights environmental problems within alternatives, those problems should be used to eliminate the alternative, or to tag it as less desirable. Instead, the PEIS states that the problems can be mitigated, with little explanation of how such mitigation might be accomplished, or the impacts of carrying out the mitigation. If environmental criteria are not used to discriminate between alternatives, this PEIS is of very little use.

Response
NEPA requires consideration of reasonable alternatives, not just the most environmentally protective alternatives. As stated in Section 1.7.3 in Volume I of the Final PEIS, DOE, in its decisionmaking process, will consider factors which favor selection of alternatives and sites that would minimize adverse environmental impacts. In accordance with CEQ guidelines, when adverse impacts are indicated, potential mitigation measures are discussed to show how DOE could reduce or eliminate such impacts. However, the impacts without mitigation are displayed in the PEIS.

13.1 Decision Criteria

Comment (3306)
The list of decision criteria should explicitly include health and safety and socioeconomic impacts.

Response
The Summary document and Volume I, Section 1.7.3, which identifies the decision factors and criteria associated with the WM PEIS, have been revised. Health and safety are included in the human health risk factor. Socioeconomic impacts are included in the economic dislocation and environmental impact factors.

Comment (3786)
The public needs to know what the siting criteria will be.

Response
Decisions on which DOE sites will host waste management facilities will be made on the basis of this WM PEIS and other relevant input (e.g., other risk studies). Factors and criteria for these siting decisions are explained in Volume I, Section 1.7.3. Decisions as to where on a selected site a waste management facility will be located will occur after consideration of sitewide or project-level NEPA reviews. Such NEPA reviews will include public participation. Thus, the public will be informed of siting criteria on a site-specific or project-level basis.

Comment (3799)
DOE needs to consider the people that they are affecting by their decisions.

Response
As a programmatic EIS, the WM PEIS assesses a variety of impact parameters for the five waste types under the different alternatives. Impact parameters relating to people, for example, include human health, socioeconomic conditions, and environmental justice. Moreover, DOE considers public input a major driver of the WM PEIS process. In many instances, public comments have precipitated changes in the PEIS.

Comment (3861)
DOE should consider these decision criteria: logistics, economics, and public health and safety.

Response
As described in Section 1.7.3 in Volume I of the PEIS, DOE will consider a range of decision criteria. Logistics are considered in the decision criteria for site mission, transportation, and implementation flexibility. Economics are considered in the environmental impact, cost, and economic dislocation decision criteria. Public health and safety are considered in the human health risk and transportation decision criteria.

Comment (3901)
We need to consider future generations in these decisions.

Response
The decision criteria for preferred alternative selection included human health risk, which includes long-term (multi-generational) risk.

13.1 Decision Criteria

Comment (3922)
DOE needs to explain the criteria they will use to make the final decision regarding disposal facilities and how those criteria might apply to Argonne National Laboratory-East (ANL-E).

Response
The WM PEIS outlines the decision criteria and factors for the development of its preferred alternatives in Volume I, Section 1.7.3. Records of Decision will be issued following this WM PEIS for each waste type.

Comment (4236)
If reducing waste volume and treatment also reduces the possibility of waste leaching into the environment or groundwater, then the cost is worthwhile.

Response
Environmental impact, health risk, and cost are among a number of decision criteria DOE considered in selecting its preferred alternatives for each waste type identified in Section 3.7 (Volume I). Chapter 1, Section 1.7.3, in Volume I of the PEIS describes the factors and criteria considered.

Comment (4440)
With respect to the factors and criteria DOE may use to select preferred alternatives, DOE should explain what is meant by minimizing adverse environmental impacts in detail, including:

- How risks during treatment, storage and disposal are weighed for those immediately impacted versus all future generations (DOE had a tradition of using time-discounting in related risk management decisionmaking, and this and alternatives to this approach need to be fully evaluated);

- How environmental impacts are evaluated for onsite workers (for whom the risk can be considered to be voluntary) versus the general public, and associated trade-offs;

- How trade-offs between the different factors, such as cost and environmental impacts, are evaluated should be explained;

- The DOE administrative mechanisms and lines of authority used to make such decisions and the tools DOE uses for this purpose.

Response
The WM PEIS evaluates the potential health risk from waste treatment and storage for offsite populations and DOE site workers resulting from facility releases during the projected 10-year period of waste management operations. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for high-level waste storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. The WM PEIS evaluates risks to receptors for a single lifetime (70 years).

The PEIS also evaluates health risk from the disposal of low-level mixed waste and low-level waste for successive lifetimes (143 lifetimes of 70 years) of the hypothetical farm family over a 10,000-year period of analysis. However, it evaluates each lifetime independent of risks estimated for other lifetimes and does not discount risk estimates on the basis of time.

13.1 Decision Criteria

Section 5.4.1 in Volume I and Appendix D in Volume III describe the methodology for worker risk. The WM PEIS does not distinguish voluntary risk from involuntary risk, and assumes no trade-offs between worker risk and public risks.

Section 1.7.3 in Volume I describes the waste management decisions to be made by DOE. The decision process will occur after publication of the Final WM PEIS. The decision process is not part of the PEIS preparation, although the Final PEIS describes the preferred alternatives in Volume I, Section 3.7, and the reasons they are preferred. DOE asked for public input on the decision process during the public meetings on the Draft WM PEIS. The Records of Decision will explain how DOE used the impacts presented in the WM PEIS, together with other factors including cost, in the decisionmaking process.

13.2 Decision Process

Comment (466)
DOE needs to delineate whether site-specific environmental concerns are secondary to programmatic decisions being considered.

Response
DOE does not consider site-specific concerns to be secondary to programmatic concerns, even though it will deal with programmatic issues first in relation to waste management. The WM PEIS will help DOE make broad-based decisions, the implementation of which could require additional sitewide or project-level NEPA reviews to provide more in-depth assessments of impacts at potentially affected sites. Additional reviews would also consider the location, design, and operation of proposed waste management facilities at the particular DOE sites selected on the basis of the WM PEIS.

Comment (536)
DOE needs to clarify whether the WM PEIS will enable decisions on the treatment, shipment, and disposal of low-level waste, and whether this document will affect the levels of waste entering Idaho.

Response
The WM PEIS supports decisionmaking on the treatment, storage, and disposal of low-level waste at all DOE sites, including the Idaho National Engineering Laboratory (INEL) (see Volume I, Chapter 7). Under Regionalized Alternative 5, INEL would receive low-level waste from other sites for treatment or disposal. Under all other low-level waste alternatives, INEL would treat and dispose of its own low-level waste or ship it offsite for treatment and disposal.

Comment (538)
DOE needs to clarify if it will use other documents or impact analyses to make decisions regarding the treatment, transportation, and disposal of low-level waste at INEL, and to identify those documents.

Response
Section 1.8 in Volume I of the WM PEIS discusses the relationship of other documents and programs to the WM PEIS. It includes a discussion of the SNF/INEL EIS, in which DOE analyzed the treatment, transportation, and disposal of low-level waste at INEL. The impacts of actions analyzed in the SNF/INEL EIS were included in the cumulative impacts analysis in Chapter 11 of the WM PEIS. DOE will also consider other DOE studies in making waste management decisions, as discussed in Section 1.8.1 in Volume I.

Comment (554)
The low-level and low-level mixed waste storage (disposal) evaluation should consider the siting evaluation process utilized by the various compact commissions. The evaluation and implementation strategies should indicate the regulatory risk and implementation flexibility decision criteria identified in the WM PEIS.

Response
DOE will consider not only all applicable regulations in siting future low-level and low-level mixed waste disposal facilities, but also relevant guidance to the extent possible. Further, DOE typically includes both regulatory risk and implementation flexibility in its evaluations of the merits of proposed future programs.

13.2 Decision Process

The primary objective of the siting evaluation process used by interstate low-level waste disposal compacts is to ensure the public is protected from releases of radiation. Performance assessments, which must relate to specific locations, confirm that releases are below the threshold set to protect the public. DOE uses the same process that compacts do to determine the location of a disposal facility on a site, and performance assessments to demonstrate that a site is suitable. Because the WM PEIS is a programmatic document, however, it does not consider specific locations for disposal facilities. The exact location of such a facility on a DOE site selected on the basis of this WM PEIS would be the subject of a sitewide or project-level NEPA analysis.

A facility for the disposal of low-level mixed waste must conform not only to standards set by the compacts for protection against radiological releases, but also to standards set by the EPA or a State agency to protect the public from hazardous chemical releases, in accordance with the Resource Conservation and Recovery Act. Section 1.7.4 discusses the use of commercial facilities.

Comment (1115)
The WM PEIS should provide an upgraded sensitivity analysis of all the decisionmaking factors that DOE will use for Records of Decision.

Response
Section 1.7.3 in Volume I of the WM PEIS describes the decision factors and criteria, many of which are not related to environmental impacts. The Records of Decision will be based on these factors and criteria. However, DOE will not perform a sensitivity analysis in the PEIS on decision factors that are not related to environmental or human health impacts, because such an analysis is beyond the scope of the WM PEIS and the requirements of NEPA. The decision factors and criteria not related to impacts analyzed in the WM PEIS will be considered through other documents and processes.

Comment (1164)
If no objections are made to DOE, plans for disposal at the Paducah Gaseous Diffusion Plant (PGDP) would proceed.

Response
This is not the case. DOE will base its programmatic decisions related to national waste management configurations on the Final WM PEIS and other studies, and on decision factors and criteria, most of which DOE identified in the Draft PEIS (Section 1.8) and in the Final WM PEIS (Section 1.7.3). DOE explicitly invited public input on these factors and criteria and on the decisionmaking process that will select the preferred alternatives.

Comment (1578)
It is difficult to believe that DOE does not know which alternatives are preferred.

Response
CEQ regulations implementing NEPA require the agency to identify its preferred alternative, if one is known, in the Draft EIS, and to identify the preferred alternative in the Final EIS unless another law prohibits the expression of such a preference.

In the Draft WM PEIS, DOE identified preferred alternatives for management of three of the five waste types because, at that time, only those had been developed. DOE intended to benefit from the public

13.2 Decision Process

input as to the selection of preferred alternatives. Selection factors criteria for the preferred alternatives are identified in Section 1.7.3 in Volume I in the WM PEIS. Section 3.7 in Volume I of the Final WM PEIS identifies preferred alternatives and the reasons they are preferred for management of all of the five waste types.

Comment (1595)
DOE needs to clarify how it will make its decisions if all 16 potential communities oppose the PEIS proposals, and what it will take to get a site off the list.

Response
Volume I, Section 1.7.3, describes the WM PEIS decision factors and criteria, and Volume I, Section 3.7, describes DOE's preferred alternatives and the reasons they are preferred.

DOE analyzed 17 major sites in the WM PEIS. The designation of a site as "major" does not mean it will be selected for a waste management role. Rather, it means that DOE analyzed potential impacts from waste management activities.

DOE must select a preferred alternative for each waste type to meet the urgent national priority for sound waste management. While residents might perceive that one approach, such as decentralization, offers particular benefits or damage to a community or region, DOE must base its decisions on the diverse national needs and issues that affect many sites and regions.

Comment (1630)
DOE needs to explain how it will decide what the nationwide alternatives will be.

Response
CEQ regulations for implementing NEPA require an EIS to identify preferred alternatives, and for Federal agencies, including DOE, to announce their decisions on EISs in Records of Decision. Volume I, Section 1.4.1, describes the NEPA process, including the Record of Decision process. Section 3.7 identifies DOE's preferred alternatives, and the reasons they are preferred, for managing the WM PEIS wastes. Section 1.7.3 lists and describes the decision factors and criteria DOE will employ to make decisions based on the WM PEIS.

Comment (2305)
It is unclear how DOE will make the ultimate decision on the management of the various wastes found at numerous waste sites and how it will coordinate decisions made by individual sites; therefore, DOE should explain how and by whom these decisions will be made, how discrepancies will be resolved, and what appeals communities have.

Response
The WM PEIS evaluates alternatives for the treatment, storage, and disposal of radioactive and hazardous wastes. It is an integrated examination of the impacts of Department-wide management decisions for each waste type and of the collective impacts for all waste facilities at a given site.

The WM PEIS identifies DOE's preferred alternatives and the reasons they are preferred for each of the five waste types considered (see Volume I, Section 3.7). The decision factors and criteria identified in Section 1.7.3 were refined based on public comments and were used to help select preferred

alternatives. DOE decisionmakers will consider these decision factors and criteria and public input to develop Records of Decision. No sooner than 30 days after public availability of the Final WM PEIS, DOE can begin to issue its Records of Decision, which the Secretary of Energy will sign and in which DOE will announce and explain its programmatic waste management decisions.

The programmatic waste management decisions which result from the PEIS form a base for sitewide or project-level decisionmaking, including subsequent sitewide or project-level NEPA reviews. These reviews will be tiered from the programmatic decisions. They will also include further public involvement opportunities, including those associated with the National Dialogue and the Environmental Management Ten Year Plan discussed in Section 1.8.2 in Volume I of the WM PEIS.

Comment (2969)
In its decision process DOE should consider that transportation poses greater risk to the general public than construction and operation of waste management facilities, yet decentralization is generally more expensive.

Response
The facts that transportation associated with the Regionalized and Centralized Alternatives would pose greater risks than those associated with the Decentralized Alternatives, and that the Decentralized Alternatives would be more expensive, is a primary issue in the DOE waste management evaluation. This WM PEIS analysis will be the basis for decisions that will weigh costs, risks, and other criteria. Section 1.7.3 in Volume I of the WM PEIS includes both cost and human health risk as decision criteria and factors.

Comment (2971)
In its decision process, DOE should carefully consider the aesthetics of shipping low-level waste any appreciable distance.

Response
Section 1.7.3 in Volume I of the WM PEIS identifies transportation (in terms of the amount required) as a decision criterion. However, aesthetics of transportation of low-level waste was not evaluated in the WM PEIS because the types of trucks or trains involved would be essentially identical to the types of trucks or trains used to ship similar nonwaste materials.

Comment (2990)
In its decision process, DOE should consider what impacts the agency's choices would have on the diversification of local economies.

Response
At the programmatic level, DOE was not able to consider the effects on potential economic diversification of a locality because of the complexity involved in such an analysis and has not included this in the decision criteria. The waste management actions in most cases would lead to substantially increased expenditures in the local economy at each site. How these funds would affect economic diversity would depend on an array of factors external to the simple model used to estimate economic effects and would require making a great deal of assumptions to make any reasonable forecast. The speculative nature of such forecasts would make them of only marginal value in programmatic decisionmaking. This site-specific topic can better be considered at the site level.

13.2 Decision Process

Comment (2995)
DOE needs to consider the requirements of DOE Orders in its decisionmaking process.

Response
DOE will comply with all applicable laws, regulations, and Orders. Section 1.7.3 in Volume I of the WM PEIS identifies compliance with DOE Orders as part of the regulatory compliance decision criterion.

Comment (3170)
DOE should develop an effective decisionmaking process to integrate EISs dealing with waste storage, treatment, and disposal. This process must be designed in a way that will earn the agreement of the affected States and Indian Nations, and the support of Site-Specific Advisory Boards and other affected stakeholders; this process must also contain a strong public involvement element. The Site-Specific Advisory Boards can play a key role in public involvement, but it must be augmented by a broader outreach program. DOE should work with stakeholders to ensure that their values are factored into alternatives being considered in the WM PEIS.

The Washington State Department of Ecology and the U.S. EPA should be fully involved in decisions that would impact the Hanford Site, particularly in decisions that could compete with or detract from the site's cleanup mission and the resources it requires.

Response
DOE agrees that there is a need for the development of an effective process that will integrate decisions DOE makes on waste treatment, storage, and disposal with those dealing with the disposition of other radioactive materials. In the Fall of 1995, DOE began a "National Dialogue" on radioactive waste and materials disposition with interested States, Site-Specific Advisory Boards, and other interested public. The purposes of the National Dialogue are to promote openness, to increase trust and confidence in DOE decisionmaking, and to complement the traditional public outreach efforts conducted under the process prescribed by NEPA and other environmental regulations. The National Dialogue effort will enable DOE and stakeholders, especially affected States, to explore potential trade-offs in decisionmaking that could benefit DOE and its host communities. At first, the National Dialogue will focus on decisions that DOE must make over the next few years and that could affect more than one DOE site, how DOE will arrive at the decisions, and how stakeholders can influence the decisions. While DOE's close work with the National Governors Association will be a cross-cutting vehicle for interactions with the States, the National Dialogue effort will strive to reach traditional and nontraditional stakeholders in an open and inclusive manner.

DOE has revised Volume I, Section 1.8.2, of the WM PEIS to include a description of this National Dialogue initiative. Chapter 11 considers the impacts of the actions associated with the PEIS in combination with the impacts of other DOE actions.

Section 1.7.3 in Volume I identifies the factors and criteria that DOE will use in its waste management decisionmaking process. Among the criteria that DOE will look for in selecting waste management alternatives are consistency with other DOE studies and comparability across sites, and the distribution of waste management facilities in ways that are equitable.

13.2 Decision Process

DOE has provided several opportunities for the public to provide input to the PEIS process. DOE's public participation effort for the PEIS is detailed in Volume I, Sections 1.7.1 and 1.7.2. Comments received from individual members of the public, interest groups, Federal, State, and local agencies, and others have played a significant role in shaping the PEIS and DOE's decisionmaking process.

As required by NEPA, DOE has or will consult with Federal and State agencies with jurisdiction by law or special expertise in the proposed action(s). Consultations with State agencies will occur during the development of sitewide or project-level NEPA documents that address specific locations of potential waste management facilities.

Comment (3659)
How is DOE going to make a decision based on impacts to water, ecological, cultural, and land-use impacts when it will be necessary to prepare site-specific studies prior to the selection of a site for the location of a facility? This seems to be an attempt to put the cart before the horse and would result in an irretrievable commitment of resources without proper NEPA-required impact analysis.

Response
The WM PEIS provides a screening-level analysis of the potential for impacts to water resources, ecological resources, and land use at the 17 major DOE sites. The PEIS analysis indicates that there is little potential for significant impacts on these resources at the sites for all waste types and alternatives because DOE will have considerable flexibility in siting any proposed waste management facilities and, thus, should be able to avoid or minimize such impacts. Therefore, these impacts should not weigh heavily in decisionmaking. More detailed analyses of these impacts would be done in sitewide and project-level NEPA analyses before a facility is located at a site and an alternative is implemented.

DOE acknowledges that the lands used for waste management facility construction, particularly disposal units, would constitute an irreversible commitment of resources--although exactly where those lands would be located at a site has yet to be determined.

Comment (3770)
DOE needs to be responsible in its decisionmaking.

Response
DOE intends to be responsible in its decisionmaking. Section 1.7.3 in Volume I has been revised to explain the decision process for making waste management decisions subsequent to issuance of the Final PEIS.

Comment (3794)
DOE needs to ensure the public that their meetings and opinions matter in the decisionmaking process.

Response
The CEQ and DOE NEPA regulations, under which this WM PEIS is prepared, mandate rigorous public participation efforts including public meetings. DOE considered all comments received on the Draft WM PEIS while preparing the Final PEIS. In numerous instances, public comments caused changes in the Draft PEIS that are reflected in the final version. Public input was also a major driver for the selection of preferred alternatives and will be considered in the decisionmaking process. Public input caused substantial changes to the decision factors and criteria to be used in the waste management

13.2 Decision Process

decisionmaking process (Volume I, Section 1.7.3). See Volume I, Section 1.7.2, for a summary of the comments DOE received and the changes DOE made to the PEIS based on those comments.

Comment (3795)
DOE needs to educate the public about the decisionmaking process and how it differs from a local referendum.

Response
As described in Volume I, Section 1.7.3, of the Final WM PEIS, decisions on waste management sites will be based on the information and analyses in the WM PEIS and other considerations such as regulatory compliance, budget constraints, schedules, compliance with regulatory agreements, including public input on each of the preferred alternatives for each waste type, national priorities, and other DOE studies. For example, DOE will continue to work with the DOE Disposal Workgroup and with State representatives in the National Governors Association to evaluate and discuss the issues related to the potential disposal of residuals from treatment of low-level mixed waste at sites subject to the FFCAct. DOE's Nuclear Material and Waste Dialogue Team, established in 1995, will work with interested members of the public and the National Governors Association to explore potential decisionmaking principles that may help DOE in making decisions that reflect public concerns.

The Records of Decision issued on the basis of the WM PEIS will identify sites at which waste management activities will occur. However, a decision on the specific technology and the particular location of a waste management facility at a site will be made on the basis of sitewide or project-level NEPA reviews.

Comment (3801)
DOE needs to help the public understand what steps will be taken in the process after the programmatic decisions are made.

Response
No sooner than 30 days after issuance of the WM PEIS, DOE may publish a Record of Decision that reflects consideration of the WM PEIS analyses, preferred alternatives, and other appropriate factors. Programmatic decisions on waste management may be issued individually for each waste type. In this way, the decisions would occur in a timely manner, which could be phased as the programs mature, and with appropriate discussion with States, regulators, members of Congress and other members of the public.

Implementation of the programmatic decisions would commence upon publication of the Record of Decision. If this involves modification of an existing waste management facility or the construction of new facilities, a determination would be made as to the need for further site-specific NEPA review. In this case, opportunities for additional public participation would arise.

Implementation planning would also involve efforts to assist DOE in complying with all State and Federal regulations, including preparing and submitting all required permit applications, and conducting all required consultations. This could include, for example, compliance with Federal transportation regulations as well as with DOE stipulations regarding the provision of appropriate information to State and local governments.

13.2 Decision Process

Comment (3805)
National papers, such as the *Chicago Tribune,* are carrying stories about this situation. The sooner decisions are made, the better. These news stories make our property values decrease.

Response
DOE is committed to developing a strategy for safe and efficient management of its radioactive and hazardous waste. This includes a timely conclusion of pertinent NEPA reviews and decision processes. WM PEIS Records of Decision will be published as soon as possible, but no sooner than 30 days after issuance of the Final WM PEIS, as required by NEPA. DOE is working hard to maintain an open, cooperative, fair, and constructive relationship with the public, including the press.

Comment (3908)
Any decision we make could be altered. Immediately remove ANL-E from consideration. DOE needs to explain how the waste management decisions will be staggered.

Response
Section 1.6 in Volume I of the WM PEIS provides an overview of the waste management sites covered in the PEIS and Section 3.5 describes the methodology used by DOE for selecting and identifying alternatives. DOE has not found any technical bases that would warrant removal of ANL-E as a major site alternative.

After the Final PEIS is published, the Record of Decision process will start. DOE does not expect that all waste management decisions will be made at one time for all waste types. DOE anticipates that the PEIS will result in separate Records of Decision by waste type to be issued in a staggered fashion starting in calendar year 1997. Section 1.7.3 in Volume I has been revised to explain the waste management decision process.

Comment (4335)
DOE's WM PEIS is a major step toward public understanding and involvement in decisionmaking. For the first time, citizens have available to them, in one document, a great deal of information about the wastes in the complex and the options for treating and disposing of those wastes.

Response
Thank you for your comment.

13.3 Record of Decision

Comment (1756)
Will there be future multiple WM PEIS Records of Decision and what is the potential timetable for these decisions?

Response
DOE anticipates that the PEIS will result in separate Records of Decision by waste type to be issued in phases starting in calendar year 1997. Section 1.7.3 in Volume I has been revised to explain the decision process for making waste management decisions subsequent to issuance of the Final PEIS.

Comment (2208)
Does DOE have an administrative appeal process to challenge the Record of Decision and, if so, where was it codified?

Response
DOE has no administrative appeals process for Records of Decision. Assuming that the issuance of a Record of Decision is the final agency action in a particular case, all such appeals would be through the Administrative Procedure Act.

Comment (3789)
DOE needs to inform the public about the timetable for making decisions. There is a lot of waste; temporary storage is probably worse than permanent storage.

Response
The WM PEIS addresses treatment, storage, and disposal strategies for the management of hazardous and radioactive waste over the next 20 years. Storage is defined as the collection and containment of waste awaiting treatment or disposal. Storage can occur on a longer term basis (i.e., decades or longer), for example, as in the case of high-level waste until its acceptance at a geologic repository.

As soon as possible, but no sooner than 30 days after DOE publishes the Final PEIS, it will publish Records of Decision for the waste types. DOE anticipates that the PEIS will result in separate Records of Decisions by waste type and are anticipated to be issued in a staggered fashion starting in calendar year 1997. Section 1.7.3 in Volume I has been revised to explain the decision process for making waste management decisions subsequent to issuance of the Final PEIS.

Comment (3792)
DOE needs to let the public know when the final decisions are made.

Response
Individuals receiving the Final WM PEIS will remain on the mailing list to receive the Records of Decision supported by the WM PEIS. A *Federal Register* notice will be published for each Record of Decision.

14. DOE Policies, Mission, Authorities, and Responsibilities

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(No comments were received for this section)

14.1 General Comments

Comment (371)
Several commentors suggested that DOE discontinue the generation of waste. DOE should change its mission and stop production of waste, nuclear power plants, and weapons, as well as funding for the nuclear industry. DOE should consider renewable energy, increased efficiency, and conservation in its decisions. Tax money should be spent on resources that can be recycled and used without endangering human or animal life.

Response
Issues relating to DOE's energy mission (e.g., nuclear energy, alternative and renewable energy resources, energy efficiency and conservation) and DOE's defense mission (e.g., production of nuclear weapons) are outside the scope of the WM PEIS.

Since the end of the Cold War there has been a shift away from the nuclear arms race and toward environmental restoration and waste management. DOE is committed to operating its facilities and managing its wastes safely and in compliance with all applicable laws and regulations, so that human health, safety, and the environment are not endangered.

The WM PEIS is a tool to help DOE develop a national waste management strategy for its radioactive and hazardous wastes. The wastes addressed in the WM PEIS primarily resulted from the development, production, and testing of nuclear weapons, and are mostly in storage pending treatment or disposal. The majority of additional wastes projected will be generated as a result of environmental restoration, decontamination and decommissioning, and other DOE energy research activities.

DOE is strongly committed to pollution prevention and reduction in all its program activities. Recycling is part of DOE's pollution prevention strategy, and is practiced to the extent possible. Appendix G in Volume IV of the WM PEIS addresses pollution prevention for the Waste Management Program. Individual DOE sites have site-specific waste minimization and pollution prevention programs and plans in place.

Comment (379)
Other waste cleanup or disposal issues must not slow the Hanford cleanup effort or divert funding or resources from Hanford cleanup.

Response
DOE is committed to cleaning up the Hanford Site and other DOE sites. The overall goal at the Hanford Site is to cleanup the site in accordance with the Hanford Federal Facility Agreement and Consent Order (commonly known as the Tri-Party Agreement), other agreements, and all applicable Federal, State, and local laws. The Tri-Party Agreement between DOE, EPA, and the Washington State Department of Ecology was signed in 1989 and has been formally amended four times since. It defines DOE actions to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and the State of Washington Hazardous Waste Management Act. It includes a framework for permitting treatment, storage, and disposal units for the management of hazardous and mixed wastes at the Hanford Site. Compliance with regulatory requirements, including those of the Hanford Tri-Party Agreement, is an important decision criterion considered by DOE in selecting preferred alternatives and will be considered in making programmatic waste management decisions. The decision criteria and factors DOE is using are described in Volume I,

Section 1.7.3, of the WM PEIS. DOE's preferred alternatives and the reasons they are preferred are described in Section 3.7.

Comment (1620)
DOE has done a lot for the African American community in Nevada by its educational programs and employment opportunities at the Nevada Test Site (NTS).

Response
Thank you for this comment.

Comment (1623)
DOE and NTS have helped Nevada grow; many people do not appreciate this.

Response
Thank you for your comment.

Comment (2131)
DOE should not have 54 nuclear generating sites because there are duplicate facilities.

Response
As described in Section 1.6 in Volume I of the WM PEIS, there are 54 sites for which DOE has some waste management responsibility and that are within the scope of the WM PEIS. These sites vary in terms of their operations and missions, and their facilities are not duplicative. Not all of the 54 sites are nuclear generating facilities.

Comment (2324)
Technological advances must be tempered with the lessons learned through history. The history of nuclear power has taught us two basic lessons: (1) nuclear energy is a marvelous resource that has brought technological advances that continue to improve our quality of life; and (2) waste disposal is a risky business and we have much to learn.

Response
DOE is committed to pursuing advances in technology research, development, and application. For example, within DOE's Office of Environmental Management, the Office of Technology Development is responsible for managing an aggressive national program of applied research, development, demonstration, testing, and evaluation for environmental cleanup, waste management, and related technologies. The Technology Development Program takes a focused, problem-oriented approach to having technologies available for use to support DOE's environmental management needs in a manner that also supports DOE's industrial competitiveness goals. The Technology Development Program is designed to resolve major technical issues, to rapidly advance beyond current technologies for waste management operations, and to expedite compliance with applicable environmental laws and regulations. More detail is provided in Appendix H in Volume IV of the WM PEIS.

Comment (2374)
Commentors want DOE to stop creating nuclear waste, in general or at specific sites, and contend that waste management problem will not be solved until waste generation is halted.

14.1 General Comments

Response
DOE has been instructed by the President and Congress to conduct activities related to energy research and to produce nuclear materials and components for national defense. Although DOE has a number of programs for waste minimization and pollution prevention (see Volume IV, Appendix G), some wastes inevitably result from DOE activities. DOE will continue to perform the activities that produce wastes, applying aggressive pollution prevention techniques, until directed otherwise by the President and Congress. Even if DOE stopped generating wastes, it would still be responsible for the existing inventories of wastes.

Comment (3325)
Why were waste management, environmental restoration, and prevention of pollution and contamination not always a part of DOE's central mission, but left to a moral and ethical minority until NEPA was created, although, (1) the scientific community that created nuclear power has always known that nuclear waste would be created and that it could be handled safely and properly without contaminating the environment, and (2) the government and its agencies are empowered to protect the citizens and management of nuclear waste has always been the responsibility of the government.

The lack of a United States Management Plan from the very beginning of the nuclear industry has caused the public to investigate and question what is going on, which is further evidenced by problems with the existing law, for example, (1) environmentally sound management of hazardous waste from "cradle to grave" under RCRA should mean from beginning to end; and (2) the spirit and intent of CERCLA is frustrated by the fact that Superfund money allocated for liability, compensation, remediation, and emergency response is being eaten away by legal fees, since citizens across the country have to file against the Federal Government for justifiable compensation.

Response
During the years of the Manhattan Project and the "Cold War," wastes from nuclear weapons production were managed in accordance with generally accepted practices of the time that were established by the scientific community. Time, experience, and research have shown that some of the past practices were not protective of long-term human health and the environment. DOE has learned through its own experience, and that of the nuclear industry in general, and is applying new knowledge and technologies to manage its facilities in an environmentally protective and cost-effective manner. DOE is in the process of remediating past contamination, upgrading current waste management practices, and planning future waste management activities and pollution prevention efforts. In addition to complying with all applicable laws and regulations, DOE strives to obtain public input, protect human health and safety, and emphasize environmental responsibility within DOE.

DOE agrees that laws passed to solve complex problems such as CERCLA and RCRA should be revised when experience and needs show changes are warranted. For example, within the Superfund process the rise of the share of non-cleanup or "transaction costs" such as legal fees has become a major concern, which is being considered by Congress. DOE is providing input to Congress on that law. In other instances, administrative changes may be made through agency regulations. Public input is a major ingredient in those processes.

Comment (3340)
DOE should explain why it assumes the continuation of the nuclear industry and its waste generation for a projected 20 years rather than shutting it down as a "failure and an economic albatross." We

need to see a full breakdown of the economics of the nuclear industry and determine how it performs as a free-market commodity.

Response
DOE has been instructed by the President and Congress with conducting activities related to energy and to producing nuclear materials and components for national defense. The WM PEIS addresses the management of the waste that is generated by these activities at DOE facilities.

The generation of waste by the nuclear industry and the economics of the nuclear industry are beyond the scope of the WM PEIS.

Comment (3347)
There should be a moratorium on the production of any nuclear products until the waste management questions have been answered.

Response
DOE has been instructed by the President and Congress with responsibilities for nuclear materials related to national defense and scientific and energy research. Changes in DOE's mission are not within the scope of this WM PEIS. As stated in Section 2.2 in Volume I, DOE must manage its current and anticipated volumes of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste in order to comply with all applicable Federal and State laws, to protect human health and safety, and to enhance protection of the environment. The WM PEIS is one element of DOE's effort to find a programmatic answer to waste management issues.

Comment (3681)
The right people are not running DOE today. The handful of DOE employees who know what they are doing are not the ones managing this agency.

Response
Individuals are appointed to the upper management positions at DOE by the President, with the advice and consent of the Senate. Concerns about the appointment of these managers are outside the scope of the WM PEIS.

Comment (3687)
A U.S. task force must be convened and created for implementation after the American public's reviews and evaluations. The U.S. policy on the management of the nuclear industry *must become reality*, and political intervening must be restricted to a minimum of watchdog oversight. The Office of the Secretary of the Department of Energy must become a separate elected position voted upon to be filled by the American public. And, quite frankly, the noted Civic Leaders across the country who have both thwarted and supported the Nuclear Age should be the determining factors on which individuals sit to comprise this task force.

Response
United States policy and laws governing the nuclear industry are outside the scope for the WM PEIS. Those policies and laws are set by Congress and the President. Both Congress and the President are elected by the American people. The Secretary of Energy is appointed by the President, with the advice and consent of the Senate. DOE strongly believes in a democratic process of agency oversight,

14.1 General Comments

which includes viable public involvement in planning and executing DOE programs. For this WM PEIS, DOE worked hard to involve the public through the various forums provided (e.g., meetings, workshops, hearings), length of comment periods (e.g., 150 days on the Draft WM PEIS), Environmental Management Advisory Board and Site-Specific Advisory Board processes, and other activities.

Comment (3688)
There are approximately 600 nuclear reactors worldwide. Efforts should be made to scale down, upgrade technology, recycle, and address the mechanics of management as if your environment depended on it. "The Nuclear Age will take us into the 21st Century, we can go kicking and screaming or we can go challenging one another to produce the absolute best."

Response
Issues related to domestic and international energy research and policy are outside the scope of the WM PEIS, which is an analysis of the environmental impacts of alternatives to safely and efficiently manage DOE's radioactive and hazardous wastes. Those wastes result primarily from nuclear defense activities; i.e., the development, production, and testing of nuclear weapons at a variety of sites located around the United States.

Comment (4007)
Several commentors advanced agency-credibility issues. The following statements were made:

- The government has not developed the necessary degree of trust to permit it to make decisions on radioactive and hazardous waste disposal. The public needs to be skeptical about being told it is safe.

- Offsite contamination at the Portsmouth Plant is covered up.

- DOE has falsified my records.

- If the public and the agency learn to work in cooperation rather than opposition, privatization will result in the cloak of privacy for profit replacing the cloak of secrecy for the national defense and security.

Response
The Secretary of Energy places great emphasis on openness and public involvement. The Secretary's *Guidance on Implementation of the Department's Public Participation Policy* (July 29, 1994) states, "The business of the Department must be open to the full view of those whom it serves, consistent with applicable laws, regulations, and contracts. This policy marks a clear break with past practice by challenging the Department and its contractors to perform to a new standard of openness and service. The Department will incorporate public input into its decisions where appropriate and feasible and will provide feedback to the public on its reasoning."

DOE is committed to a policy of open dialogue, interaction, and information exchange with the public. Over the past years, DOE has stepped up its efforts to earn trust and enhance cooperation. DOE believes that such a policy is in the interest of both accomplishing DOE's mission and program objectives and satisfying the legitimate interest in informed participation in DOE decisionmaking

processes. If privatization occurs, appropriate regulatory oversight, along with public vigilance, would assist DOE in complying with applicable laws and regulations.

Comment (4035)
It will be difficult for DOE to fund large-scale waste management and environmental restoration programs if the WM PEIS is devoid of a serious discussion of the risks from nuclear and hazardous materials, as opposed to waste management remedial actions. DOE environmental restoration programs must compete for funding with DOE's traditional first priority programs--maintaining the nuclear arsenal and developing new weapons systems.

Response
The WM PEIS is a tool to assist DOE in development a national waste management strategy. Risk analyses form an integral part of the document. Chapter 5 in Volume I of the WM PEIS explains methodology, while Chapters 6 through 10 provide the impacts analysis, focusing on human health and the environment. Chapter 11 provides the cumulative impacts analysis. Appendices C and D in Volume III, and E and F in Volume IV also contain risk analyses.

Environmental restoration decisions are not within the scope of this programmatic waste management study, primarily because of their site-specific nature. Site-specific issues involve questions of cleanup levels, future land use, etc. Volume I, Section 1.7.1, explains why environmental restoration waste was removed from the scope of the WM PEIS. Appendix B in Volume III provides estimates of the wastes that could result from environmental remediation activities at DOE sites that would require treatment and disposal.

The Executive and Legislative Branches of the Federal Government play an important role in the implementation of the DOE Waste Management Program, including projects deemed necessary as a result of the WM PEIS. The budget for the program is ultimately controlled by the President and Congress.

The Executive Branch is required by law to submit annual estimates for operations of its programs and initiatives to the Legislative Branch. This submittal includes funding for DOE and its Waste Management Program. The Legislative Branch develops an annual Appropriations Act to fund Federal programs and initiatives.

The Legislative Branch can choose to limit or increase the funding to specific programs recommended by the Executive Branch. As an alternative, general reductions or increases can be taken or granted. In such cases, specific "report language," which accompanies the Appropriations Act, can clarify the intent of Congress.

Thus, DOE is unable to guarantee full funding for specific projects and programs. Preferred alternatives identified in the WM PEIS, and subsequent Records of Decision, are contingent on the annual Appropriations Act and report language.

Comment (4036)
The necessary Federal environmental restoration effort could be halted in its infancy because of (1) DOE's waste of huge amounts of funds on management perks, "reports upon reports," and

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abandoned projects; and (2) DOE's inability to police its contractors (who are getting rich off DOE programs) and accomplish genuine site remediation.

Response
The Environmental Restoration Program is not within the scope of the WM PEIS. It is DOE policy to ensure that DOE and its contractors are subject to the same rules of accountability as other Federal agencies and their contractors. DOE is in the process of implementing a realignment strategy to streamline and strengthen its programs across the complex. This initiative also extends to DOE's use of contractors to meet its mission. DOE encourages the public to report to DOE specific instances of "management perks," "abandoned projects," and deficient contractor oversight.

14.2 Waste Management Program

Comment (4)
I recommend that DOE consider broadening its work on wastes by encouraging research on microbial waste treatment and disposal.

Response
Due to the programmatic nature of the document, the WM PEIS assumes generic treatment and disposal technologies for purposes of comparing programmatic management options. While technology research, as such, is outside the scope of the WM PEIS, Appendix H in Volume IV does address the potential impact of technology development on the Waste Management Program.

Comment (588)
DOE needs to seriously address the problem of what to do with all of the radioactive byproducts of the nuclear industry and the DOE nuclear weapons enterprise. Only a national, immediate, and concerted effort to discontinue the production of extremely hazardous wastes will save us from its dire consequences.

Response
The WM PEIS was prepared to help DOE develop a national waste management strategy. The PEIS addresses, in a programmatic manner, five types of radioactive and hazardous wastes produced over the past years by national defense activities. These five waste types are described in Section 1.5 in Volume I of the WM PEIS. The PEIS does not address radioactive wastes produced by commercial activities. DOE does not have the authority or responsibility for making decisions on such wastes. DOE has addressed the management of its spent nuclear fuel in the SNF/INEL PEIS. In addition, the disposal of spent nuclear fuel and defense high-level waste will be addressed in DOE's Yucca Mountain Repository EIS. Both documents are described in Section 1.8.1 in Volume I of the WM PEIS.

Since DOE's mission includes national defense activities, DOE will continue to generate defense wastes unless directed to do otherwise by the President and Congress. However, DOE is strongly committed to pollution prevention. DOE's pollution prevention activities related to waste management are described in Appendix G in Volume IV of the WM PEIS.

Comment (1515)
DOE does not know how to manage the waste coming from the nuclear materials.

Response
The WM PEIS has been prepared to enhance the management of DOE's current and anticipated volumes of radioactive and hazardous wastes to ensure safe and efficient management of these wastes, to comply with all Federal and State laws, and to protect public health and safety and the environment.

The WM PEIS analyzes a range of alternatives covering where to store, treat, and dispose of DOE's radioactive and hazardous wastes. Appendix H in Volume IV of the WM PEIS describes the emerging technologies that could influence the Waste Management Program.

Comment (1516)
DOE needs to consider who will be liable for the waste management decisions made today.

14.2 Waste Management Program

Response
DOE is responsible for the waste management decisions made as a result of the WM PEIS activities. DOE believes that the decisionmaking process is sound. DOE must comply with all applicable laws, including those governing liability issues.

Comment (1639)
Postpone lasting decisions regarding the WM PEIS until there is a meaningful public process involving citizens from all sites across the complex, elected officials, other State officials and advisory boards representing citizens living near DOE weapons plants to address questions of equity in the benefits and burdens of the Cold War legacy. The WM PEIS alone is not adequate on its own to solve radioactive waste problems. People need to talk together to deal with waste management issues. This discussion should include, for example, what material is out there, what wastes citizens are willing to keep onsite or receive from other sites, what are the possibilities if there is no repository at Yucca Mountain or if the Waste Isolation Pilot Project (WIPP) never becomes operational.

Response
DOE will use all relevant information, in addition to the WM PEIS, necessary for making responsible waste management decisions. DOE agrees that public input to the decision process will be worthwhile. Forthright dialogue with the public on the important issues regarding the management of the nation's nuclear waste is important to DOE as well as to the potentially affected communities.

DOE specifically sought comments on the Draft WM PEIS from State and local officials as well as the general public. DOE is also sponsoring a "National Dialogue" initiative, described in Volume I in Section 1.8.2, to provide a forum to communicate with interested members of the general public, State and Tribal Governments, and representatives from the Site-Specific Advisory Boards to discuss potential national decisions on waste management and on the inter-site management and disposition of other nuclear-materials. This initiative is discussed in Section 1.8.2 in Volume I of the Final WM PEIS.

DOE is considering how best to sustain and strengthen that initiative to provide additional avenues for public input to the decisionmaking processes. The ensuing public dialogue will specifically include input to the development of waste management decisions on a national scale, and could include the example topics identified in the comments as they are relevant to waste management decisions and of concern to public participants.

Comment (1784)
All wastes need to be stored indefinitely. The concept behind disposal is faulty. There is no "away" to put this material.

Response
The disposal activities proposed in the WM PEIS extend to low-level mixed waste and low-level waste. DOE will manage these wastes to ensure compliance with applicable laws, to protect public health and safety, and to enhance protection of the environment.

DOE considers disposal as a reasonable waste management alternative in this WM PEIS. However, before implementing any disposal decision, DOE would prepare performance assessments on all required disposal facilities and discuss disposal requirements and criteria.

The WM PEIS does analyze storage options, for example, in the No Action Alternative. The No Action Alternative might not necessarily comply with the applicable law. However, analyzing the potential impacts of the first 20 years of indefinite storage provides an environmental baseline against which the impacts of other alternatives can be applied.

Comment (1791)
DOE needs to make a long-term commitment to these wastes.

Response
Chapter 2 in Volume I of the WM PEIS describes the purpose and need for DOE action. DOE will manage its current and anticipated volumes of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste to ensure compliance with the applicable laws, to protect public health and safety, and to enhance protection of the environment. DOE is committed to finding long-term solutions to the issues of managing such wastes.

Comment (1794)
DOE needs to be able to process wastes and use these facilities for environmental restoration wastes as well.

Response
Appendix B in Volume III of the WM PEIS describes how environmental restoration wastes transferred to the Waste Management Program could affect the waste management facilities. DOE assumed that waste treatment facilities would be constructed in 10 years and that wastes would be treated in the following 10 years. Since the design life of these facilities would be 20 years, DOE assumes that they could be used to treat environmental restoration wastes through the end of their design life. In addition, excess capacity at waste management facilities could be used to treat environmental restoration wastes.

Comment (2068)
DOE needs to look at waste management holistically and at the early, conceptual stages of project development.

Response
The WM PEIS is being written at the earliest possible stage of project development for a nationwide strategy to treat, store, and dispose of DOE wastes. It is intended to enhance DOE's management of its radioactive and hazardous waste in order to comply with applicable laws, to protect public health and safety, and to enhance protection of the environment. In anticipation of future decisions DOE will make regarding waste management activities, the WM PEIS serves as an overview from which more detailed sitewide or project-level NEPA reviews can be conducted.

Comment (2114)
DOE has spent considerable money and professional time on the problems of waste. Nevertheless, the leaks continue. Get to the source of the problem.

Response
DOE is committed to operating its facilities and managing its wastes safely and in compliance with all applicable laws and regulations. If a release occurs, it is contained and remediated, and the source of the problem is identified and corrected. Remedial actions are conducted on a priority basis.

14.2 Waste Management Program

Comment (2690)
The Idaho Nuclear Waste Agreement could serve as a basis for agreements with other states.

Response
Thank you for this suggestion. However, the motivation of the Idaho/DOE/Navy agreement regarding spent nuclear fuel shipments included the need to ensure the Navy's fleet of nuclear powered warships could fulfill their national security mission, and the need for DOE to recover spent fuel containing highly enriched uranium from foreign research reactors in support of U.S. nonproliferation policy. Therefore, that agreement should not be viewed as a precedent for emulation by other States.

Comment (3850)
Instead of cutting back on waste production, DOE spends large amounts of money on an EIS. Consolidate waste, knowledge, facilities, and resources. Downsize DOE operations. Choose sites that are not densely populated for disposal and storage.

Response
With the end of the Cold War in 1989, and the reduced need for special nuclear material and other DOE products, DOE waste production has decreased. However, DOE still has a large inventory of various waste types. DOE must manage its current and anticipated volumes of low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste in order to comply with all applicable Federal and State laws, to protect public health and safety, and to enhance protection of the environment. In evaluating the potential health risks of the disposal of low-level mixed waste and low-level waste, DOE considered the sizes of the offsite populations living in the vicinity of the candidate disposal sites. The results of the analyses are presented in Section 5.4.1.2.3 in Volume I. Health risks for storage of low-level mixed waste, low-level waste, transuranic waste and high-level waste at DOE sites are contained in Volume I, Sections 6.4, 7.4, 8.4, and 9.4, respectively. This WM PEIS is complex; it evaluates 5 waste types at 17 sites, with 4 broad approaches to choosing the DOE sites that will manage these wastes: No Action, Regionalized, Decentralized, and Centralized.

DOE developed the WM PEIS to inform the public and decisionmakers of the potential impacts of these proposed Federal actions and to identify which of these impacts might be significant to human health or the environment. Section 5.4.1.2 in Volume I of the WM PEIS details information on populations and individuals at risk. In general, the PEIS considers three population groups: the offsite population (those living within a 50-mile radius of the site, as well as within 0.5 miles on each side of the transportation routes); the onsite population (workers on DOE sites who are not involved in actual environmental management activities); and facility workers (waste management workers including those operating trucks and trains transporting waste). As Section 5.4.12 states, determining populations and individuals at risk is a complex analysis dependent on facility siting locations, well defined exposure routes, and population dietary habits.

Comment (3854)
We must dispose of our waste in as safe and decent a manner as we possibly can and we will spend money to do this. This is not the problem. We've got to deal with what we've got.

14.2 Waste Management Program

Response
The WM PEIS reflects DOE's commitment to developing and implementing a Department-wide strategy to safely and responsibly manage the waste produced over the years by national defense activities.

Comment (3862)
DOE's policy should be to move waste from densely populated areas to less-densely populated areas.

Response
It is DOE policy to meet its mission in a manner that complies with the applicable law, protects public health and safety, and enhances the protection of the environment. To identify reasonable proposed sites for waste management facilities in the WM PEIS, DOE determined where the largest volumes of waste are and where transportation requirements would be minimized. Other site-selection criteria included the characteristics of the waste, specialized treatment requirements, and existing facilities. Sites in less densely populated areas were considered for waste management activities. However, the remoteness of alternative locations for waste management sites constitute only one factor in evaluating alternatives. Other criteria would be construction/modification of facilities, increased transportation requirements, etc. Although storage and disposal in less-densely populated regions may lessen some impacts, the risks from transporting waste to these remote areas would increase. These trade-offs are described in the WM PEIS and are important factors that will be considered in the decision process. Waste management decision factors and criteria are described in Section 1.7.3 in Volume I of the WM PEIS.

Comment (3900)
Don't create nuclear waste. Put the waste in a better geologic area. Encourage cleanup, which could benefit our community. Nuclear accidents do happen.

Response
DOE has been charged by the President and Congress with responsibility for nuclear materials related to national defense and scientific and energy research. Although these activities do generate waste, DOE is committed to an aggressive policy of pollution prevention. Appendix G in Volume IV of the WM PEIS addresses pollution prevention for the Waste Management Program.

DOE is proposing to dispose of transuranic waste at a geologic repository called WIPP, which is near Carlsbad, New Mexico. For high-level waste canisters, DOE is currently studying a candidate geologic repository at Yucca Mountain in Nevada.

DOE actively supports site-specific cleanup through its Environmental Restoration Program. Members of affected communities can obtain information about DOE's cleanup programs in their areas by contacting the local DOE site offices.

In addition to risks from construction and routine facility operations, the WM PEIS analyzes impacts from potential treatment and storage facility accidents and transportation accidents. More detail is provided in Appendices E and F in Volume IV of the PEIS.

14.3 Reactor Programs/Nuclear Weapons Programs

Comment (157)
Nuclear armaments must be abolished worldwide.

Response
The WM PEIS addresses the environmental impacts of waste management alternatives. Issues related to other missions assigned to DOE by law (for example, the nuclear weapons programs) and international disarmament policy are outside the scope of this WM PEIS.

Comment (472)
DOE should curtail its planned stockpile stewardship experiments because of the danger of treating mixed wastes at Lawrence Livermore National Laboratory (LLNL) and transporting them across busy California highways to Tracy for burial.

Response
Issues relating to stockpile stewardship are analyzed in DOE's Stockpile Stewardship and Management PEIS, which is described in Section 1.8.1 in Volume I of the WM PEIS. Impacts from this program are considered in the WM PEIS cumulative impacts analysis (see Chapter 11 in Volume I).

The potential quantities of low-level mixed waste that could be generated as a result of stockpile stewardship and management alternatives being considered for LLNL are quite small (564 cubic meters per year at LLNL and 10 cubic meters per year at Site 300). The increased production from stockpile stewardship and management activities would be a minor contribution to waste management cumulative impacts when compared to the potential impacts of alternatives considered by this WM PEIS. Under any stockpile stewardship and management alternative, LLNL would continue its mission as a multipurpose laboratory.

A shutdown of the nuclear weapons program is currently not considered a reasonable alternative. Further, a shutdown would not eliminate the need for managing existing radioactive and hazardous wastes.

The WM PEIS analyzed impacts on human health and the environment from waste treatment at candidate sites, as well as transportation requirements. This analysis is discussed in the waste type chapters, Chapters 6 through 10 in Volume I of the WM PEIS, and the cumulative impacts analysis, Chapter 11 in Volume I. In general, the analysis finds that impacts would be small. There are no notable national trends for offsite population risks from treatment of low-level mixed waste; however, some sites, such as LLNL, would probably require different technologies to minimize treatment risks.

Comment (1577)
Instead of preparing the elaborate Draft WM PEIS, DOE needs to weigh the cost and benefit of producing nuclear weapons and the burden of irreversible damage posed by the resulting waste. Production is still occurring at Sandia National Laboratories-New Mexico (SNL-NM), and Los Alamos National Laboratory (LANL).

Response
Although the U.S. nuclear weapons stockpile is being significantly reduced, the President and Congress have directed DOE to continue to maintain the safety and reliability of the enduring nuclear weapons stockpile. The Stockpile Stewardship and Management PEIS analyzed the environmental impacts

associated with various downsizing alternatives to allow for the continued production and maintenance of nuclear weapons in the absence of underground nuclear testing, including any such activities proposed to be conducted at SNL-NM and LANL. In conjunction with this activity, DOE has considered the cost of nuclear weapons and has extensively analyzed the costs and benefits of all the alternatives analyzed in the Stockpile Stewardship and Management PEIS. Section 1.8.1 in Volume I of the WM PEIS discusses the relationship between the Stockpile Stewardship and Management PEIS and the decisions to be made based on the WM PEIS analysis.

The cumulative impacts of waste management and stockpile stewardship and management activities, together with the impacts of other reasonably foreseeable future actions, are evaluated in Volume I, Chapter 11, of the WM PEIS.

Comment (2825)
In Volume I, Section 1.5.4, the relationship between spent nuclear fuel and targets is not clear. Are targets a subset of spent nuclear fuel? If not, in what waste category are they included?

Response
Spent nuclear fuel is managed as described in the SNF/INEL EIS Record of Decision and includes uranium/neptunium targets that have been irradiated in a nuclear reactor. Upon irradiation, such targets produce products similar to spent nuclear fuel. Other targets would be managed differently. For example, metal targets irradiated to determine how well they maintain their structural integrity in intense neutron fluxes would be managed as low-level waste. Targets used for the production of tritium are also managed as low-level waste after the tritium has been recovered. The text box in Volume I, Section 1.5.4, of the WM PEIS has been revised to describe the waste classification of neptunium/plutonium targets.

Comment (2891)
Volume I, Page 9-32, 1st paragraph: Are these canisters in fact "similar to the others being managed at the INEL site?"

Response
The comment refers to canisters of foreign research reactor spent nuclear fuel. For analysis purposes, the foreign research reactor spent nuclear fuel presumably would be chemically processed at Idaho National Engineering Laboratory (INEL) producing high-level waste. It is expected that this high-level waste would be immobilized using similar technologies (i.e. canister technologies) applied to the high-level waste already at INEL. The management and transportation of these canisters are discussed in further detail in the SNF/INEL EIS, Volume II, Part A, Section 3.4.

Comment (3339)
Actual costs are not compared with the actual income DOE derives from the nuclear weapons complex. This should be demonstrated before deciding that these alternatives would not impact the national economy, as the WM PEIS repeatedly states.

Response
DOE does not derive any income from the nuclear weapons complex. DOE uses funds appropriated by Congress to fulfill its mission. Chapter 4 in Volume I of the WM PEIS, which describes the affected

14.3 Reactor Programs/Nuclear Weapons Programs

environments at the 17 "major" DOE sites, shows the socioeconomic baseline and impacts data accounting for the economic effect of current expenditures at the sites.

14.4 Other Programs

Comment (1176)
If Argonne National Laboratory-East (ANL-E) has no long-term plan to dispose of its nuclear waste other than in densely populated areas, then perhaps they should get out of the nuclear research business.

Response
The WM PEIS is an important tool in DOE's process to develop a long-term plan to manage waste generated at DOE sites, including ANL-E. Volume I, Section 1.7.3, of the WM PEIS describes the waste management decisions to be made by DOE. DOE used the decision factors and criteria described in Section 1.7.3 to make preferred alternative decisions for each waste type. Population surrounding the site is an element of the human health risks decision criteria.

The mission for ANL-E, a 4,670-employee research and development multipurpose laboratory, is to conduct programs in basic energy and related sciences. ANL-E is an important engineering center for the study of nuclear and nonnuclear energy sources. Thus, ANL's activities form an essential part of DOE's mission, which is mandated by the President and Congress. DOE has no plans to change the mission of the laboratory.

Comment (1507)
DOE should have good jobs at LLNL, but not in weapons research or in treating wastes.

Response
LLNL's major programs include defense and related programs, laser fusion, laser isotope separation, biomedical and environmental research, and environmental restoration and waste management. LLNL employs 11,220 people.

LLNL's activities form an essential part of DOE's mission, which includes national defense as well as waste management. DOE's mission is mandated by the President and Congress. DOE will perform its functions until directed to do otherwise. DOE has no plans to change the multipurpose mission of LLNL.

Comment (1568)
The Nevada Test Site (NTS) is under-utilized. It should be the headquarters for the research and development needed for the transition from fission energy to safer, clean energy sources.

Response
While the WM PEIS is a national study that evaluates alternatives to help DOE make Department-wide decisions on where to treat, store, and dispose of its wastes generated at DOE sites in the United States, this document is not site-specific in nature and does not make decisions. Furthermore, issues related to other missions assigned to DOE by law (e.g., energy policy and research) are outside the scope of the WM PEIS.

As identified in Section 1.8.1 in Volume I of the WM PEIS, DOE has prepared a sitewide EIS, for NTS that addresses the environmental impacts of alternatives for the continued operations of NTS and other DOE activities in the State of Nevada. The EIS analyzes the impacts from DOE programs at NTS, the Tonopah Test Range, portions of the Nellis Air Force Range Complex, the Central Nevada Test Area, and the Project Shoal Area. These programs include ongoing activities for the stewardship of the Nation's nuclear weapons stockpile, management of radioactive waste, nondefense research and

14.4 Other Programs

development, and environmental restoration. The EIS also examines newer programs such as the proposed Solar Enterprise Zone sites at NTS, Dry Lake Valley, Eldorado Valley, and Coyote Spring Valley, in accordance with the NTS mission of demonstrating the capability to provide alternative energy sources, including solar energy, to meet power needs for the southwestern United States. A copy of the NTS EIS can be reviewed at the DOE Nevada Operations Office public reading room located at 2621 Losee Road, Building B-3, Las Vegas, Nevada.

Comment (1930)
Is Brookhaven National Laboratory (BNL) necessary? If it were closed we wouldn't have to worry about nuclear waste.

Response
The mission for BNL, a 3,557-employee site, is to conceive, design, construct, and operate research facilities for fundamental scientific studies and to conduct basic and applied research in the physical, biomedical, and environmental sciences and selected energy technologies. BNL's activities form an essential part of DOE's mission, which is mandated by the President and Congress. Even if DOE facilities were shut down, radioactive wastes would continue to be generated due to environmental restoration and decontamination and decommissioning activities.

Comment (2099)
DOE should reevaluate the 1950's effort to recycle nuclear waste rather than disposing of it (e.g., encapsulate it in silicon); the technology for recycling always existed and recycling is safe.

Response
The WM PEIS is DOE's national study on management alternatives for wastes that generally cannot be recycled, but are managed through safe and efficient storage, treatment, and disposal. Recycling can be a viable practice for small subsets of materials, such as spent fuels. However, those are outside the scope of the WM PEIS and are not addressed in this document.

Comment (3936)
Foreign, commercial, and military spent nuclear fuel is not included in DOE's Draft WM PEIS. The Spent Nuclear Fuel EIS, intended to address spent nuclear fuel in a separate document, does not consider the dangers and adverse impacts of increasing the volume of high-level liquid waste in DOE inventory.

Response
Since the scope of the WM PEIS is restricted to waste management activities, the management of foreign, commercial, and military spent nuclear fuel is not included in the analysis. Spent nuclear fuel is not considered to be waste.

In February 1996, DOE issued the Foreign Research Reactor Spent Nuclear Fuel EIS to evaluate alternatives for managing spent nuclear fuel from foreign research reactors in a manner consistent will United States nuclear weapons nonproliferation policy. The SNF/INEL PEIS, issued in April 1995, evaluates alternatives for managing existing and reasonably foreseeable inventories of U.S. Government-owned spent nuclear fuel through the year 2035. DOE issued a Record of Decision in May 1995. Section 1.8.2 in Volume I of the WM PEIS contains a description of these two NEPA reviews that are related to the WM PEIS. The cumulative impacts analysis in Chapter 11 in Volume I

considers impacts from other programs, including the spent nuclear fuel management described in both NEPA reviews.

High-level waste is generated by reprocessing spent nuclear fuel. In the past, DOE reprocessed spent nuclear fuel. However, all of DOE's reprocessing facilities either have ceased to operate or are rapidly phasing out of operations, because continued recycling of plutonium and uranium for weapons production is no longer a national priority. In limited circumstances, some unstable spent nuclear fuel may be reprocessed to help stabilize this material. Thus, DOE anticipates only a small increase in high-level waste inventories. While the WM PEIS analyzes only the impacts of storing vitrified high-level waste, the Yucca Mountain Repository EIS would address disposal of spent nuclear fuel and defense high-level waste in a licensed geologic repository. The Yucca Mountain Repository EIS would include an analysis for the disposal of commercial spent nuclear fuel.

Comment (3937)
DOE does not consider impacts from reprocessing of spent nuclear fuel, even though the agency has had knowledge of United States Enrichment Corporation's (USEC's) intention to reprocess since the Energy Policy Act of 1992, which created USEC and began the privatization of both the Portsmouth Plant and PGDP. Reprocessing of spent nuclear fuel at the Portsmouth Plant and/or PGDP is a foreseeable impact with significant consequences to the human environment, and require DOE to issue an EIS rather than a Finding of No Significant Impact by agreement with NRC on this action.

Response
USEC does not intend to reprocess any spent nuclear fuel; its primary mission is uranium enrichment. In addition, reprocessing of spent nuclear fuel is not feasible with the type of equipment at PGDP. Since high-level waste is generated by reprocessing spent nuclear fuel, useful information can be obtained from the WM PEIS High-Level Waste Technical Report, which is available in the DOE public reading rooms listed in Section 1.9 in Volume I of the Final WM PEIS.

The management of spent nuclear fuel is outside the scope of this PEIS. DOE evaluated alternatives for managing existing and reasonably foreseeable inventories of U.S. Government-owned spent nuclear fuel through the year 2035 in the SNF/INEL EIS, which was issued as a final document in April 1995. DOE issued a Record of Decision in May 1995. The cumulative impacts analysis in Chapter 11 in Volume I of the PEIS considers other actions, such as the management of spent nuclear fuel.

14.5 Past Practices/Credibility

Comment (1511)
DOE has already made the decisions about waste management. DOE is not credible.

Response
While there are ongoing waste management operations at the sites, DOE needs to enhance the management of its current and anticipated volumes of radioactive and hazardous wastes in order to ensure safe and efficient management of these wastes, to comply with all applicable Federal and State laws, and to protect public health and safety and the environment. The WM PEIS is a national planning tool to provide necessary information needed for DOE to make strategies decisions on where to treat, store, and dispose of radioactive and hazardous wastes. Section 1.7.3 in Volume I of the WM PEIS describes the decisions DOE has to make.

Comment (1649)
DOE lied to me about the test I witnessed at NTS in 1993, and I hold it responsible for all my ailments. I am concerned about the others present on that trip, and the effects of that test on them. DOE should not lie to us anymore.

Response
Historically, the primary mission of NTS was to conduct nuclear tests. Since the current moratorium on testing began in October 1992, this mission has changed to maintain a readiness to conduct tests, if so directed, in the future. However, no nuclear tests have been conducted at NTS since the moratorium was declared, and the last nuclear test was conducted on September 23, 1992.

Comment (1684)
A commentor believes insurance companies and health care providers are covering up and helping DOE and subcontractors sweep health problems under the rug, and alleges specific radioactive exposures to SRS workers and charges coverup activities.

Response
The WM PEIS examines potential radiation exposures to offsite populations and site workers resulting from programmatic waste management alternatives. In addition, the WM PEIS contains a cumulative impacts analysis that considers estimates of radiation doses from existing activities and other ongoing site actions. Health effects from previous radiation exposures are not considered in the WM PEIS. DOE has a number of ongoing efforts to address historic site-specific radiation doses and effects, and is working with other Federal and State agencies to study and report on any health-related effects from previous exposures. DOE's policy is to be open with and accountable to the public. This comment was forwarded to the DOE SRS Operations Office.

Comment (3344)
This is the third set of public comments we have submitted to DOE in the past 10 days, and it is truly impossible to do a thorough job. The amount of paperwork generated by DOE--with immense documents full of senseless deceit and vague oversights that try to keep us confused and confounded--jeopardizes thorough public comment. The cumulative impacts of all DOE operations are tragic to the earth, air, water, public health, and economy.

14.5 Past Practices/Credibility

Response

The subject of the WM PEIS is complex. Because of the important waste management decisions DOE must make and the high degree of public interest in these decisions, DOE believes the detailed impacts evaluation and lengthy discussion in the WM PEIS are warranted. The WM PEIS includes the consideration of other programs and actions (see Section 1.8 in Volume I) and in the analysis of cumulative impacts (see Chapter 11 in Volume I). To facilitate public comment on this complex document, DOE held the public comment period open for 150 days. DOE has conformed to NEPA and CEQ regulations in preparing the WM PEIS.

14.6 Public Awareness/Education/Outreach

Comment (386)
Oregonians want a role for the State of Oregon in decisions at Hanford and insist on more than an advisory role to assure their interests are fully taken into account at Hanford.

Response
As a matter of policy, DOE encourages active citizen involvement in such site actions as cleanups, land-use and site planning, and waste management actions. To that end, DOE has established a number of mechanisms for public involvement at Hanford and at other DOE sites. The citizens of Oregon are encouraged to use those mechanisms to ensure that their interests are expressed and communicated to DOE. DOE has worked hard to increase the State of Oregon's voice in Hanford decisions. Through the Hanford Advisory Board, the Oregon Waste Board, and other Oregon environmental groups and stakeholders, DOE believes that Oregon is being heard and has provided valuable input into decisions affecting Hanford. DOE looks forward to continued cooperation with the State of Oregon.

Comment (1615)
Some commentors suggested that the Department should engage in local dialogue on environmental restoration wastes at all sites; others suggested that the Final WM PEIS reflect enhanced public participation on "national environmental restoration issues."

Response
DOE believes that national level decisionmaking is not possible for the Environmental Restoration Program because site cleanup decisions are more properly driven by local site conditions and the concerns of site-specific stakeholders (see Section 1.7.1 in Volume I of the WM PEIS). Appendix A in Volume III of the WM PEIS outlines opportunities for public involvement in planning and decisionmaking for DOE's environmental restoration activities. Also, DOE has enhanced Section 1.8.2 in Volume I to discuss DOE's National Dialogue and Environmental Management Ten Year Plan opportunities for public participation in decisionmaking.

Comment (3800)
DOE needs to educate the public about the difference between a programmatic EIS and a site-specific EIS.

Response
As described in Section 1.8.1 in Volume I of the Final WM PEIS, three levels or "tiers" of NEPA documentation may be prepared: programmatic, sitewide, and project-level. Programmatic documents, such as the WM PEIS, inform decisions on broad agency actions, such as the adoption of future proposed plans, programs, and strategies. The second-tier, sitewide NEPA documents, allow DOE to consider changes in the overall operation of a site, including mission changes, and provide a current environmental baseline for the site, both to support and to simplify project-level NEPA documents. The third-tier, project-level NEPA documents, evaluate the impacts of a specific project proposed for a specific location on a site, and are intended to identify and evaluate alternatives on how the facility should be constructed and operated. Sitewide NEPA documents, which evaluate projects that could be implemented in the near-term at a site, would also include project-level NEPA reviews if sufficient information is available to allow the proposed to be adequately analyzed.

14.6 Public Awareness/Education/Outreach

The public is involved in all three types of NEPA documentation and they are informed regarding the nature of the analyses and anticipated decisions for these NEPA reviews. DOE believes this involvement provides adequate information to members of the public.

14.7 Social Choice

Comment (522)
DOE needs to weigh the potential costs of risk reduction afforded by the alternatives to store, treat, and manage these wastes against the cost of other risk-reducing activities by other Federal programs, such as childrens' immunization programs and transportation safety.

Response
The WM PEIS is a tool to assist DOE in developing a national strategy for the treatment, storage, and disposal of DOE's radioactive and hazardous waste. DOE needs to enhance the management of its waste to comply with applicable laws, and to enhance protection of human health and the environment. The WM PEIS presents risk analyses, for example, in the areas of human health and transportation. The WM PEIS also presents cost estimates for building and operating waste management facilities, and for transportation. Federal programs other than waste management are outside the scope of this document.

Comment (1640)
The problems of nuclear waste transcend the technical issues; they include the realms of ethics, conscience, and spirit.

Response
Thank you for your comment.

Comment (2311)
The delay of the vitrification plant at Hanford might put us at risk; we need to spend the money on cleanup, not on large, indigestible documents.

Response
As described in Section 1.8.2 in Volume I of the WM PEIS, which provides information on other NEPA documents and decisions that are related to the WM PEIS, the Tank Waste Remediation System EIS includes an evaluation of vitrifying high-level waste. Treatment, including vitrification, of high-level waste is outside the scope of the WM PEIS. Decisions regarding vitrification of high-level waste will be made based on the Tank Waste Remediation System EIS.

DOE's Environmental Restoration Program, which is not within the scope of the WM PEIS, was established to address environmental contamination. The Environmental Restoration Program encompasses a wide range of activities, such as stabilizing contaminated soil, treating groundwater, decommissioning process buildings, including nuclear reactors and chemical separations plants, and exhuming buried drums of waste. The extent to which a site is "cleaned up" will depend largely on assumptions regarding future land use. For most sites, the process of determining future site use has just begun.

The WM PEIS was prepared to help DOE develop a Department-wide waste management strategy. Moreover, DOE must comply with the law, in this case the National Environmental Policy Act of 1969. NEPA requires Federal agencies to consider the potential environmental consequences related to their proposed actions before they can be taken and to prepare detailed statements on environmental impacts, alternatives to the proposed action, and measures to avoid or minimize adverse impacts. The WM PEIS was prepared to satisfy the requirements of NEPA. In addition, the WM PEIS provides

technical information for use in the future NEPA reviews that would be required prior to specific decisions about facilities, facility locations on sites, and waste management technologies.

14.8 Funding

Comment (490)
Considering the current Federal budget decline and Congressional funding reductions, it seems that the alternatives evaluated in the WM PEIS are the least likely to be funded. If the alternatives are not relevant because budget constraints prevent them from being implemented, the PEIS will have to be redone. DOE should develop strategies for programs to ensure their funding and protect them from politics. DOE must ensure accountability, efficiency, and allocation of funds for high priority items.

Response
The regulations do require DOE to evaluate reasonable alternatives to the proposed action. The alternatives considered in the PEIS encompass reasonable alternatives that DOE could implement. To do this, DOE had to assume that funds would be available to implement any of the alternatives, including no action. As long as DOE is able to implement waste management alternatives within the range of the alternatives presented in the WM PEIS, it would not have to supplement the PEIS.

The Executive and Legislative Branches of the Federal Government play important roles in the implementation of the DOE Waste Management Program, including projects deemed necessary as a result of the WM PEIS. The budget for the program is ultimately controlled by the President (Executive Branch) and Congress (Legislative Branch).

The Executive Branch is required by law to submit annual estimates for operations of its programs and initiatives to the Legislative Branch. This submittal includes funding for DOE and its Waste Management Program. The Legislative Branch develops an annual Appropriations Act to fund Federal programs and initiatives. Preferred alternatives identified in the WM PEIS, and decisions made in subsequent Records of Decision, are contingent on the annual Appropriations Act and the language contained therein. Where the annual appropriations permit flexibility in implementing its provisions, DOE has the flexibility to protect or limit specific programs based on its own discretion and priorities.

15. Out of Scope Comments

Comment (42)
The PEIS needs to include the relationship between (1) ongoing nuclear research and the use of nuclear power and (2) the increase in the number of nuclear weapons and the increased likelihood of their use.

Response
The WM PEIS is a national decisionmaking tool to assist DOE in its strategy to treat, store, and dispose of wastes in a safe and efficient manner that minimizes the impacts associated with waste management. The relationship between (1) nuclear research and the use of nuclear power and (2) the increase in the number of nuclear weapons and the increased likelihood of their use is, therefore, outside the scope of the WM PEIS.

Comment (112)
Several commentors suggested alternatives or provided comments that were meant to be humorous, facetious, or otherwise did not contribute to improving the WM PEIS or the overall Waste Management Program.

Response
DOE recognizes that some members of the public disagree with the alternatives being considered for management of radioactive and hazardous wastes. DOE has made every effort to respond fully to all substantive comments on the WM PEIS, as well as the public's general concerns and questions about DOE's waste generation and management activities. DOE cannot respond to comments that lacked the substance conducive to a response.

Comment (154)
Some commentors oppose nuclear energy development. One commentor stated that nuclear energy is an economic failure; another stated that it is not worth the negative impact on our planet.

Response
Issues relating to nuclear energy development are outside the scope of the WM PEIS.

Comment (188)
Commentors favor development of alternative, renewable energy sources, such as solar energy, because such sources would be safer than nuclear energy.

Response
Issues relating to renewable energy are outside the scope of the WM PEIS.

Comment (198)
Members of the public used the WM PEIS public comment post office box address to submit comments on the Stockpile Stewardship and Management PEIS.

Response
All comments on the Stockpile Stewardship and Management Programmatic EIS have been made available to DOE's Office of Fissile Materials Disposition.

Comment (204)
DOE needs to evaluate stabilized waste forms in the WIPP SEIS-II.

15. Out of Scope Comments

Response
This comment was forwarded to the DOE Carlsbad Area Office.

Comment (223)
Should there be legislation for malicious crimes committed with radioactive material (including wastes)? What guidelines are there for product liability risks if a tool or instrument produces or causes radiation?

Response
Issues relating to malicious crimes committed with radioactive materials and product liability are outside the scope of the WM PEIS.

Comment (274)
A commentor believes that INEL should take all of the non-aluminum clad spent nuclear fuel that can be shipped there. The technology to handle and process this material without contaminating groundwater resources is available.

Response
This comment is outside the scope of the WM PEIS. Processing of spent nuclear fuel at INEL is addressed in the SNF/INEL PEIS and the Foreign Research Reactor Spent Nuclear Fuel EIS.

Comment (314)
The WM PEIS should include an analysis of local and global impacts of the use of various quantities of nuclear weapons under several scenarios.

Response
Issues relating to local and global impacts of the use of nuclear weapons is outside the scope of the WM PEIS.

Comment (1641)
DOE is proposing to build a new production reactor at SRS to produce tritium, even though DOE has great problems with plutonium contamination and there is a question about what DOE will do with all this material.

Response
The production of tritium and the remediation of contamination are outside the scope of the WM PEIS. The Record of Decision for the Tritium Supply and Recycling PEIS does not include a new production reactor at SRS. SRS is considered as a possible site for an accelerator to produce tritium. Plutonium is not used, nor is it generated as a result of the accelerator production of tritium. Remediation of contamination (including any plutonium contamination), is being addressed by site-specific cleanup actions under CERCLA or RCRA.

Comment (1692)
DOE should supply additional information to the Citizens Advisory Board at Rocky Flats Environmental Technology Site (RFETS) on the potential buildup of hydrogen associated with use of the 50-year plutonium canister. The safety of the welding process and the potential reaction of the heat and hydrogen are in question.

Response
This issue is outside the scope of the WM PEIS. This comment has been forwarded to the DOE RFETS Operations Office.

Comment (1695)
One commentor stated that the plutonium at RFETS should be kept onsite and that DOE needs a state-of-the-art treatment facility to process the RFETS plutonium to a nonproliferable form before it is transported. Another commentor expressed concern about the safe storage of plutonium at RFETS, given the site's proximity to the airport, and believes that DOE takes a "cavalier" approach to the storage of plutonium at RFETS in light of the strategic nature of plutonium as a military commodity.

Response
The issues of storage and processing of plutonium at RFETS are outside the scope of the WM PEIS. Plutonium is used in the development and production of nuclear weapons for national defense and, as such, is a special nuclear material as defined by Section 51 of the Atomic Energy Act of 1954. However, DOE has prepared, and is preparing, other NEPA documents that address plutonium at RFETS. These documents, which are identified in Section 1.8.1 in Volume I of the WM PEIS, include the Plutonium Interim Storage EIS for RFETS and the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS. The Records of Decision from these documents should determine issues relating to plutonium storage and processing at RFETS.

Comment (1818)
In the event that the Area 3 or Area 5 disposal sites at NTS are considered for confinement of greater-than-Class-C and special-case wastes, the difficulties associated with meeting the waste acceptance criteria for dissimilar waste types must be addressed. Defense Nuclear Facilities Safety Board Recommendation 94-2 requires that composite effects be evaluated when contiguous burial facilities exist. If DOE proceeds with a co-disposal decision at one of the existing disposal sites on NTS, the problems associated with addressing composite effects will have to be addressed.

Response
As described in Section 1.5.6 in Volume I of the WM PEIS, management of greater-than-Class-C and special-case wastes is outside the scope of the WM PEIS. Greater-than-Class-C and special-case wastes would have to be evaluated in separate NEPA analyses and as part of the cumulative waste management effects analysis if the decision is made, at some future time, that DOE should consider a proposal to dispose of either or both of these wastes at NTS.

Comment (1863)
A commentor requested evaluation of the National Tritium Labeling Facility at Lawrence Berkeley Laboratory; wastes from the facility should not be transported on public roads and they should not be disposed of at Lawrence Livermore National Laboratory (LLNL).

Response
The WM PEIS analyzes programmatic alternatives to manage DOE's waste management complex. The National Tritium Labeling Facility is not part of the waste management complex and, therefore, is not within the scope of this PEIS. However, wastes generated at this facility would be managed within the Waste Management Program. Under most WM PEIS alternatives, these wastes would be treated at the Lawrence Berkeley Laboratory and disposed of either at the Hanford Site or the Nevada Test Site

15. Out of Scope Comments

(NTS). They would be disposed of at LLNL under the WM PEIS No Action, Decentralized, and Regionalized 1 and 2 Alternatives.

Comment (1897)
Widespread opposition is organized for cleanup of Paducah site, and further contamination is bound to bring the "tree huggers" out in force.

Response
Use of existing facilities or new facilities to dispose of wastes is not projected to result in any significant risk of contamination at the PGDP. As part of implementing DOE-wide waste management strategies, additional studies will identify the precise location, capacity, and design of facilities at individual sites. These additional studies will also include opportunities for members of the public to express their opinions and concerns.

Comment (1943)
Who will get the contract to install the storage containers at Argonne National Laboratory-East (ANL-E)?

Response
Contracting issues are outside the scope of the WM PEIS. If DOE needs to acquire storage containers, it will use standard Government procurement procedures.

Comment (2097)
The public should be notified in the newspapers about unsafe conditions. There are leaking pipes at Portsmouth. The public was told that DOE is not responsible. DOE needs to tell the public who is responsible. The EPA has tested our water and indicated that there are 25 counts of radon in the water. Several counties in Ohio have contaminated drinking water wells. Pike County is not identified. How can this be? We want the water cleaned up. The public is concerned about the rusty, corroding, leaking uranium hexafluoride cylinders at Portsmouth. Remove the cylinders immediately. DOE needs to consider impacts to the cylinders from a severe earthquake. DOE should not cover up the fact that plant operations are killing children and poisoning our water supply.

Response
DOE complies with all applicable regulations regarding public notification of potentially hazardous conditions. Portsmouth has a local stakeholder group established to deal with local issues. The public is invited to attend any local stakeholder group meeting and voice their concerns.

Section 4.4.12 in Volume I of the WM PEIS provides information on the affected environment at the Portsmouth Plant. However, cleanup of contamination caused by past practices is outside the scope of the WM PEIS. These comments have been forwarded to the DOE Portsmouth Plant office.

Uranium hexafluoride is considered a source material, not a waste; consequently, issues pertaining to uranium hexafluoride management are outside the scope of the WM PEIS. DOE is preparing an EIS that will evaluate alternative strategies for long-term management of DOE-owned depleted uranium hexafluoride currently stored at the K-25 Site in Oak Ridge, Tennessee; at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky; and at the Portsmouth Plant, in Ohio. The Notice of

Intent was published in the *Federal Register* on January 25, 1996, and the Draft EIS is scheduled to be available for public review in February 1997.

Comment (2126)
The concept of the internal combustion engine has been obsolete for over 50 years. But because of the oil cartels and the corrupt government regulations, we and the rest of the world have been forced to use gasoline for over 100 years.

Response
Issues pertaining to advances in automotive technologies and government energy policies and laws are not within the scope of the WM PEIS.

Comment (2128)
Big business is primarily responsible for destroying the water we drink, the air we breathe, and the food we eat. They have no care for the world they destroy, only for the money they make in the process. For companies making $10 million a day by dumping lethal, toxic waste into the ocean, it is only good business to continue doing that. We are angry because we are all being chemically and genetically damaged.

Response
Environmental contamination by "big business" is not within the scope of the WM PEIS.

Comment (2134)
DOE should explain why there is a nuclear reactor at BNL.

Response
BNL operates two research reactors that are used by scientists to study metals, ceramics and biological molecules, and to develop new cancer therapies. Both reactors are many times smaller and less powerful than a commercial utility nuclear power reactor. BNL's reactors are also designed for a different purpose than commercial power reactors. Instead of maximizing the amount of heat that can be generated by the reactor core, BNL's research reactors maximize the number of subatomic particles, called neutrons, that can be used by the scientists for their research.

Comment (2158)
DOE needs to do something to stop the hole in the ozone being created by hydrogen fluoride.

Response
DOE is committed to phasing out ozone-depleting substances and will discontinue use of these substances according to EPA phaseout schedules. Other actions related to the use of ozone-depleting substances are outside the scope of the WM PEIS.

Comment (2165)
A commentor stated that workers at PGDP have a high rate of neutron exposure and DOE needs to explain how they are monitoring this.

15. Out of Scope Comments

Response
Neutrons are produced by a nuclear reaction. PGDP does not have any material that produces a nuclear reaction, or the capability of producing such a reaction. PGDP has not and will not produce nuclear reactions. Therefore, no one has been exposed to neutrons at PGDP.

As part of normal operations, PGDP conducts routine monitoring of all employees who work in or have occasion to be in a radiological area. This monitoring is conducted by the use of small dosimeters worn by each of those employees. These are exchanged quarterly. The removed dosimeters are then analyzed to determine if an employee received a radiation dose. Employees also undergo annual physical examinations, part of which check for radiation dosage.

Comment (2226)
In-place treatment of high-level waste in the tanks at Hanford is unacceptable.

Response
Treatment of high-level waste is outside the scope of the WM PEIS. Although Section 1.7.4 in Volume I of the PEIS mentions that treatment of some high-level waste is being privatized at the Hanford Site, the potential environmental impacts of high-level waste treatment are examined in sitewide or project-level NEPA documents and safety assessments, including the Hanford Tank Waste Remediation System EIS described in Volume I, Sections 1.8.1 and 9.1.2.1.

Comment (2233)
We are particularly concerned about the capping and ignoring of monitoring wells at PGDP that showed plutonium in the groundwater. This is dishonest and stupid.

Response
DOE, in accordance with State laws and regulations, abandons monitoring wells that are no longer needed or that are no longer are in good operating condition. In addition, at its own expense, DOE locked and capped about 100 residential wells near PGDP, and is providing these residents with municipal water. This action was taken due to offsite contamination of the groundwater primarily with trichloroethylene and technetium-99.

However, no monitoring wells were abandoned and ignored because of plutonium. Plutonium was found in one well at concentrations slightly above the detection limit. However, followup sampling activities by DOE and the Commonwealth of Kentucky found no plutonium. Thus, the one event was determined to be invalid.

Comment (2251)
The U.S. engages in too much duplicity about international treaties on nuclear arms. More international monitoring is needed.

Response
Compliance with international nuclear treaties is outside the scope of the WM PEIS.

Comment (2257)
A commentor believes ANL-E should remain a research facility.

Response
The WM PEIS addresses the environmental impacts of alternative waste management strategies. Some of the waste produced at DOE sites originates from research activities, so research sites must also manage the wastes they generate, even if those wastes are disposed of offsite. ANL-E will remain a multi-purpose site, and its missions will include energy research and waste management.

Comment (2259)
We are very concerned about the attempt of the ANL-E facility to obtain City of Chicago water, since most people in the area draw on the local aquifer for drinking water. Why does ANL-E need Chicago city water? Water that is good enough for the rest of the community should be good enough for ANL-E, too.

Response
During the summer of 1996, ANL-E began to use Lake Michigan water. Previously, ANL-E used well water, which it treated and softened. As a consequence of the softening process, the site's water had high concentrations of dissolved solids. Transferring to Lake Michigan water, which was offered to ANL-E by the DuPage County Water Commission, avoids this problem. ANL-E's discontinuation of use of well water will reduce the demand on the aquifer.

Comment (2316)
DOE should restore Hanford Advisory Board funding; enhance education and involvement; establish a special committee to integrate/coordinate; and not have a piecemeal approach.

Response
DOE is taking steps to improve the coordination and integration of its decisionmaking processes. These steps include providing briefings to groups such as the chairpersons of the Site-Specific Advisory Boards (including the Hanford Advisory Board) on upcoming DOE decision processes and how they might interrelate. Other groups include the national-level Environmental Management Advisory Board, the National Governors Association, and the State and Tribal Government Working Group. Part of the goal of such briefings is to provide a clearer picture of how actions at one DOE facility or site could affect another, as well as to identify the cumulative effects of several contemplated actions at an individual site. Input is also being sought from these groups on how DOE can enhance education and involvement and which decision processes the groups feel would most benefit from greater coordination or integration. Adequate funding for advisory boards is outside the scope of the WM PEIS.

Comment (2631)
Moving radioactive waste and plutonium through Puget Sound ports should be strongly opposed because of (1) the impacts of shipping such hazardous material through the sensitive waters of the Sound are unknown, especially considering that foreign freighters may not meet the stricter registry rules for U.S. vessels; (2) the dangers involved with unloading and shipping the materials to Hanford; and (3) Hanford has enough problems funding cleanup efforts without adding additional waste materials.

Response
The WM PEIS does not analyze shipment of any hazardous waste, transuranic waste, low-level waste, low-level mixed waste, or high-level waste through Puget Sound, with the exception of minor volumes of low-level mixed waste generated at the Puget Sound Naval Shipyard. Further, the WM PEIS does

not consider spent nuclear fuel issues. Details on spent nuclear fuel and alternatives with potential Puget Sound implications can be obtained from the SNF/INEL PEIS and the Foreign Research Reactor Spent Nuclear Fuel EIS. The cumulative impact analysis in Chapter 11 in Volume I of the WM PEIS does consider site-specific programs, for example, at the Hanford Site.

Comment (2701)
A commentor opposes the production of tritium.

Response
Section 1.8.2 in Volume I of the WM PEIS contains a description of NEPA reviews that are related to the WM PEIS, including the Tritium Supply and Recycling PEIS.

Comment (2702)
One commentor opposed bringing radioactive rods to the Savannah River Site (SRS). Another commentor suggested that DOE not store spent fuel rods at SRS, but that they be stored "somewhere else and use what we [SRS] do have to generate electricity at reasonable rates."

Response
The scope of this WM PEIS is restricted to waste management activities on a programmatic level. Issues relating to electricity generation and to the management of radioactive rods at SRS is not covered by this document. In February 1996, DOE issued the Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel EIS to address management of spent nuclear fuel from foreign research reactors. The Record of Decision was published in the *Federal Register* on May 13, 1996. The Record of Decision identified that the foreign research reactor spent nuclear fuel would be accepted into the U.S. and that the aluminum-based fuel would be managed at SRS, and that the TRIGA fuel would be managed at INEL. In April 1995, DOE issued the SNF/INEL EIS, which evaluates alternatives for managing existing and reasonably foreseeable inventories of U.S. Government-owned spent nuclear fuel; a Record of Decision was issued in May 1995. Site-specific waste management activities for SRS were analyzed in the SRS Waste Management EIS of July 1995. Section 1.8.2 in Volume I of the WM PEIS contains descriptions of these NEPA reviews. The cumulative impacts analysis in Chapter 11 in Volume I of the WM PEIS considers impacts from other programs such as the management of spent nuclear fuel.

Comment (2775)
DOE should consider changing the location of research that generates waste to one or two locations in the country, away from populated areas, and then not have to worry about disposing of the waste in highly populated areas or transporting the waste through areas that are highly populated.

Response
The configuration of DOE research facilities is outside the scope of the WM PEIS.

Comment (2989)
If the Oak Ridge Reservation (ORR) is selected as a center for treatment of offsite wastes, ORR wastes should be treated first.

Response
The order in which waste is treated at a regional treatment center is outside the scope of the WM PEIS.

15. Out of Scope Comments

Comment (3324)
Why weren't the Manhattan Project scientists put in charge of the Atomic Energy Commission at its inception? Why were politicians directing the advance of Atomic Energy?

Response
The Atomic Energy Commission was established by the Atomic Energy Act of 1946 as the successor to the Manhattan Engineer District. The Commission was composed of five members appointed by the President with the advice and consent of the Senate. Among the early chairmen of the Atomic Energy Commission were scientists from the Manhattan Project.

Comment (3412)
Many members of the public submitted comments related to the *Draft Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel*. The commentors were adamantly opposed to the use of Puget Sound and the ports of Tacoma, Washington, and Seattle, Washington, as a point of entry for receipt of foreign research reactor spent nuclear fuel.

Response
These comments relating to the acceptance of foreign research reactor spent nuclear fuel into the United States are outside the scope of the WM PEIS. This issue was the subject of the Foreign Research Reactor Spent Nuclear Fuel EIS, which was issued in February 1996. The Record of Decision was published in the *Federal Register* on May 13, 1996. The Record of Decision identified the Charleston Naval Weapons Station in South Carolina and the Concord Naval Weapons Station in California as the ports of entry for receipt of the foreign research reactor spent nuclear fuel.

Comment (3426)
Many commentors provided comments on Hanford and the Storage and Disposition of Weapons Usable Fissile Materials Draft Programmatic Environmental Impact Statement. Comments included the following: weapons plutonium should be turned into reactor fuel at Hanford, not vitrified; the reprocessing of plutonium is too dangerous (and, therefore, commentors are opposed to it); weapons plutonium should not be turned into reactor fuel at Hanford, it should be vitrified; weapons plutonium should be vitrified with high-level nuclear waste so that it is hard to recover and can be disposed of; vitrification is the best option for weapons plutonium and should be pursued far more aggressively; whether weapons plutonium should be vitrified with high-level waste so that it is hard to recover and can be disposed of or turned into reactor fuel depends on the relative cost and cost-benefit effects of each.

Response
Decisions related to plutonium reprocessing or vitrification and the Storage and Disposition of Weapons Usable Fissile Materials Draft Programmatic EIS are outside the scope of the WM PEIS. The WM PEIS does not address weapons-grade nuclear material, which is not classified as waste. Section 1.8.2 in Volume I describes the WM PEIS relationship to other NEPA documents, including the Storage and Disposal of Weapons-Usable Fissile Materials PEIS and Section 11.6 includes the impacts identified in that PEIS for the Hanford Site. Any waste resulting from actions taken from the Fissile Materials PEIS would be stored, treated, or disposed of in accordance with the decisions for that waste type resulting from the WM PEIS.

15. Out of Scope Comments

Comment (3524)
DOE should adopt the following system to solve the fundamental flaws in the current waste management siting method and maximize social welfare, take full account of social and environmental costs, and still achieve fairness: (1) reduce waste disposal requirements to a minimum, primarily through price incentives and eliminating bidder subsidies for waste generation; (2) consider all waste streams together (as opposed to having separate regulations for different waste streams); (3) have the Federal Government decide how much disposal capacity and how many facilities are needed, after available means of waste minimization have been exhausted; (4) have the Federal Government, through a new Federal Waste Disposal Commission (modeled after the Base Closure Commission), assign to States capacity allocations by considering geological and other physical requirements of a facility, the amount and kinds of waste generated within the State's borders, and whether the State is already a net importer or exporter of waste; (5) give the State the responsibility for finding a home within its borders for that waste by encouraging volunteer communities using a compensation auction (e.g., technical assistance grants); (6) have interested volunteer municipalities conduct a public referendum on the site, which must meet minimum technical criteria (e.g., depth to bedrock, distance from population centers, no siting in floodplains, etc.); (7) upon favorable outcome of the referendum, site the facility at the community; and (8) sanction States that do not meet their responsibilities by a cutoff (i.e., allow other States to close their borders to that State's waste).

Response
Thank you for your comment. However, the thrust of the comment is outside the scope of DOE's mission, under the current regulatory framework.

Comment (3664)
How does DOE calculate in the migration of the waste to the Pecos River in a short amount of time, the contamination of the Rio Grande and the seven rivers which flow from the Rio Grande into Mexico?

Does the Mexican Government have concerns about the possible contamination of their water supplies from WIPP? Has the DOE consulted with the Mexican Government on any type of environmental international agreements that will have to be met in regards to potential impacts of the WIPP site?

Response
Disposal of transuranic waste at the Waste Isolation Pilot Plant (WIPP) is outside the scope of the WM PEIS. The disposal impacts from operating WIPP as a transuranic waste repository are addressed in the WIPP SEIS-II.

Comment (3678)
The "disposal" of high-level waste is not an issue where the public, as well as the States and Native Nations, will sit back and wait for DOE or any facet of the Federal Government to make top-down decisions.

Response
The impacts of disposing of high-level waste in a repository are not within the scope of the WM PEIS, but will be analyzed in a subsequent DOE NEPA document relating to a geologic repository.

Comment (3683)
Why is the nuclear age not utilizing this ultimate science determining the environmental applications for remediation. Is not all matter comprised of atoms?

Response
Due to their site-specific nature, environmental restoration and remediation activities are outside the scope of the WM PEIS, which is an analysis of alternatives for managing, at a programmatic level, wastes generated by DOE operations. Environmental restoration and remediation actions are conducted by the DOE Environmental Restoration Program, and are governed primarily by the provisions of CERCLA and RCRA.

Comment (3888)
DOE needs to use solar energy or recycle nuclear energy.

Response
Issues relating to energy research are outside the scope of this WM PEIS, which is a programmatic study on waste management options.

Comment (3952)
DOE transfer [to the United States Enrichment Corporation] of the Portsmouth Plant and PGDP, its sister facility in Paducah, Kentucky, was a major Federal action with direct and foreseeable significant impacts on the human environment issued a Finding of No Significant Impact. Privatization and commercialization of the Portsmouth and Paducah facilities to United States Enrichment Corporation (USEC) and Nuclear Regulatory Commission oversight of USEC operations was an action mandated by Congress in Energy Policy Act of 1992. The DOE decision to issue a Finding of No Significant Impact rather than an EIS was both inappropriate and misleading.

Response
DOE believes that the level of NEPA review on the transfer of PGDP and the Portsmouth Plant to the United States Enrichment Corporation was appropriate. The transfer is outside the scope of the WM PEIS.

Comment (4030)
The PEIS does not provide an adequate public health justification for the proposed action. The Draft WM PEIS contemplates a massive expenditure of discretionary funds - between $30 and $40 billion - over the life cycle of the project. These funds will be applied to transportation and custodial storage of hundreds of thousands of cubic meters of radioactive waste, as well as the construction of significant new infrastructure in existing and new waste management facilities. In the current budgetary regime, these funds will be drawn away from other programs that also impact public health. Yet the WM PEIS devotes little space to examining the public health justifications that presumably drive the project, and the public is given no basis for comparison between the direct impacts of the project (such as transportation accidents) and the human health threats sought to be mitigated by DOE's waste management and "disposal" efforts. Instead, the WM PEIS only evaluates direct impacts and risks from waste management activities themselves, not from the programs that generate the waste, the stockpiles of inventoried wastes, or from contaminated facilities.

15. Out of Scope Comments

Response
With respect to the human health risk/cost trade-offs within DOE's waste management responsibility, one of the waste management alternatives considered in the WM PEIS is the No Action Alternative. The No Action Alternative provides an estimate of health effects and costs if DOE continues with current activities that generate waste and continues with current waste management strategies and activities. The comparison of alternatives in each waste-type chapter shows how the No Action Alternative compares with the range of possible action alternatives in terms of cost and public and worker risk. The human health and environmental impacts of individual DOE programs and projects have been or will be analyzed in separate NEPA reviews. Section 1.8.1 in Volume I summarizes these NEPA reviews and discusses their relationship with the WM PEIS.

With respect to the broader issue raised by the commentor, including DOE's wide range of responsibilities, analysis of the public health justification for spending public funds on waste management instead of other public health threats is not within the scope of the WM PEIS because DOE is required by law to manage its wastes. DOE is required by the Atomic Energy Act (42 USC 2011 *et seq.*) to manage the radioactive wastes that it generates. Low-level mixed waste, low-level waste, transuranic waste, and high-level waste have radioactive component. In addition, DOE needs to make waste management decisions concerning hazardous waste and hazardous components in mixed wastes (waste that is both hazardous and radioactive) in order to comply fully with RCRA (42 USC 6901 *et seq.*). RCRA sets forth requirements for managing hazardous waste including mixed waste. Low-level mixed waste, some high-level waste, and some transuranic waste are mixed wastes and might be subject to RCRA. RCRA requires EPA to issue land disposal restrictions (40 CFR 268), which prohibit storage of hazardous and mixed wastes, except to facilitate proper recovery, treatment, and disposal. The Federal Facility Compliance Act (42 USC 6961 *et seq.*) amended RCRA to allow EPA and individual States to impose fines and penalties on Federal facilities for RCRA violations.

Decisions about expenditures of Federal funds to address public health threats are made by Congress, which presumably considers such cost/benefit trade-offs as the commentor has noted. On its part, DOE has begun a "National Dialogue" initiative to provide a means for comprehensive discussion with government officials, regulatory authorities, and other interested organizations and public regarding the major materials, waste management, and cleanup decisions, DOE needs to make over the next few years. This dialogue, which is described in Volume I, Section 1.8.2, of the WM PEIS, will include public participation and input on national environmental restoration issues.

Comment (4034)
A true no action benchmark analysis would require DOE to acknowledge that the continued development, testing, and fabrication of nuclear weapons involves adding greater quantities of extremely dangerous materials that presently have no permanent disposal options, will remain dangerous for thousands of years, and will cause environmental, public health, and economic impacts.

Response
While the WM PEIS analyzes alternatives related to waste management activities, the Stockpile Stewardship and Management PEIS, which is described in Section 1.8.1 in Volume I of the WM PEIS, analyzes the potential consequences to the environment if certain changes to the Nuclear Weapons Complex are implemented.

Comment (4067)
In order to find real alternatives to "business as usual," DOE should analyze the impacts of radioactive waste that has been dumped into oceans to determine the effects on living creatures; this could be useful for long-term disposal plans.

Response
NEPA and CEQ regulations require Federal agencies to include in an EIS a discussion of reasonable alternatives to the proposed action. Agencies must provide sufficient information for each alternative to permit reviewers to evaluate the comparative merits of those alternatives. The NEPA process does not generally include an analysis of past actions. Rather, reasonable alternatives for proposed actions are considered.

Ocean disposal is not an option that DOE is considering for this WM PEIS, and effects of ocean disposal of radionuclides on marine organisms, if any, is outside the scope of this PEIS.

Comment (4071)
DOE should end all production, distribution, and promotion of "agents of death." "A basic humanist view of ethics will prevent another tragedy like Hiroshima...Because you do not respect the earth and life, many bad things manifest as people [lose] respect for life too." Domestic violence increases when people copy the "power trips" of their government leaders.

Response
The policies of the United States with regard to defense are set by Acts of Congress and Presidential authority. Issues related to defense policy and domestic violence are not within the scope of the WM PEIS. DOE is analyzing alternatives for achieving a downsized nuclear weapons complex (see the Stockpile Stewardship and Management PEIS described in Section 1.8.1).

Comment (4277)
Production and use of plutonium should be stopped, because the government cannot account for what is around now.

Response
Policy decisions regarding production and use of plutonium production and use are outside the scope of the WM PEIS. Plutonium is not considered a waste. Decisions relating to plutonium would be based on the Storage and Disposition of Weapons-Usable Fissile Materials PEIS described in Section 1.8.1 in Volume I of the WM PEIS. In addition, since plutonium is a special nuclear material, the DOE Safeguards and Security Program, described in Section 4.3.12 (Volume I), is used to protect and account for the amount in DOE's inventory.

Comment (4402)
DOE analyzes foreign wastes (from commercial power plants and/or defense wastes from around the world that will be managed by and within the United States by DOE) as a tangential matter and not as an integral part of DOE's waste management scheme, thus minimizing health risks and impacts on humans and the environment. DOE must concurrently analyze the management and impacts of foreign nuclear wastes with domestic DOE nuclear waste inventories in a new WM PEIS.

15. Out of Scope Comments

Response
DOE does not accept wastes from foreign commercial power plants or defense wastes from "around the world." DOE does accept spent nuclear fuel from foreign research reactors.

Comments relating to the acceptance of foreign research reactor spent nuclear fuel into the United States are outside the scope of the WM PEIS. DOE issued the Final Foreign Research Reactor Spent Nuclear Fuel EIS in February 1996 (DOE/EIS-0218F). Answers to the above questions can be found in that document. The Record of Decision was issued on May 13, 1996, and identified the Charleston Naval Weapons Station in South Carolina and the Concord Naval Weapons Station in California as the ports of entry for receipt of the foreign research reactor spent nuclear fuel.

Comment (4431)
A former employee of a DOE contractor asserted that he was terminated from working on the preparation of the WM PEIS due to his disclosures and efforts to include in the Draft PEIS certain environmental impacts at some DOE sites, environmental impacts of high-level waste treatment, and uncertainties in available information on these impacts.

The commentor suggested that DOE:

- Publicly acknowledge the inaccuracies in the WM PEIS and terminate whatever is left of the contract with META/Berger;

- Hold new WM PEIS public hearings in Washington, D.C., so local interested parties will have an opportunity to participate without excessive travel costs;

- Consider having the WM PEIS revisions administered by a widely respected institution independent of Argonne National Laboratory and, preferably, independent of DOE;

- If the PEIS is to be restricted to waste management, republish it as a Draft PEIS, and not as a Final PEIS, to provide adequate opportunity for external review of the draft document;

- Use new contractors and DOE personnel (who have been screened to ensure that they would be unlikely to tolerate coverups) to revise the Draft WM PEIS (or preferably create a PEIS for all of DOE) who understand models, uncertainties, and the information needed by administrators to make wise decisions;

- Consider instituting an environmental security clearance procedure for all persons in DOE and on the staff of DOE contractors who have environmentally sensitive positions to screen out those who are likely to tolerate or institute coverups from positions where they may have an opportunity to behave in this way;

- Offer backpay, expenses and secure, full-time employment to those who were working on the PEIS but were terminated for trying to prevent misleading characterizations of impacts;

- Provide adequate funding, authority, resources and staff to the Secretary of Energy, the Assistant Secretary for Environmental Management, the Office of Contractor Employee Protection, and others in DOE who have responsibilities involving the prevention of coverups and misleading

characterizations of impacts by DOE, e.g., contractors and the protection of those who reveal coverups.

Response
As required by NEPA, public involvement plays a major role in the process that culminates in the issuance of a final EIS. It constitutes a major driver in delineating the scope of an EIS and in moving from a draft to a Final EIS, and serves as a vehicle of control and revision of inaccuracies where they occur. DOE views public response and acknowledgment of errors as part of its commitment to openness.

Regarding the commentor's suggestions on how DOE should deal with its contractors, DOE supervises and provides guidance to its contractors to ensure that the final document is sound. As the Federal action agency, DOE is required by NEPA to retain ownership of the EIS process. Thus, DOE will apply the supervision and guidance aspect referred to in the comment to any organization it enlists to support its efforts.

DOE believes that the Draft WM PEIS met the requirements of the CEQ regulations and NEPA. Therefore, it is not necessary to revise and reissue the Draft WM PEIS for public comment. Substantial changes were made to the PEIS in response to public comments to improve the analysis and correct factual errors.

The DOE Office of Contractor Protection is addressing the commentor's contention of wrongful termination. In addition to a DOE investigation, EPA conducted an independent investigation of the allegations made against DOE and its contractors, including META and Louis A. Berger and Associates, Inc., and determined that there was no evidence of a coverup or deliberate misrepresentation of data. META and Louis A. Berger and Associates, Inc., remain integral parts of the WM PEIS project team.

Comment (4493)
The human health impacts associated with DOE and EPA standards should have been summarized in Section 4.3 of the Draft WM PEIS. With a 70-year exposure at 100 mrem (the DOE standard), the lifetime probability of an individual contracting cancer would be 1%. A 70-year exposure at 10 millirem (the EPA standard) would cause a 0.1% chance of cancer. Both values exceed the 1 in 10,000 risk limit in CERCLA and RCRA regulations and guidelines, and exceed limits that would be acceptable to many members of the public.

DOE should evaluate the possibility of changing its limit for multimedia exposure for the MEI, from 100 mrem to 1 mrem, a value that would be consistent with a 1 in 10,000 cancer risk limit in EPA regulations and guidelines, as well as the (CERCLA) national Contingency Plan. In addition, using a multimedia exposure of 0.01 mrem to the MEI as a point of departure indicating a need for further reduction in exposure should be considered. A 0.01 mrem exposure over a lifetime would cause a one in one million risk of cancer and be consistent with the one in one million goal in the Clean Air Act of 1990 and CERCLA rules and guidelines. These exposure limits should be considered in the WM PEIS, along with alternative timetables for compliance.

15. Out of Scope Comments

Response

It is not the purpose of the WM PEIS to evaluate EPA and DOE standards, or to evaluate the acceptability of health risks resulting from current conditions at DOE sites. Rather, the purpose of the WM PEIS is to show, on a relative basis, the impacts, including health risks, resulting from the proposed waste management alternatives.

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References

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Individuals	Comment/Response Index Location(s)
Abbate, Kathleen A.	3.5.1 (209)
Abell, Thomas L.	3.5.1 (209)
Adamo, James A.	3.5.1 (209)
Adle, Dorothy R.	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Ahouse, Loretta	3.3 (141), 4.2 (395), 5.2 (14), 6.4 (396), 11.3 (397), 11.3 (398), 12.2 (206), 12.2 (363), 12.2 (365), 12.2 (1484)
Ahouse, Loretta	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 9.3 (3422), 11.3 (4140), 12. (152), 15. (3412), 15. (3426)
Alletta, Marian	3.5.1 (209)
Amrein, Polly	3.5.7 (123), 6.7 (25)
Anderson, Joan	3.1 (1937), 8.1.2 (1938), 8.3.3 (1940), 8.3.3 (3742), 15. (1943)
Anonymous, Lynn	3.5.2 (541), 4.2 (451)
Anonymous	11.6 (1877)
Arsenault, Gwendolyn M.	3.5.1 (209)
Arsenault, Robert J.	3.5.1 (209)
Arsenault, Robert J.	3.5.1 (209)
Auclair, Janet M.	3.4.1 (71)
Baker, Gloria	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 9.1 (276)
Baldwin, Mary K.	3.5.1 (209)
Ball, Eldon L.	14.1 (2374), 15. (3412)
Balle, Sally A.	3.5.1 (209)
Banks, Paula S.	3.5.1 (209)
Baran, Kenneth	3.5.1 (209)
Bardorzi, Margaret	3.5.1 (209)
Baron, Robert L.	3.5.1 (209)
Barton, Mary	3.5.15 (1682), 9.1 (1685), 14.5 (1684), 15. (2702)
Baum, Bonnie F.	3.5.1 (209)
Beasley, Patsy T.	3.5.10 (369)
Bechina, Joseph	3.5.1 (209)
Bechina, Margaret	3.5.1 (209)
Bedayn, Janice	3.1 (487), 4.2 (483), 5.2 (481)
Belford, Joan	3.5.1 (209)
Beranek, Joellen	3.5.1 (209)
Bernardi, Gene	3.5.7 (123), 5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.3 (22), 6.7 (25), 11. (24), 15. (1863)

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Individuals	Comment/Response Index Location(s)
Bierschenk, Bert	3.5.1 (209), 12. (152)
Blachowicz, Natalie A.	3.5.1 (209)
Blachowicz, Natalie	3.3 (141), 3.5.1 (209)
Blesy, Harold H.	3.5.1 (209)
Blesy, Harold H.	3.5.1 (209)
Bloomberg, Miriam	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Boije, Hope	3.1 (1288), 5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.7 (25), 8.3 (1286), 8.3 (1287), 11. (24),
Bomicino, Sandra	3.5.1 (209)
Bonavolonta, Albert	3.5.1 (209)
Boragudi, Rosemary	3.5.1 (209)
Borgersen, R.	5.2 (156), 14.3 (157), 15. (154)
Borowiak, Linda	3.5.1 (209)
Boyce, Mary C.	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Boyce, Sally	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3.1 (4235), 9.3 (3422), 12. (152), 13.1 (4236), 15. (3412), 15. (3426)
Boyd, Betty	3.5.10 (369)
Brandt, Howard	3.5.1 (209)
Brandt, Jolene	3.5.1 (209)
Brandt, Robert R.	3.5.1 (209)
Brechin, Vernon J.	2. (3539), 3.4.2 (520), 4.1 (1554), 4.2 (3531), 4.3 (3533), 4.3 (3535), 8.1 (3528), 8.1 (3530), 8.1.4 (3537), 9.2 (207), 11.2 (3527), 11.2 (3538)
Broida, Janet	3.5.1 (209)
Brooking, Mary Ellen	3.5.10 (369)
Brown, Elizabeth	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Brown, Rachel	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3.1 (4235), 9.3 (3422), 12. (152), 13.1 (4236), 15. (3412), 15. (3426)
Bryer, Elizabeth	3.5.4 (1952), 6.6 (3272), 12. (152), 15. (3412)
Bucic, George	3.5.1 (209)
Bucic, Margaret	3.5.1 (209)

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Individuals	Comment/Response Index Location(s)
Burkhardt, Leonard	14.2 (588)
Buxton, Michelle	6.7 (25)
Calamia, Carolyn	3.5.1 (209), 12. (152), 12.2 (254)
Campo, Jeannette E.	3.5.1 (209)
Carmichael, Jean	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Carnevale, Marilyn	3.5.1 (209)
Carr, Kathy	3.5.1 (209)
Cartwright, Karen	3.5.1 (209), 12.2 (254)
Chembryl, Fzoul	15. (112)
Christensen, Neil	3.5.1 (209)
Claffey, Jocelyn D.	3.5.1 (209)
Cloutier, Richard E.	3.5.1 (209)
Cohen, Arlene G.	3.3 (141)
Conner, Phoebe	3.5.4 (1952), 6.6 (1954), 10.2 (2634)
Coots, Lou	3.5.10 (369), 4.1 (3404), 8.3 (2674), 12. (2687)
Copeland, Paul	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24), 14.1 (371)
Corcoran, Mary	3.5.1 (209), 6.7 (25), 8.3.2 (438)
Cornett, C. Lawrence	3.1 (4442), 3.2.3 (3212), 4.2 (4433), 4.2 (4490), 4.2 (4492), 4.2 (4494), 4.2 (4495), 4.2 (4506), 4.2 (4512), 4.2 (4513), 5.1 (4425), 5.1 (4514), 5.2 (4417), 5.2 (4419), 5.2 (4426), 5.2 (4432), 5.2 (4443), 5.2 (4454), 5.2 (4468), 5.2 (4474), 5.2 (4483), 5.2 (4488), 5.2 (4520), 5.2 (4521), 5.2 (4526), 5.2 (4528), 5.2 (4530), 5.2 (4531), 5.2 (4532), 5.2 (4533), 5.2 (4534), 5.2 (4535), 5.2 (4536), 5.2 (4537), 5.2 (4538), 5.2 (4539), 5.2 (4540), 5.2 (4547), 5.2.1 (4469), 5.2.2 (4445), 5.2.2 (4473), 5.2.2 (4524), 5.2.2 (4525), 5.2.2 (4544), 5.2.2 (4545), 5.2.3 (4446), 5.2.3 (4476), 5.2.3 (4486), 5.3 (4450), 5.3 (4455), 5.3 (4461), 5.3 (4516), 5.3 (4542), 5.3 (4543), 5.3 (4549), 5.4 (4451), 5.4.1 (4491), 5.4.1 (4519), 5.4.2 (4527), 5.4.2 (4529), 5.11 (4415), 5.11 (4471), 5.11 (4553), 5.11 (4554), 5.11 (4557), 5.11 (4558), 5.12 (4452), 5.12 (4550), 6.2 (4448), 6.4 (4556), 6.6 (1670), 6.6 (4453), 6.6 (4475), 7. (4435), 7. (4456), 7. (4560), 7. (4561), 7. (4562), 7. (4563), 8.1 (4457), 8.1 (4515), 8.1.4 (4423), 8.1.4 (4465), 8.3 (4481), 8.3.1 (4460), 8.3.1 (4467), 9.2 (207), 9.2 (4436), 9.2 (4439), 9.2 (4458), 10.2 (4466),

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Cornett, C. Lawrence	11.1 (4421), 11.1 (4437), 11.2 (4463), 11.2 (4546), 11.4 (1138), 11.4 (4464), 11.6 (4413), 12. (4427), 13.1 (4440), 15. (4431), 15. (4493)
Curcio, John L.	3.5.1 (209), 12. (152), 12.2 (254)
Daly, John	3.5.1 (209)
Dastillung, Vicky	8.1 (1087), 11.4 (1138), 11.4 (2710), 14.6 (1615)
Data, Joseph R.	3.5.1 (209)
DeLuca, Lydia J.	3.5.1 (209)
DeVoy, Tiffany	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 5.11 (4375), 6.6 (4148), 8.1 (3424), 8.3.1 (4235), 9.3 (3422), 12. (152), 13.1 (4236), 15. (112), 15. (3412), 15. (3426)
DeVoy, Tiffany, Hearing	3.6 (2215), 8.3.2 (2214), 12.2 (254), 12.2 (1484), 12.2 (2217), 12.2 (2218)
Deen-Freemire, Joanne	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Degelman, Norman	3.5.7 (123), 6.7 (25)
DelBarba, Connie	3.5.1 (209)
DelBarba, Kris	3.5.1 (209)
Dellamaria, Anne	3.5.1 (209)
Deutscher, Ludell	5.2 (14), 5.2 (16), 5.2 (17), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 8.3.1 (2651), 14.1 (371),
DiPietro, Frank S.	3.5.1 (209)
Dian, Rudolph F.	3.5.1 (209)
Dillard, Kirk W.	3.5.1 (209)
Donahoo, Judy E.	3.5.1 (209), 15. (2257), 15. (2259)
Dorfman, Kari	3.5.7 (123), 11.3 (237), 14.2 (588)
Dortch, Jotilley	3.5.10 (369), 5.1 (1159), 5.2 (1168), 12. (152), 13.2 (1164)
Dostillung, Vicky	11.4 (160), 13.1 (158)
Dulany, Susan S.	14.1 (371), 15. (2701), 15. (2702)
Dunn, Pamela	3.5.3 (1761), 8.1 (1087), 8.1.2 (3964), 9.2 (207), 9.3 (3969), 9.3 (3976), 9.3 (3978),
Dybala, Richard J.	3.5.1 (209)
Dyson, Jessica, Hearing	3.3 (141), 11. (2206), 12. (152), 12.2 (363), 12.2 (1484)
Eagan, James L.	3.1 (220), 5.8 (219), 10.1 (221), 10.1 (222), 15. (223)
Ebins, Nancy	5.4 (1323)
Edsall, Jane	3.5.2 (541)
Edwards-Cotter, Anne	3.5.1 (209), 12.2 (206)
Ehlers, Betsy	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122),

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Individuals	Comment/Response Index Location(s)
Ehlers, Betsy	6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Eldredge, Fran	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Ellington, Cletus M.	6.4 (396), 15. (112)
Engelsman, Donna	3.5.1 (209)
Englund, Charles	3.1 (2655), 3.5.1 (209), 3.5.1 (2650), 3.5.1 (2654), 8.3.1 (2651)
Ericson, Stephanie	3.5.7 (123), 6.7 (25), 12. (152), 12.2 (206)
Fabilli, Virginia	6.7 (25), 8.3.1 (2651), 11.3 (237), 15. (198)
Falotico, Pamela	3.5.1 (209)
Fauci, Joanie	3.3 (141)
Featherstone, John	3.5.1 (209)
Fein, Anna	3.5.1 (209)
Feldman, Edith W.	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Fields, Sharon	3.5.10 (369), 12.2 (206)
Filer, William	3.4.1 (71), 3.5.1 (209), 6.1 (23)
Fleming, Jack W.	3.5.7 (123), 8.3.1 (176)
Forbes, Pam	3.5.10 (369)
Forcella, Lauren S.	6.7 (25), 8.3.1 (2651), 8.3.2 (194), 14.3 (157), 15. (154), 15. (188), 15. (198),
Foreman, Shelby	3.5.1 (209), 6.3 (22), 12.2 (206)
Foss, Louise	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 8.3.3 (1020), 11. (24)
Foulk, Robert	3.4.1 (71), 3.5.1 (209)
Fraser, Jane	3.5.1 (209)
Fratieola, Karen	3.5.1 (209)
Freeman, Jennifer	6.7 (25), 8.3.1 (2651), 11.3 (237)
Freund, George A.	11.1 (4421), 11.4 (2689), 14.2 (2690)
Giambrone, Dominic	3.5.1 (209), 12.2 (206), 12.2 (254)
Gillespie, Gretchen	3.5.1 (209)
Graber, Jean W.	3.5.10 (369), 14.1 (371)
Graffenius, Robert	3.5.1 (209)
Gray, Barbara B.	3.4.1 (71), 3.5.10 (369)
Gray, Dean	3.5.1 (209)
Greco, Armando	3.5.1 (209), 12.2 (254)
Green, Patricia	3.5.7 (123), 5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84),

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Green, Patricia	6.3 (22), 6.7 (25), 11. (24)
Greenfield, Rebecca L.	3.5.1 (209)
Grganto, Milan	3.4.1 (71), 3.5.1 (209)
Gross, Ingrid	3.5.1 (209)
Grove, Marjorie	6.4 (396), 9.1 (2610), 15. (3412)
Guglietta, Peter	3.4.1 (1926), 3.5.1 (209)
Gurka, Becky	3.3 (141), 3.3 (2345), 3.5.3 (2339), 3.5.8 (2337), 5.6 (2346), 5.6 (2351), 6.5 (2338), 8.1.2 (2341), 8.1.3 (2343), 8.1.5 (2352), 8.3.1 (2340), 11. (531), 11.2 (2347), 11.2 (2354), 10.2 (2634), 15. (2631)
Gurley, Worth	3.5.1 (209), 5.2 (2777), 8.1 (1830), 15. (2775)
Gustafson, Eric	3.5.1 (209)
Hagon, Cindie	6.3 (22)
Hahn, Dixie	3.1 (36), 3.2.3 (39), 3.2.5 (41), 4.3 (40), 5.2 (34), 5.3 (37), 8.3.1 (7), 8.3.1 (8), 8.3.1 (10), 8.3.1 (11), 8.3.1 (33), 8.3.1 (35), 11.2 (2), 11.2 (3), 11.2 (6)
Hamilton, Ellie	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24), 3.5.1 (209)
Harmon, Ann	3.5.10 (369), 12. (152)
Hauge, Rosemarie	3.1 (197), 6.7 (25), 6.8 (189), 6.8 (191), 8.1 (195), 8.3 (185), 8.3.1 (2651), 8.3.3 (199)
Hayden, James E.	3.5.1 (209)
Herbert, Patricia	6.7 (25), 8.3.1 (2651), 11.3 (237), 15. (198)
Hermer, Leonard	3.5.1 (209)
Herrick, Nancy A.	3.5.1 (209)
Hickey, Patricia	3.5.1 (209)
Hinkelman, Daena	6.7 (25), 8.3.1 (2651), 11.3 (237)
Ho, Esther	5.2 (14), 5.2 (16), 5.5 (19), 5.5 (100), 5.11 (122), 6.7 (25), 9.1 (265), 3.5.4 (1952), 5.11 (3411), 5.11 (4133), 6.6 (4148), 15. (3412)
Holmgren, Rod	6.7 (25), 8.3.1 (2651)
Hostetler, Greg	3.5.1 (209)
Hoye, Evelyn	3.5.10 (369)
Huebsch, Jeffrey B.	3.5.1 (209)
Hurd, Margaret	3.5.1 (209)
Hynes, Vivian	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (4133), 6.6 (4148), 8.3.1 (4235), 9.3 (3422), 12. (152), 13.1 (4236), 15. (3412), 15. (3426)
Iazzetto, Ross J.	3.5.1 (209)
Illegible, Carlel	3.1 (13), 8.1 (4044)
Illegible	
Inderbitzer, Margaret	

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Irwin, Shirley	11.5 (3780)
Ivancevic, Dan	3.5.1 (209)
Izett, Mary W.	5.2 (14), 5.2 (16), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.3 (22), 6.7 (25), 11. (24),
Jacobs, Sharon K.	3.5.1 (209)
Janicijevic, Alexander	3.5.1 (209)
Jeffers, Dawn J.	3.5.1 (209)
Johnson, Betty G.	3.5.10 (369)
Johnston, Sarah	3.5.10 (369)
Jones, Francis R.	8.1.2 (1929)
Jones, Frank E.	5.2 (14), 5.2 (16), 5.2 (17), 5.2 (583), 5.5 (19), 5.5 (100), 5.10 (20), 5.11 (122), 6.1 (23), 6.2 (84), 6.7 (25),
Jones, Gerry	3.5.10 (369), 3.5.10 (4570)
Jones, Jeffrey W.	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.2 (84), 6.3 (22), 6.7 (25), 15. (188),
Jones, Lori	3.5.1 (209)
Kalisik, Amelia	3.5.1 (209)
Kanner, Pamela	3.5.1 (209)
Kapustka, Dennis W.	3.5.1 (209)
Kassl, Sharon	3.5.1 (209)
Katsaros, John A.	3.5.1 (209), 12.2 (254)
Kearney, Tim	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 9.3 (3422), 12. (152), 15. (3412), 15. (3426)
Keiser, LeRoy H.	3.5.1 (209), 12.2 (254)
Kelly, Del	3.5.1 (209)
Kelly, Gerald W.	3.5.1 (209)
Kelly, Stephen S.	5.2 (14), 5.2 (16), 5.2 (17), 5.2 (619), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24), 12. (152), 15. (188)
Kennerley, Peggy	3.5.10 (369)
Keplinger, Erin	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 6.7 (4354), 8.1 (3424), 9.3 (3422), 12. (152), 15. (3412), 15. (3426)
Kerrigan, Rosemary	3.5.1 (209)
Kilchenman, Candace	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 5.12 (689), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 6.8 (189), 8.3.1 (2651), 8.3.3 (691), 11. (24)
King, Joan O.	3.6 (143), 6.7 (25), 6.7 (4572),

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Individuals	Comment/Response Index Location(s)
King, Joan O.	14.1 (371)
Klafeta, Lynn	3.5.1 (209)
Kluglein, June	3.5.2 (541), 14.4 (1930)
Konrad, Colin	3.5.1 (209), 12.2 (206)
Koss, Ginny	3.5.1 (1066)
Kozak, John W.	5.2 (14), 5.2 (16), 5.2 (17), 5.2 (583), 5.5 (19), 5.10 (20), 5.11 (122), 6.1 (23), 6.3 (22), 6.7 (25)
Kramp, Geraldine A.	3.4.1 (71), 3.5.1 (209)
Kramp, Geri	3.4.1 (71), 3.5.1 (209)
Krefft, Robert	3.5.1 (209)
Kudelka, Linda	3.5.1 (209)
Kurley, Michael L.	3.5.1 (209)
Laird, Jeanne	3.5.1 (209)
Lamar, E. K.	3.5.10 (369)
Lamb, Lorene	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Lamb, Ronald	12.2 (254)
Larsen-Beville, Sherry	3.5.7 (123), 12.2 (254)
Latvala, L. F.	8.3.3 (57), 11.5 (56)
LeNeave, Billie J.	3.5.10 (369)
LeTourneau, Edward A.	3.5.1 (209)
Lee, James	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 9.3 (3422), 12. (152), 15. (3412), 15. (3426)
Lela, John	3.5.1 (209)
Levigne, Joseph J.	3.5.1 (209)
Levitt, Alda	3.5.1 (209)
Lewis, George B.	3.5.10 (369), 15. (112)
Lewis, Tommy	3.5.10 (369), 15. (112)
Lindsay, Dorothy E.	3.5.1 (209)
LoVirolo-Bhurhan, Judith	6.7 (25)
Longo, Alice	15. (3412)
Losey, David C.	11.3 (2718)
Lukaszewski, Leon	5.2 (14), 5.2 (17), 5.5 (19), 5.10 (20), 5.11 (122), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24), 12. (152)
Maalem, Angelique	3.5.1 (1295)
MacDonald, A.	8.3.1 (2651)
Maciolek, Michelle	4.2 (483), 5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.3 (22), 6.7 (25), 11. (24),
Mack, Mary	3.5.10 (369)
Mahler, Andy	3.5.10 (369)
Malloy, Maureen	3.5.1 (209)

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Individuals	Comment/Response Index Location(s)
Mannhaupt, Jean E.	12.2 (254)
Mannhaupt, Jean E.	1. (3331), 3.1 (3332), 5.2 (3329), 5.2 (3682), 8.1 (3328), 8.1 (3685), 8.3.1 (3330), 11.4 (1138), 14.1 (3325), 14.1 (3681), 14.1 (3687), 14.1 (3688), 14.4 (2099), 15. (3324), 15. (3683),
Mareci, Norman V.	3.5.1 (209)
Masters, Gwen	3.5.1 (209)
Mateski, Andreja L.	3.5.1 (209)
Mayka, Linda S.	3.5.1 (209)
Mazzelle, Anne	3.5.1 (209)
McDade, Elinor	3.5.2 (541)
McDarnell, Cindy	3.5.1 (209)
McGowan, Joan	3.5.1 (209)
McGreal, Angela	3.5.1 (209)
McKinney-Smith, Sarah	3.5.10 (369)
Medek, Karen	3.5.1 (209)
Menendez, Patrick	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 9.3 (3422), 12. (152), 15. (3412), 15. (3426)
Mengarelli, Marcia	3.5.1 (209)
Michels, Jeanne	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.10 (20), 5.11 (122), 6.1 (23), 6.3 (22), 6.7 (25), 11. (24)
Migas, Frances	3.5.1 (209)
Miklos, Alison B.	3.5.1 (209)
Mikolajczyk, Thomas F.	3.5.1 (209)
Miller, Jane E.	3.5.10 (369)
Miller, Shirley	3.5.1 (209)
Miller, Shirley	3.5.1 (209)
Mitchell, Adele	3.5.1 (209)
Moore, Jennifer	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 12. (152), 15. (3412), 15. (3426)
Moravik, Robert S.	3.5.1 (209)
Morgan, Nick	5.2 (14), 5.10 (20), 5.11 (122), 6.3 (22), 6.7 (25), 8.1.5 (255), 12.2 (254),
Moutvic, Charles	4.1 (251), 6.3 (22), 12.2 (206)
Mueggenborg, Donald	3.5.1 (209)
Mueller, Robert	3.5.1 (209)
Muerto, Rolando	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24), 15. (154)
Muszalski, James R.	3.4.1 (71), 11.3 (1527)
Naso, Joseph C.	3.5.1 (209)
Nelson, Paul	3.5.4 (1952), 3.5.4 (3421),

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Individuals	Comment/Response Index Location(s)
Nelson, Paul	5.11 (4133), 12. (152), 15. (3412)
Newsome, Susan	5.2.3 (1182), 15. (3412)
Nix, Martin E.	15. (188)
Novak, Richard F.	3.5.1 (209)
Nurmela, Lillian	3.3 (141), 5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
O'Brien, Raymond J.	5.2 (14), 5.2 (17), 5.5 (19), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.3 (22), 6.6 (344), 6.7 (25)
O'Connor, Timothy R.	3.5.7 (123), 5.2 (14), 5.2 (16), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 6.2 (84), 6.7 (25), 11. (24), 14.1 (371), 14.2 (588)
O'Shea, Michael	3.4.1 (1869), 3.5.1 (209)
Obryk, Joseph E.	3.5.1 (209), 12. (152), 12.2 (254)
Olanoff, Samuel	11.2 (1), 11.2 (2), 11.2 (3), 14.2 (4)
Olson	3.5.10 (369)
Orednick, J. P.	3.5.1 (209)
Pardue, William M.	8.1 (27)
Parisi, MaryAnn	3.5.2 (541), 5.4 (410), 12.2 (206), 14.1 (371)
Patten, Jeff	3.5.1 (209), 12.2 (254)
Patten, Vern	3.5.1 (209), 12.2 (254)
Paull, A.	3.3 (1899), 12. (152), 15. (1897)
Paulsen-Yackle, Julie	3.5.1 (209)
Pawlak, John M.	3.3 (141), 3.5.8 (225), 8.3 (227), 12.2 (206)
Pekich, Bob	15. (112)
Penicka, Jaromir M.	3.4.1 (71), 3.5.1 (209), 4.1 (3754), 5.2 (2327), 8.1 (1830), 14.1 (2324)
Perisho, Darrell	3.5.10 (369)
Perkins, Ellen	3.5.10 (369)
Pilisuk, Phyllis E.	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.3 (22), 6.7 (25), 11. (24), 14.1 (371),
Pittman, L. B.	3.5.10 (369)
Polivka, Richard	3.5.1 (209)
Polk, David	3.5.10 (369)
Poteraske, John	3.5.1 (209)
Potersake, S.	3.5.1 (209), 12.2 (206)
Pratt, Paul W.	3.5.1 (209)
Prochut, Dianna	3.5.1 (209)
Puckett, A. B.	3.5.10 (369)
Puckett, Alfred B.	3.5.10 (369)
Puckett, Alfred B.	11.5 (3780)
Ray, Betty	3.5.10 (369), 4.1 (2138), 5.2 (881),

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Individuals	Comment/Response Index Location(s)
Ray, Betty	8.3.1 (2651)
Rees, Dianne	3.5.1 (209)
Reeves, Florence P.	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25)
Rick, Doreen	3.5.1 (209)
Ridenow, Brenda	3.5.1 (209)
Righton, Walter C.	3.5.1 (209), 12. (152), 12.2 (206)
Robbins, Don H.	5.5 (1796), 5.5 (1797), 8.3.1 (1798), 8.3.3 (1793)
Roberts, Mary L.	3.5.10 (369)
Rogers, Les	5.2 (14), 5.2 (16), 5.2 (17), 5.2 (180), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Russell, May	3.5.1 (209)
Salisbury, Diana	3.2.3 (3212), 3.6 (3931), 3.6 (3940), 4.1 (3400), 4.1 (3949), 4.1 (3950), 4.1 (3960), 4.1 (3961), 4.1 (3972), 4.1 (3977), 4.2 (3962), 4.2 (3963), 5.1 (3956), 5.2 (3942), 5.2 (3991), 5.2.1 (3992), 5.2.2 (3393), 5.2.2 (3945), 5.2.2 (3982), 5.2.3 (3993), 5.2.3 (4006), 5.2.4 (4002), 5.8 (3947), 5.9 (3984), 5.9 (3985), 5.11 (3986), 5.11 (3999), 5.12 (3944), 5.12 (3946), 5.12 (3965), 5.12 (3968), 5.12 (3970), 5.12 (4000), 6.3 (22), 6.5 (4005), 6.6 (3948), 6.6 (3981), 6.8 (3955), 8.1 (3746), 8.1 (3934), 8.1.1 (3987), 8.1.1 (3988), 8.1.1 (3989), 8.1.3 (3941), 8.1.3 (3995), 8.3.1 (3954), 8.3.1 (3990), 8.3.1 (4003), 9.3 (3994), 11.3 (4018), 14.1 (4007), 14.4 (3936), 14.4 (3937), 15. (3952)
Salisbury, Diana	5.2 (4004), 11.6 (4001)
Sarnecki, Nancy L.	3.5.1 (209), 12. (152), 12.2 (254)
Sarvey, Robert	3.5.7 (123), 5.2 (14), 5.2 (16), 5.5 (19), 5.5 (100), 5.10 (20), 6.3 (22),
Sasso, Joseph T.	3.5.1 (209)
Schlueter, Timothy	3.5.1 (209)
Schott, Beatrice	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.1.4 (4304), 8.3.1 (4235), 9.3 (3422), 13.1 (4236), 14.2 (1639), 15. (3412), 15. (3426),
Schott, Ernest	3.5.4 (1952), 3.5.4 (3421), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 9.3 (3422), 12. (152), 15. (3412), 15. (3426)
Schroeder, A. E.	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25),

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Individuals	Comment/Response Index Location(s)
Schroeder, A. E.	11. (24)
Schultz, Shirley	3.5.1 (209)
Scott, Doug	3.5.2 (541)
Senauke, Laurie	6.7 (25), 8.3.1 (2651), 11.3 (237)
Seske, Helen	3.5.1 (209)
Seyfert, Debra	3.5.1 (209)
Sharka, Rodney E.	3.5.1 (209)
Shepherd, Thomas	3.5.10 (369)
Silvestri, Laurence A.	3.5.1 (1934)
Simester, Anita	3.5.1 (209)
Simms, Lynn	3.1 (2317), 11.6 (425), 12. (152), 14.1 (2374), 15. (2316)
Simon, Ilyse	3.5.7 (123), 6.7 (25), 8.3.1 (2651), 8.3.2 (2381)
Simon, Ilyse	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 8.3.1 (4235), 9.3 (3422), 11.3 (4020), 12. (152), 15. (3412), 15. (3426), 15. (4277)
Simone, Chris	6.7 (25)
Sitasz, John S.	3.5.1 (209), 5.5 (4574)
Smith, Alan W.	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 9.3 (3422), 15. (3412), 15. (3426)
Smith, Claire	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (4133), 6.6 (4148), 8.1 (3424), 8.3 (3423), 12. (152), 15. (3412), 15. (3426),
Smith, Diane J.	3.5.1 (209)
Smith, William J.	5.2 (17), 5.5 (100), 5.11 (315), 6.7 (25), 15. (314)
Snortum, Beth	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.3 (22), 6.7 (25)
Sobotka, Frank	3.5.1 (209)
Stavropoulos	3.5.1 (209), 12. (152), 12.2 (254)
Stevens, Nancy	3.5.1 (209)
Strong, Susan C.	3.5.7 (123), 6.7 (25), 14.1 (371)
Sulhowski, Maureen	3.5.1 (209)
Sullivan, Robert G.	3.5.1 (209), 11.3 (1864), 12.2 (206)
Swada, Gary	3.5.1 (209)
Swires, Edmund B.	3.5.1 (209)
Syphers, Grant	5.2 (14), 5.2 (16), 5.2 (17), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (49), 6.2 (84), 6.7 (25), 15. (42)
Szela, Beth	3.5.1 (209)
Szila, Michael G.	3.5.1 (209)
Szymanski, Edward J.	3.5.1 (209)

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Individuals	Comment/Response Index Location(s)
Tackett, Elaine	3.5.12 (2715)
Takaro, Tim	3.5.4 (1952), 3.5.4 (3421), 5.11 (4133), 8.1 (3424), 8.3 (3423), 9.3 (3422), 12. (152)
Thomas, Dennis	5.1 (724), 5.2 (14), 5.2 (16), 5.2 (17), 5.2 (727), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24), 14.1 (371)
Thompson, Kevin	3.5.1 (209), 12.2 (206), 14.1 (371)
Thurlow, Andrew J.	3.2.3 (3212), 3.6 (3931), 6.6 (1783), 12. (152)
Tichman, Nadya	3.5.7 (123), 6.7 (25), 8.3.1 (2651), 11.3 (237)
Toms-Trend, Zimya	3.5.4 (1952), 3.5.4 (3421), 5.11 (3173), 5.11 (3411), 5.11 (4133), 6.6 (4148), 6.6 (4324), 8.1 (3424), 8.3.1 (4235), 9.3 (3422), 12. (152), 13.1 (4236), 15. (3412), 15. (3426),
Treacy, Terri	3.5.10 (369), 15. (112)
Tsutsui, Michelle	5.2 (16), 5.2 (17), 5.10 (20), 5.11 (122), 6.7 (25), 11. (24)
Uemura, Ruth	3.5.4 (1952), 3.5.4 (3421), 5.11 (3411), 5.11 (4133), 6.6 (4148), 9.3 (3422), 12. (152), 13.1 (4236), 14.1 (371), 15. (3412),
Uhler, Anne	3.5.1 (209)
Valek, Arlene F.	3.5.1 (209)
Vasvery, Mary L.	3.5.1 (209), 5.2 (2327), 12. (152), 12.2 (254)
Vavruska, Joseph R.	3.5.1 (209)
Viereck, Jennifer	5.2 (14), 5.2 (16), 5.2 (17), 5.5 (19), 5.5 (100), 5.9 (96), 5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.3 (22), 6.7 (25), 11. (24)
Wagner, Carol	3.5.7 (123), 14.1 (371)
Waitley, David W.	3.5.1 (209)
Wall, Kristine	3.5.1 (209)
Wallis, David A.	3.5.1 (209), 12.2 (206)
Wallrich, Paula J.	3.5.1 (209)
Ward, Hilda J.	3.5.10 (369)
Warton, Kathleen	3.5.1 (209)
Weeren, Herman	5.4 (166), 8.1 (164), 8.1 (476), 11.2 (168)
Weidner, Kathleen	3.5.1 (209)
Weiss, Mary	3.5.1 (209)
Wenzel, Frances	3.5.1 (209)
Westart, Mary A.	3.5.1 (209), 12.2 (206)
Weyers, John	3.5.10 (369)
Whayne, Sue	3.5.10 (369)

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Individuals	Comment/Response Index Location(s)
Wheeler, Norma S.	3.5.10 (369)
White, C. E.	15. (274)
Wiggins, Georgia D.	3.5.10 (369)
Wiltjer, Linda	3.5.1 (209), 3.5.1 (2654)
Winn, Judy	3.5.10 (369)
Wyszynski, Paul	3.5.1 (209), 12.2 (206), 15. (112)
Yuan, Lynn C.	3.5.17 (555), 5.1 (543), 5.2 (562), 5.2.2 (544), 5.2.2 (546), 5.2.2 (548), 5.2.2 (549), 5.2.2 (550), 5.2.2 (551), 5.2.2 (553), 5.2.2 (556), 5.2.2 (557), 5.2.2 (558), 5.2.3 (563), 5.2.3 (564), 5.2.3 (565), 5.2.3 (566), 5.2.3 (570), 5.2.4 (568), 5.2.4 (569), 5.2.4 (572)
Zawacki, Edwardine	3.5.8 (109), 15. (112)
Zizek, J.	3.5.1 (209)
Zmrhal, Joan	3.5.1 (209)

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Organizations and Agencies	Comment/Response Index Location(s)
AFL-CIO; Oil, Chemical & Atomic Workers	3.3 (141)
Affiliated Brookhaven Civic Association	3.4.1 (2105), 3.5.2 (400), 3.5.2 (541)
Allstate	3.5.2 (541)
Brookeridge Homeowners Association	3.5.1 (209)
Brookeridge Park District Board of Commissioners	3.5.1 (209)
Brookhaven, NY, Town of; Off. of the Super.	3.2.5 (2860), 3.3 (141), 3.4.2 (520), 3.5.2 (541), 3.5.2 (2813), 3.5.2 (2815), 3.5.2 (2850), 3.5.2 (2856), 3.5.2 (2869), 3.5.2 (2965), 4.1 (2078), 4.1 (2871), 4.1 (2876), 4.1 (2878), 4.1 (2880), 4.1 (2892), 4.1 (2898), 4.1 (2901), 4.1 (2906), 4.1 (2907), 4.1 (2908), 4.1 (2909), 4.1 (2915), 4.1 (2916), 4.1 (2928), 4.1 (2948), 4.1 (2958), 4.2 (2873), 4.2 (2911), 4.2 (4019), 5.2 (2817), 5.2 (2862), 5.2 (2938), 5.2.2 (2800), 5.2.2 (2830), 5.2.2 (2936), 5.3 (2904), 5.3 (2996), 5.4 (2864), 5.4 (2940), 5.4 (2950), 5.4 (2951), 5.4 (2980), 5.4.1 (2935), 5.4.1 (2944), 5.4.1 (2981), 5.4.1 (2983), 5.4.1 (2984), 5.4.2 (2802), 5.4.2 (2946), 5.5 (2954), 5.5 (2956), 5.5 (2987), 5.7 (2819), 5.7 (2895), 5.11 (2820), 5.11 (2829), 6.1 (2930), 8.1 (2807), 8.1.2 (2783), 8.1.3 (2780), 8.3 (2274), 9.3 (2782), 9.3 (2814), 9.3 (2826), 9.3 (3011), 9.3 (3012), 9.3 (3013), 10.1 (2795), 10.1 (2796), 10.1 (2797), 10.2 (2842), 11. (2127), 11.2 (2845), 11.2 (2846), 11.2 (2849), 11.2 (2852), 11.2 (2903), 11.2 (2964), 11.2 (2967), 11.2 (2972), 11.2 (2991), 11.2 (2993)
Bueno Los Alamos Surveillance Team (BLAST)	3.1 (3338), 3.6 (1140), 3.6 (3333), 5.4 (3345), 5.11 (3337), 5.11 (3343), 5.11 (4070), 8.1 (3342), 8.1.2 (4069), 9.1 (3346), 11. (3336), 11. (3341), 11.6 (4068), 12.2 (3334), 14.1 (3340), 14.1 (3347), 14.3 (3339), 14.5 (3344), 15. (4067), 15. (4071)
Burr Ridge, IL, Village of; Board of Trustees	3.5.1 (209), 3.5.1 (1885), 12.2 (254)
CA, State of; EPA, Dept. of Toxic Substances Cntrl	3.4.2 (1665), 10.2 (1999), 10.2 (4058)
CA, State of; Energy Commission	3.4.2 (3243), 3.5.7 (123), 5.2 (3248), 5.2 (3252), 5.2 (3257), 5.11 (1134), 6.6 (3239), 8.1.3 (3254), 9.3 (3247)
CA; Pombo, Richard W.; U.S. Congress	3.5.7 (123), 5.2 (180), 5.4.1 (179), 5.7 (177)
CA; State of; Water Resour. Cntrl. Brd.	10.1 (2297)
Carriage Way West Homeowners Assoc., Inc.	3.5.1 (209)
Citizen Alert Native American Program	3.2.3 (3212), 3.6 (3931), 5.9 (511), 8.2 (1108), 8.3.1 (3990), 11. (4032), 11.3 (4018), 11.3 (4020), 11.3 (4025), 11.3 (4027)
Citizens Against Ruining the Environment	3.5.1 (209)
Citizens Opposing a Polluted Environment	4.3 (2029), 5.2 (14), 5.2 (16), 5.2 (17), 5.2.4 (2031), 5.5 (19), 5.5 (100),

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Organizations and Agencies	Comment/Response Index Location(s)
Citizens Opposing a Polluted Environment	5.10 (20), 5.11 (122), 6.1 (23), 6.1 (49), 6.2 (84), 6.7 (25), 8.3.1 (2026), 8.3.1 (2651), 11. (24), 15. (198)
Clark Cnty, NV, Dept. of Comp. Planning	4.1 (3269), 6.4 (396), 6.6 (3272)
Clipper Exxpress Company	3.5.1 (209)
Clipper Exxpress Company	3.5.1 (209), 12.2 (254)
Coalition for Health Concerns	8.3 (2674), 14.1 (2374), 15. (188)
Coalition for Health Concerns	3.5.10 (369), 3.5.10 (2228), 8.3.1 (2175), 8.3.1 (2651), 15. (2233)
DE, State of; Dept. of Nat. Res. & Env. Cntrl.	3.2.3 (915), 3.3 (141), 3.4.1 (917), 6.7 (25), 6.7 (904), 6.8 (918)
Darien, IL, City of	3.5.1 (209)
Desert Citizens Against Pollution	5.2.2 (3255), 5.2.4 (3258), 6.7 (3249), 8.3.3 (3253), 9.3 (3256), 11.4 (1138)
Diversified Scientific Services, Inc.	6.8 (191)
Downers Grove,IL, Township of;	3.5.1 (209)
DuPage Cnty., IL, Hlth. Dept., Brd. of Hlth.	3.5.1 (209)
Dupage Cnty., IL; Cnty. Brd., Solid Wst. Mng.	3.5.1 (209)
Egan & Associates, P.C.	5.2.3 (3693), 5.2.3 (3695), 5.2.3 (3698), 6.5 (3699), 6.6 (3696), 10.1 (3694),
Energy Communities Alliance	5.2.3 (3304), 5.7 (3299), 6.1 (49), 6.5 (3288), 6.5 (3307), 6.6 (3309), 6.7 (3291), 7. (3293), 8.3.1 (3294), 9.3 (1100), 9.3 (3282), 12. (3297), 12. (3308), 13.1 (3306)
Envirocare of Utah, Inc.	6.8 (191)
Equestrian Estates Homeowners Assoc.	3.5.1 (209)
Fernald Atomic Trades and Labor Council	9.1 (1107)
Fernald Citizens Task Force	3.5.3 (1761)
Friends of Oak Ridge National Laboratory	3.3 (2328), 8.1 (2329), 8.1 (2332), 8.1 (2336), 8.3.1 (2333), 10.1 (2331), 12. (2310), 12. (2334)
Grupe Communities, Inc.	3.4.1 (71), 3.5.7 (123), 5.2 (180), 5.2.1 (67)
HI, State of; Benjamin J. Cayetano, Gov.	3.3 (141)
Hampton Roads, VA, Planning District Comm.	3.4.1 (30), 3.4.1 (31), 6.1 (1819)
Hanford Advisory Board	3.5.4 (3166), 4.3 (3158), 5.11 (3167), 8.3.2 (3161), 11.4 (3169), 13.2 (3170)
Hanford Advisory Board, Hearing	3.2.4 (2256), 3.3 (2258), 3.5.4 (2260), 11.4 (2244), 11.4 (2255)
Hanford Watch, Hearing	3.1 (2306), 3.6 (4045), 5.2 (2290), 5.2 (2293), 5.2 (2300), 5.11 (2296), 6.5 (3139), 8.1 (1652), 8.1.4 (2303), 8.3.2 (2302), 10.1 (2287), 10.1 (2297), 11. (2288), 12.2 (206), 13.1 (2304), 14.8 (490)
Heart of America Northwest	3.5.4 (1952), 3.5.4 (2181), 3.5.4 (3421), 3.5.4 (3715), 3.5.4 (3743), 5.7 (3724), 5.11 (3411), 5.11 (3736), 8.1 (3746), 8.3.1 (3738), 8.3.1 (3745), 9.2 (207), 9.3 (3729),

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Organizations and Agencies	Comment/Response Index Location(s)
Heart of America Northwest	11.4 (3750), 11.4 (3759)
Heart of America Northwest, Hearing	3.4.1 (2193), 3.5.4 (2181), 5.2 (2191), 5.2.3 (2177), 5.7 (2188), 5.11 (3411), 5.11 (4375), 8.1 (2172), 8.2 (1108), 9.3 (3422), 10.2 (2184), 11.3 (2164), 11.3 (2174), 12. (152), 12.2 (4571),
Henderson Community College	3.5.10 (369)
Hinsdale, IL, Village of; Village Board	3.5.1 (209)
Hinswood Community Association	3.5.1 (209)
ID, State of; Oversight Prog., INEL	3.1 (2416), 3.2 (2870), 3.2.1 (2436), 3.2.2 (2867), 3.3 (141), 3.3 (530), 3.4.1 (2417), 3.4.1 (4394), 3.5.5 (2583), 3.5.5 (2881), 3.5.13 (2578), 3.6 (3931), 4.1 (2482), 4.1 (2487), 4.1 (2490), 4.1 (2491), 4.1 (2492), 4.1 (2493), 4.1 (2495), 4.1 (2496), 4.1 (2497), 4.1 (2499), 4.1 (2599), 4.1 (2625), 4.1 (2865), 4.1 (2874), 4.1 (2897), 4.2 (2450), 4.2 (2485), 4.2 (2494), 4.3 (2435), 4.3 (2539), 4.3 (2541), 4.3 (2889), 4.3 (2893), 4.3 (2896), 5.1 (2645), 5.1 (3369), 5.1 (3406), 5.2 (2480), 5.2 (2503), 5.2 (2505), 5.2 (2506), 5.2 (2507), 5.2 (2508), 5.2 (2509), 5.2 (2510), 5.2 (2511), 5.2 (2512), 5.2 (2513), 5.2 (2514), 5.2 (2515), 5.2 (2530), 5.2 (2628), 5.2 (2630), 5.2 (2633), 5.2 (2635), 5.2 (2637), 5.2 (2638), 5.2 (2639), 5.2 (2641), 5.2 (2642), 5.2 (2643), 5.2 (3365), 5.2 (3370), 5.2 (3373), 5.2 (3380), 5.2 (3381), 5.2 (3384), 5.2 (3385), 5.2 (3390), 5.2 (3391), 5.2 (3407), 5.2.1 (2542), 5.2.1 (2617), 5.2.1 (2646), 5.2.1 (3383), 5.2.2 (2447), 5.2.2 (2502), 5.2.2 (2532), 5.2.2 (2533), 5.2.2 (2535), 5.2.2 (2572), 5.2.2 (3367), 5.2.2 (3393), 5.2.3 (2411), 5.2.3 (2648), 5.2.3 (2649), 5.2.3 (2657), 5.2.3 (2660), 5.2.3 (2662), 5.2.3 (2663), 5.2.3 (2667), 5.2.3 (2668), 5.2.3 (2669), 5.2.3 (2670), 5.2.3 (2672), 5.2.3 (2673), 5.2.3 (2675), 5.2.3 (2676), 5.2.3 (2677), 5.2.3 (2679), 5.2.3 (3394), 5.2.4 (2565), 5.2.4 (2566), 5.2.4 (2567), 5.2.4 (2573), 5.2.4 (2608), 5.2.4 (2618), 5.2.4 (2623), 5.2.4 (2647), 5.2.4 (2680), 5.2.4 (2683), 5.2.4 (2685), 5.2.4 (2686), 5.2.4 (3388), 5.2.4 (3389), 5.3 (2451), 5.3 (2454), 5.3 (2455), 5.3 (2456), 5.3 (2457), 5.3 (2458), 5.3 (2459), 5.3 (2460), 5.3 (2465), 5.3 (2468), 5.3 (2469), 5.3 (2470), 5.3 (2471), 5.3 (2481), 5.3 (2483), 5.3 (2484), 5.3 (2501), 5.3 (2516), 5.3 (2517), 5.3 (2518), 5.3 (2519), 5.3 (2520), 5.3 (2521), 5.3 (2523), 5.3 (2531), 5.3 (2536), 5.3 (2538),

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Organizations and Agencies	Comment/Response Index Location(s)
ID, State of; Oversight Prog., INEL	5.3 (2549), 5.3 (2550), 5.3 (2556), 5.3 (2557), 5.3 (2558), 5.3 (2559), 5.3 (2560), 5.3 (2574), 5.3 (2597), 5.4 (2528), 5.4 (2940), 5.4.1 (2449), 5.4.1 (2537), 5.4.1 (2562), 5.4.1 (2564), 5.4.2 (2526), 5.4.2 (2527), 5.6 (2473), 5.6 (2474), 5.6 (2475), 5.6 (2479), 5.6 (2488), 5.6 (2498), 5.7 (2489), 5.7 (2529), 5.7 (2888), 5.8 (2877), 5.11 (2477), 5.11 (2547), 5.11 (2594), 5.11 (2595), 5.11 (2624), 5.11 (2879), 5.12 (2544), 5.12 (3590), 6.5 (2602), 6.6 (2653), 6.6 (2659), 6.6 (3397), 6.7 (2568), 6.8 (191), 7. (2423), 8.1 (1830), 8.1 (2431), 8.1 (2434), 8.1 (2439), 8.1.1 (2421), 8.1.1 (2500), 8.1.2 (2440), 8.1.3 (2441), 8.1.3 (2575), 8.1.3 (2576), 8.1.5 (2587), 8.2 (2422), 8.3 (2274), 8.3.1 (2446), 8.3.1 (2552), 8.3.1 (2555), 8.3.1 (2570), 8.3.1 (2581), 8.3.1 (2589), 8.3.1 (2605), 8.3.1 (2606), 8.3.2 (2540), 8.3.3 (2445), 9.1 (1107), 9.2 (207), 9.2 (2415), 9.3 (2427), 9.3 (2437), 9.3 (2607), 9.3 (2629), 10.1 (2438), 10.1 (2548), 10.1 (2584), 10.1 (2652), 10.2 (1485), 10.2 (2426), 10.2 (4058), 11.2 (2543), 11.2 (2545), 11.2 (2551), 11.2 (2569), 11.2 (2620), 11.2 (2665), 11.2 (2682), 11.2 (2872), 11.2 (3368), 11.2 (3386), 11.2 (3408), 11.2 (3409), 11.2 (3410), 11.3 (2412), 11.3 (2718), 11.4 (2425), 11.4 (2428), 11.4 (2571), 11.4 (2591), 11.4 (3690), 14.3 (2891)
IL, State of; Dept. of Nuclear Safety	3.4.1 (1826), 3.4.2 (520), 3.5.1 (1831), 3.5.1 (1835), 3.5.1 (1838), 4.1 (1829), 8.1 (1830)
IL, State of; Office of the Senate President	3.5.1 (209)
IL; Meyer, Jim; St. Rep., 82nd Dist.	12.2 (254)
Inland Real Estate Investment Corp.	3.5.1 (209)
Island Closeup News Service	12.2 (206)
KY, Commonwealth of; Dept. of Environ. Prot.	3.3 (141), 3.3 (3201), 3.5.10 (3180), 4.1 (3199), 4.2 (3193), 5.3 (3192), 6.8 (2171), 8.1.1 (3189), 9.2 (3183), 9.3 (3185), 10.2 (3195),
Kingery East Citizens Advisory Committee	3.5.1 (209)
Kingery East Community Association	3.5.1 (2760), 6.1 (23), 8.3.3 (2759)
Kwanitewk NATIVE Resource/Network	3.2.3 (3212), 3.2.3 (3609), 3.2.3 (3620), 3.2.3 (3633), 3.5.4 (1952), 3.6 (3599), 4.3 (3603), 5.1 (3618), 5.1 (3650), 5.2 (3574), 5.2 (3577), 5.2 (3584), 5.2 (3596), 5.2 (3635), 5.2 (3636), 5.2 (3637), 5.2 (3639), 5.2 (3642), 5.2 (3645), 5.2 (3646), 5.2 (3647), 5.2 (3648), 5.2 (3649), 5.2.2 (3644), 5.2.3 (3566), 5.2.3 (3578), 5.2.3 (3579), 5.2.3 (3595), 5.2.3 (3612), 5.2.3 (3634), 5.2.3 (3666),

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Organizations and Agencies	Comment/Response Index Location(s)
Kwanitewk NATIVE Resource/Network	5.2.3 (3668), 5.2.3 (3669), 5.2.3 (3670), 5.2.3 (3671), 5.2.3 (3673), 5.2.3 (3675), 5.2.4 (3674), 5.4 (3593), 5.9 (511), 5.11 (3571), 5.11 (3573), 5.11 (3575), 5.11 (3691), 5.12 (3567), 5.12 (3576), 5.12 (3582), 5.12 (3585), 5.12 (3586), 5.12 (3587), 5.12 (3588), 5.12 (3590), 5.12 (3591), 5.12 (3592), 5.12 (3594), 5.12 (3662), 6.3 (22), 6.5 (3619), 6.6 (3613), 6.6 (3615), 6.6 (3616), 6.6 (3667), 6.6 (3672), 6.6 (3676), 7. (3658), 8.1.3 (3597), 8.1.3 (3598), 8.1.3 (3601), 8.1.3 (3602), 8.1.3 (3605), 8.1.3 (3606), 8.1.3 (3608), 8.1.3 (3614), 8.1.3 (3622), 8.1.3 (3623), 8.1.3 (3624), 8.1.3 (3625), 8.1.3 (3632), 8.1.3 (3995), 8.1.4 (3692), 8.3.1 (3611), 8.3.1 (3640), 9.1 (3652), 9.2 (3656), 9.3 (3655), 11. (3661), 11. (3677), 11.1 (3654), 11.2 (3610), 11.2 (3638), 11.2 (3641), 11.3 (3617), 11.3 (3689), 11.4 (3680), 11.4 (3690), 13.2 (3659), 15. (3664), 15. (3678), 15. (4034)
Kwanitewk NATIVE Resource/Network	5.9 (511), 5.11 (4400), 8.2 (1108), 8.3.1 (3990), 9.2 (207), 9.2 (4458), 11. (4032), 11. (4410), 11.1 (4408), 11.3 (4018), 11.4 (3925), 11.4 (4403), 11.4 (4407), 12. (4412), 15. (4402),
Laywood Alliance	3.3 (141), 3.5.2 (541)
League of Women Voters of Washington, Hearing	6.4 (396), 9.1 (2250), 14.1 (4007), 14.2 (1639), 15. (2251)
Lemont Township	3.5.1 (209), 4.3 (1177), 5.2 (384), 14.4 (1176)
Lemont, IL, Village of	3.5.1 (209)
Lemont, IL, Village of; Off. of the Mayor	3.4.1 (71), 3.5.1 (209)
MD, State of; Dept. of the Environ., WM Admin.	13.1 (552), 13.2 (554)
Manorville Taxpayers Association, Inc.	3.3 (141)
Mastic Acres Civic Assoc.	3.5.2 (541)
Military Production Network	3.6 (1140), 5.11 (1134), 10.1 (1146), 11.1 (4421), 11.4 (1138), 14.8 (490)
NC, State of; Wildlife Resources Commission	3.1 (1147), 3.3 (141), 3.5.4 (1148)
NJ, State of; Dept. of Environ. Protection	5.11 (1360), 5.11 (1361), 8.1.2 (1358)
NM, State of; Environment Department	3.1 (3552), 3.3 (3556), 3.3 (3557), 3.3 (3559), 3.3 (3958), 9.3 (3282), 11.2 (3550), 11.4 (3553)
NTS Community Advisory Board	6.4 (396), 6.6 (2309), 11.4 (2301), 12. (2310), 13.2 (2305), 14.2 (1639)
NV, Risk Assessment/Management Prog.	3.2.2 (1672), 6.6 (1670), 8.3.3 (1674), 9.3 (1664), 10.1 (1673), 11.4 (1662), 11.4 (1667), 12. (152), 13.1 (1668)
NV, State of; Dept. of Admin.	3.3 (141), 3.5.8 (1803), 5.2.3 (1807), 5.11 (1811), 6.3 (22), 6.4 (396), 8.2 (1108), 10.1 (1816), 10.2 (1817), 10.2 (1999), 15. (1818),

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Organizations and Agencies	Comment/Response Index Location(s)
NY, State of; Dept. of Env. Consv.	3.5.2 (541), 4.2 (4017), 4.2 (4019), 5.11 (4021), 8.1 (4015)
NY; Forbes, Michael P.; U.S. Congress	3.3 (141), 3.5.2 (541)
National Assn. of Atomic Veterans	3.2.3 (3212), 3.6 (3931), 5.9 (511), 8.1.4 (3929), 8.2 (1108), 8.3.1 (3990), 9.3 (3930), 11. (4032), 11.3 (4018), 11.4 (3925)
National Congress of American Indians	5.9 (511), 5.9 (4014), 5.12 (4008), 5.12 (4010), 6.3 (22), 10.3 (4009)
Nye Cnty., NV, Nuclear Waste Repository Proj. Off	3.5.8 (3311), 5.2 (3287), 5.2.3 (3304), 5.8 (3301), 5.8 (3302), 5.12 (3295), 6.4 (396), 6.5 (3288), 6.5 (3307), 6.6 (3309), 6.7 (3291), 9.3 (1100), 9.3 (3282), 11.2 (3285), 12. (3308), 13.1 (3861)
OH, State of; EPA	3.2.1 (3017), 4.1 (3003), 4.1 (3008), 4.1 (3038), 4.2 (3005), 4.2 (3007), 5.1 (3060), 5.2 (3016), 5.2.2 (3018), 6.8 (191), 9.3 (3019), 11.2 (3015)
OR, State of; Dept. of Energy	3.5.4 (3166), 6.4 (396), 8.3.3 (389), 10.1 (392), 10.1 (2297), 11.4 (2318), 14.1 (379), 14.6 (386)
OR, State of; Dept. of Energy	3.5.4 (1952), 3.5.4 (3166), 4.1 (3196), 4.1 (3200), 4.1 (3204), 4.2 (3194), 4.2 (3197), 4.2 (3225), 5.2 (3229), 5.2 (3231), 5.2.2 (3182), 5.2.2 (3235), 5.2.2 (3246), 5.2.3 (3126), 5.2.3 (3128), 5.2.3 (3206), 5.2.3 (3208), 5.2.3 (3210), 5.2.3 (3215), 5.5 (3177), 5.7 (3242), 5.8 (3238), 5.9 (511), 5.9 (3226), 5.9 (3230), 5.11 (1134), 5.11 (3173), 6.6 (3209), 6.6 (3217), 6.6 (3221), 7. (2270), 7. (3203), 9.2 (3183), 9.3 (3244), 10.1 (3187), 11. (4410), 11.4 (2318), 11.4 (3174), 12. (152), 12.1 (3172), 12.2 (3186),
OR, State of; Dept. of Energy, Hearing	3.3 (141), 3.4.2 (2240), 3.5.4 (2238), 4.1 (3196), 5.2.3 (2230), 5.9 (511), 5.11 (3411), 5.12 (2236), 10.1 (392), 11. (1113), 11.4 (2244), 11.4 (2245), 11.4 (2318), 12.2 (365), 14.1 (379), 14.6 (386), 15. (2226)
ORR Local Oversight Comm., Inc.	3.4.1 (2949), 3.5.9 (1871), 5.1 (2914), 5.1 (2929), 5.2 (2900), 5.2 (2921), 5.2 (2924), 5.2.2 (2941), 5.2.2 (2947), 5.11 (2595), 6.5 (2927), 6.5 (2931), 6.5 (2939), 8.1 (2905), 8.1 (2910), 8.1 (2937), 8.1.1 (2953), 8.1.3 (2957), 8.2 (1108), 8.3 (2926), 8.3.3 (2913), 9.3 (3282), 10.1 (2297), 10.1 (2923), 11.2 (2919), 11.4 (133), 12. (152), 13.1 (2966), 13.1 (2974), 13.1 (2975), 13.1 (2985), 13.1 (2992), 13.2 (2969), 13.2 (2971), 13.2 (2990), 13.2 (2995), 15. (2989)
Phoenix Environmental Corporation	11.4 (133)
Physicians for Social Responsibility, Hearing	7. (2270), 8.1 (2269), 8.2 (2267),

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Physicians for Social Responsibility, Hearing	8.3 (2274), 8.3.1 (2272), 11.3 (2261), 11.3 (2263), 11.4 (2264)
Reg. Assoc. of Concerned Environmentalists	2. (3352), 3.1 (3349), 3.1 (3350), 3.1 (3351), 3.5.10 (369), 4.1 (2138), 4.1 (3374), 4.1 (3375), 4.1 (3379), 4.1 (3398), 4.1 (3399), 4.1 (3400), 4.1 (3404), 4.2 (3403), 5.2 (3357), 5.2 (3362), 5.2 (3363), 5.2 (3377), 5.4.2 (3364), 5.5 (3366), 5.11 (3353), 5.11 (3354), 5.11 (3355), 5.11 (3356), 5.11 (3376), 6.3 (3371), 6.6 (3402), 9.1 (3359), 9.2 (207), 11.2 (2), 11.4 (1138),
Rocky Flats Citizens Advisory Board	3.1 (3268), 3.2.3 (3212), 3.5.13 (3260), 3.5.13 (3267), 4.1 (3265), 8.1 (3262), 8.3 (3270), 8.3.2 (3271), 9.3 (3282), 11.2 (2), 11.4 (3276), 12. (152)
Rocky Mountain Peace Center	3.2.3 (3212), 3.5.13 (3218), 3.6 (3214), 6.5 (3227), 8.1 (3262), 8.1.3 (1758), 8.3 (3222), 11. (3228), 14.2 (1639), 14.2 (1784),
SC, State of; Off. of the Gov.; Grant Services	3.1 (542)
SRS Citizens Advisory Board	3.2.3 (2385), 3.2.3 (2405), 3.2.4 (2407), 4.1 (2387), 5.2 (2386), 5.2 (2388), 5.2 (2398), 5.2 (2400), 5.2.2 (2393), 5.11 (1134), 5.11 (2391), 5.12 (2384), 6.7 (2390), 8.1 (2392), 8.1.4 (2406), 8.1.5 (2404), 11.2 (2), 11.2 (2410), 11.3 (2403), 11.3 (2409), 12. (2402)
Save Our World	3.5.2 (541), 15. (188)
Sawmill Creek Homeowners Association	3.5.1 (209)
Southwest Research and Information Center	3.2.3 (3146), 3.2.3 (3148), 3.2.3 (3150), 4.1 (3153), 5.2.1 (3151), 5.2.2 (3147), 5.11 (1134), 5.11 (3143), 5.11 (3154), 5.11 (3155), 5.11 (3548), 8.1.4 (3145), 8.3.1 (3149), 10.1 (3152), 11.1 (4421)
Southwest Riverview Homeowners Civic Assoc.	3.5.1 (209), 12.2 (254)
Southwest Riverview Homeowners Civic Assoc.	3.5.1 (209)
Stone Environmental Engineering Services, Inc.	6.8 (191)
Suffolk Cnty., NY; Water Authority	3.3 (141), 3.5.2 (541)
Suffolk Cnty., NY; Off. of the Cnty. Legislature	3.4.1 (71), 3.5.2 (541), 4.1 (2078), 5.3 (579), 5.4.1 (577), 5.11 (122), 12.2 (254),
TN; State of; Dept. of Environ. & Conservation	3.4.2 (1744), 3.5.9 (1693), 3.5.9 (1697), 3.5.9 (1871), 4.1 (1718), 4.1 (1726), 4.1 (1729), 4.2 (1710), 4.2 (1724), 5.2 (1735), 5.2.1 (1702), 5.2.2 (1675), 5.2.2 (1678), 5.2.2 (1680), 5.2.2 (1681), 5.2.2 (1706), 5.2.2 (1733), 5.2.2 (1736), 5.2.2 (1738), 5.3 (1720), 5.3 (1745), 5.3 (1750), 5.4 (2940), 5.4.1 (1746), 5.6 (1722), 5.11 (1361), 5.11 (1737), 5.11 (1751), 5.11 (1874), 5.12 (1714), 6.8 (191), 8.1.1 (1688), 8.1.2 (1747), 8.1.3 (1748), 8.1.5 (1749), 8.3 (1743), 10.2 (1999), 11.2 (1687),

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Organizations and Agencies	Comment/Response Index Location(s)
TN; State of; Dept. of Environ. & Conservation	11.2 (1716), 11.4 (1690)
TN; State of; Don Sunquist, Gov.	3.5.9 (1871), 5.2.2 (1675), 5.11 (1874)
TX, State of; Office of the Governor	3.5.11 (3236)
Tartan Ridge of Burr Ridge Community Assoc.	3.5.1 (209)
The Lake-in-the-Woods, CAM	3.5.1 (209)
The Woodlands of Darien Condominium Assoc.	3.5.1 (209)
Tracy, CA, City of; City Manager's Office	3.5.7 (123), 5.4.1 (179), 6.6 (344)
U.S. Dept. of Hlth & Human Serv., Pub. Hlth. Serv.	5.2 (892)
U.S. EPA, Office of Federal Activities	3.2.5 (2034), 3.2.5 (2036), 3.2.5 (2039), 3.2.5 (2040), 3.4.1 (1986), 3.5.2 (2090), 5.1 (2056), 5.2 (2072), 5.2.1 (1985), 5.2.2 (3393), 5.4.1 (2064), 5.4.2 (2085), 5.5 (2077), 5.11 (2082), 5.12 (3594), 6.5 (2032), 6.7 (25), 8.1 (2079), 8.1.1 (2002), 8.1.1 (2003), 8.1.5 (2038), 8.3.1 (2011), 8.3.1 (2014), 8.3.1 (2016), 10.1 (2061), 10.1 (2063), 10.2 (1999), 11.2 (2055)
U.S. EPA, Region X	3.4.1 (2847), 5.2 (2816), 5.2 (2827), 5.2 (2831), 5.2 (2833), 5.2 (2834), 5.2 (2836), 5.2 (2838), 5.2.2 (2835), 5.2.2 (3393), 5.3 (2818), 5.3 (2844), 5.5 (2851), 5.5 (2853), 5.7 (2812), 6.5 (2821), 6.8 (191), 8.1 (2823), 8.1.5 (2855), 8.3.1 (2848), 9.3 (2809), 11.2 (1716), 11.2 (2840), 14.3 (2825)
VA, Commonwealth of; Dept. of Environ. Qlty.	3.3 (141), 5.3 (1824), 5.4 (1822), 6.1 (1819), 10.1 (1821)
W. Shoshone Nat. Council, Nuc. Waste Prog.	10.3 (1643), 10.3 (3315)
WA, State of: Dept. of Fish and Wildlife	4.1 (3041), 4.1 (3043), 4.1 (3048), 4.1 (3053), 4.1 (3077), 4.1 (3544), 5.5 (2954), 5.5 (3095), 5.5 (3564), 5.7 (3085), 5.7 (3554), 5.11 (3093), 5.11 (3411), 5.11 (3548), 11.2 (3057),
WA, State of; Dept. of Ecology	1. (3036), 3.5.4 (3088), 4.1 (1554), 4.1 (3038), 4.1 (3040), 4.1 (3041), 4.1 (3043), 4.1 (3046), 4.1 (3047), 4.1 (3048), 4.1 (3052), 4.1 (3053), 4.1 (3072), 4.1 (3077), 4.1 (3115), 4.1 (3116), 4.1 (3117), 4.1 (3120), 4.1 (3544), 4.2 (3039), 4.2 (3050), 5.1 (3027), 5.1 (3033), 5.1 (3060), 5.1 (3102), 5.1 (3108), 5.1 (3650), 5.2 (3026), 5.2 (3029), 5.2 (3073), 5.2.2 (3068), 5.2.2 (3080), 5.2.3 (3110), 5.2.3 (3121), 5.2.3 (3122), 5.2.3 (3125), 5.2.3 (3126), 5.2.3 (3128), 5.2.3 (3130), 5.2.3 (3131), 5.2.3 (3140), 5.2.4 (3081), 5.3 (3025), 5.3 (3061), 5.3 (3103), 5.3 (3104), 5.4 (3106), 5.4 (3107), 5.4 (3109), 5.4.1 (3075), 5.4.1 (3084), 5.5 (2954), 5.5 (3069), 5.5 (3112), 5.5 (3366), 5.6 (3113), 5.7 (3067), 5.7 (3071), 5.7 (3085), 5.7 (3554),

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WA, State of; Dept. of Health	5.3 (1775), 10.1 (2297), 11. (1773), 13.1 (1772)
Western States Legal Foundation/Tri-Valley CAREs	3.1 (4053), 3.5.7 (123), 3.5.7 (4048), 3.5.7 (4062), 3.6 (4045), 5.2 (4033), 5.2 (4039), 5.7 (4061), 6.7 (25), 8.1 (4038), 8.1 (4044), 8.1 (4046), 8.1 (4065), 9.2 (4047), 9.3 (3247), 9.3 (3282), 10.2 (4058), 11. (4052), 11.3 (1527), 11.4 (1138), 11.4 (4028), 11.4 (4037), 11.4 (4051), 12. (4054), 14.1 (4035), 14.1 (4036), 15. (4030), 15. (4034)
Women's Internat. League for Peace and Freedom	14.3 (1577)

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Argonne, IL, 1/24/96	3.3 (141), 3.4.1 (71), 3.4.1 (3782), 3.4.2 (520), 3.4.2 (3921), 3.5.1 (209), 3.5.1 (1833), 3.5.1 (3752), 3.5.1 (3915), 4.1 (3727), 4.1 (3754), 4.1 (3763), 4.1 (3910), 4.2 (3757), 4.2 (3781), 4.2 (3787), 4.2 (3859), 4.2 (3876), 4.2 (3913), 5. (3785), 5.1 (3804), 5.2 (3755), 5.2 (3758), 5.2 (3776), 5.2 (3802), 5.2 (3880), 5.2 (3881), 5.2 (3884), 5.2 (3902), 5.2 (3905), 5.2 (3906), 5.2.2 (3783), 5.2.4 (3779), 5.2.4 (3909), 5.3 (3857), 6.1 (49), 6.1 (3711), 6.1 (3897), 6.1 (3919), 6.2 (3716), 6.3 (22), 6.6 (3872), 6.7 (2568), 8.1 (1830), 8.1 (3740), 8.1.1 (3761), 8.1.2 (3796), 8.1.3 (3808), 8.1.3 (3923), 8.3 (2274), 8.3.1 (3773), 8.3.1 (3775), 8.3.1 (3912), 8.3.3 (3741), 8.3.3 (3742), 8.3.3 (3771), 9.1 (3807), 9.1 (3856), 9.2 (3717), 10.1 (3784), 11. (2222), 11.2 (3767), 11.2 (3822), 11.2 (3875), 11.2 (3917), 11.3 (3766), 11.5 (3780), 12. (3886), 12.2 (3774), 12.2 (3797), 12.2 (3914), 13.1 (3786), 13.1 (3799), 13.1 (3861), 13.1 (3901), 13.1 (3922), 13.2 (3770), 13.2 (3794), 13.2 (3795), 13.2 (3801), 13.2 (3805), 13.2 (3908), 13.3 (3789), 13.3 (3792), 14.1 (4007), 14.2 (3850), 14.2 (3854), 14.2 (3862), 14.2 (3900), 14.6 (3800), 15. (3888)
Argonne, IL, 10/26/95	3.1 (391), 3.3 (141), 3.4.2 (520), 3.5.1 (209), 3.5.1 (458), 3.5.1 (465), 3.5.1 (471), 5.2 (384), 6.3 (22), 6.7 (25), 8.1 (1830), 8.3.1 (467), 12. (152), 12.2 (206), 13.2 (466), 14.8 (490)
Arvada, CO	3.1 (1762), 3.3 (141), 3.3 (1760), 3.5.8 (1759), 3.5.13 (1764), 3.5.13 (1778), 3.5.13 (3218), 4.2 (1707), 4.2 (1780), 4.3 (1731), 5.2 (1728), 5.2 (1752), 5.2.1 (1723), 5.2.2 (1713), 5.2.2 (1753), 5.4.1 (1727), 6.7 (25), 8.1 (1652), 8.1.3 (1758), 8.3 (1725), 8.3 (1769), 8.3 (1774), 8.3 (1788), 8.3.1 (1523), 8.3.1 (1694), 8.3.1 (1721), 8.3.1 (2651), 8.3.2 (1782), 8.3.3 (1730), 8.3.3 (1754), 9.1 (2146), 9.3 (1689), 9.3 (1696), 11. (531), 11.2 (1719), 11.3 (1755), 12. (152), 12. (2310), 12.2 (206), 12.2 (254), 12.2 (1484), 13.3 (1756), 14.2 (1784), 14.2 (1791), 14.2 (1794), 15. (1692), 15. (1695)
Brookhaven, NY	3.1 (2113), 3.2.2 (2048), 3.3 (141), 3.4.1 (71), 3.4.1 (2105), 3.5.2 (541), 3.5.2 (2109), 3.5.17 (4444), 4.1 (2078), 4.1 (2909), 4.2 (2102),

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Fernald, OH	3.4.2 (520), 8.1 (1087), 8.1 (1105), 8.1.2 (1089), 8.2 (1108), 8.3.1 (1117), 9.1 (1107), 9.3 (1100), 11. (1113), 11. (1114), 11.3 (1109), 11.3 (1112), 11.3 (1116), 11.4 (133), 11.4 (1103), 12.2 (206), 13.2 (1115)
Idaho and Boise, ID	3.3 (141), 3.3 (530), 3.4.1 (528), 3.5.5 (537), 5.7 (523), 5.9 (511), 5.9 (532), 6.2 (534), 6.8 (191), 8.3.1 (525), 9.3 (517), 11. (531), 11.2 (2), 11.2 (519), 11.3 (398), 11.4 (509), 12.2 (1484), 13.2 (536), 13.2 (538),
Las Vegas, NV	3.1 (1570), 3.1 (1638), 3.4.1 (1650), 3.5.8 (225), 3.5.8 (1588), 3.5.8 (1627), 3.6 (1621), 3.6 (1636), 4.1 (1644), 4.2 (1626), 5.2 (1613), 5.2.1 (1583), 5.9 (511), 5.9 (532), 6.6 (1607), 6.6 (1618), 6.6 (1624), 6.6 (1629), 6.6 (1645), 6.6 (1647), 6.6 (1651), 6.6 (1670), 6.6 (3272), 6.7 (25), 6.7 (1608), 8.1 (1584), 8.1 (1652), 8.3.2 (1646), 9.2 (207), 10.3 (1643), 11.4 (133), 11.4 (1611), 11.4 (1614), 11.6 (1632), 11.6 (1648), 12. (152), 12.2 (254), 12.2 (1576), 12.2 (4568), 13.1 (1605), 13.1 (1633), 13.1 (1634), 13.2 (1578), 13.2 (1630), 14.1 (371), 14.1 (1620), 14.1 (1623), 14.2 (1639), 14.4 (1568), 14.5 (1649), 14.6 (1615), 14.7 (1640), 15. (1641)
Oak Ridge, TN	3.4.2 (520), 5. (499), 5.2 (494), 5.2.1 (493), 5.2.2 (478), 5.2.2 (498), 5.3 (512), 5.4.2 (474), 5.11 (1361), 6.5 (505), 6.5 (3139), 6.7 (25), 6.8 (191), 8.1 (476), 8.1 (2910), 8.1.2 (495), 8.2 (1108), 8.3.1 (507), 8.3.1 (514), 8.3.3 (506), 9.2 (207), 9.3 (488), 11.2 (3550), 11.4 (489), 11.4 (508), 14.7 (522), 14.8 (490),
Paducah, KY, and Portsmouth, OH	3.1 (1147), 3.1 (2148), 3.4.2 (520), 3.5.10 (369), 3.5.10 (2180), 3.5.12 (2076), 3.5.12 (2093), 4.1 (2130), 4.1 (2138), 4.1 (2216), 4.2 (2101), 4.2 (2145), 4.2 (2192), 4.2 (2212), 5.1 (2197), 5.2 (1752), 5.2 (2135), 5.2 (2161), 5.2 (2163), 5.2 (2168), 5.2 (3377), 5.2.1 (2137), 5.2.2 (2106), 5.4.2 (2202), 5.5 (2199), 5.6 (2086), 5.11 (2194), 6.2 (2084), 6.7 (25), 6.8 (2171), 8.1 (2154), 8.1 (2155), 8.1.1 (2074), 8.1.2 (2080),

Hearings	Comment/Response Index Location(s)
Paducah, KY, and Portsmouth, OH	8.1.3 (2071), 8.3.1 (2110), 8.3.1 (2175), 8.3.1 (2651), 9.1 (2096), 9.1 (2146), 9.3 (2190), 11. (531), 11. (2222), 11.4 (2189), 11.5 (2157), 11.6 (2160), 12. (2187), 12. (2310), 12.2 (206), 12.2 (254), 13.3 (1756), 13.3 (2208), 14.1 (2374), 14.1 (4007), 14.2 (2114), 15. (188), 15. (2097), 15. (2126), 15. (2128), 15. (2158), 15. (2165),
Pendleton/Portland, OR; Lacey/Pasco/Seattle, WA	3.1 (2306), 3.1 (2317), 3.2.4 (2256), 3.3 (141), 3.3 (2258), 3.4.1 (2193), 3.4.2 (2240), 3.5.4 (2181), 3.5.4 (2238), 3.5.4 (2260), 3.6 (2215), 3.6 (4045), 4.1 (3196), 4.3 (2201), 5.2 (2191), 5.2 (2290), 5.2 (2293), 5.2 (2300), 5.2 (2315), 5.2.1 (2307), 5.2.3 (2177), 5.2.3 (2196), 5.2.3 (2230), 5.2.3 (2313), 5.2.4 (2203), 5.5 (2077), 5.7 (2188), 5.7 (2319), 5.9 (511), 5.11 (2296), 5.11 (3411), 5.11 (4375), 5.12 (2236), 6.1 (2314), 6.4 (396), 6.5 (3139), 6.8 (2195), 7. (2270), 8.1 (1652), 8.1 (2172), 8.1 (2269), 8.1.2 (2200), 8.1.4 (2198), 8.1.4 (2303), 8.2 (1108), 8.2 (2267), 8.3 (2274), 8.3.1 (2272), 8.3.2 (2214), 8.3.2 (2302), 9.1 (2250), 9.3 (3422), 10.1 (392), 10.1 (2287), 10.1 (2297), 10.2 (2184), 11. (1113), 11. (2206), 11. (2288), 11.3 (2164), 11.3 (2174), 11.3 (2261), 11.3 (2263), 11.4 (2244), 11.4 (2245), 11.4 (2255), 11.4 (2264), 11.4 (2318), 12. (152), 12.2 (206), 12.2 (254), 12.2 (363), 12.2 (365), 12.2 (1484), 12.2 (2217), 12.2 (2218), 12.2 (4571), 13.1 (2304), 14.1 (379), 14.1 (4007), 14.2 (1639), 14.6 (386), 14.7 (2311), 14.8 (490), 15. (2226), 15. (2251), 15. (2316)
Santa Fe, NM	3.2.3 (1564), 3.3 (141), 3.5.6 (1488), 3.5.6 (1490), 3.5.6 (1566), 3.6 (1140), 3.6 (1513), 4.2 (1574), 4.3 (1560), 5.2 (17), 5.2.1 (1486), 5.2.4 (1550), 5.3 (1553), 5.4 (1323), 5.4.2 (3364), 5.5 (1559), 5.6 (1510), 5.9 (1561), 5.12 (1504), 5.12 (1506), 5.12 (1508), 5.12 (1528), 6.3 (22), 6.7 (25), 8.3.1 (1523), 8.3.3 (1565), 9.2 (207), 10.2 (4058), 12. (152), 12. (4054), 12.2 (1484), 12.2 (1567), 13.1 (1525), 13.1 (1541), 13.1 (1542), 13.1 (1545), 13.1 (1547), 14.2 (1515), 14.2 (1516), 14.3 (1577), 14.5 (1511)
Tracy, CA	3.3 (141), 3.4.1 (71), 3.5.7 (123), 3.5.7 (1597), 3.5.7 (1603), 3.5.8 (1551), 4.1 (1554), 4.2 (1558), 4.2 (1604), 5.2 (180), 5.2 (1505), 5.2 (1514), 5.4.1 (179), 5.4.1 (1556), 5.4.2 (1598), 5.10 (20), 5.11 (1520), 6.3 (22), 6.6 (1487), 6.7 (25), 8.1 (1530), 8.1 (1652), 8.1 (2154), 8.1.2 (1498), 8.1.5 (255), 8.3.2 (1540),

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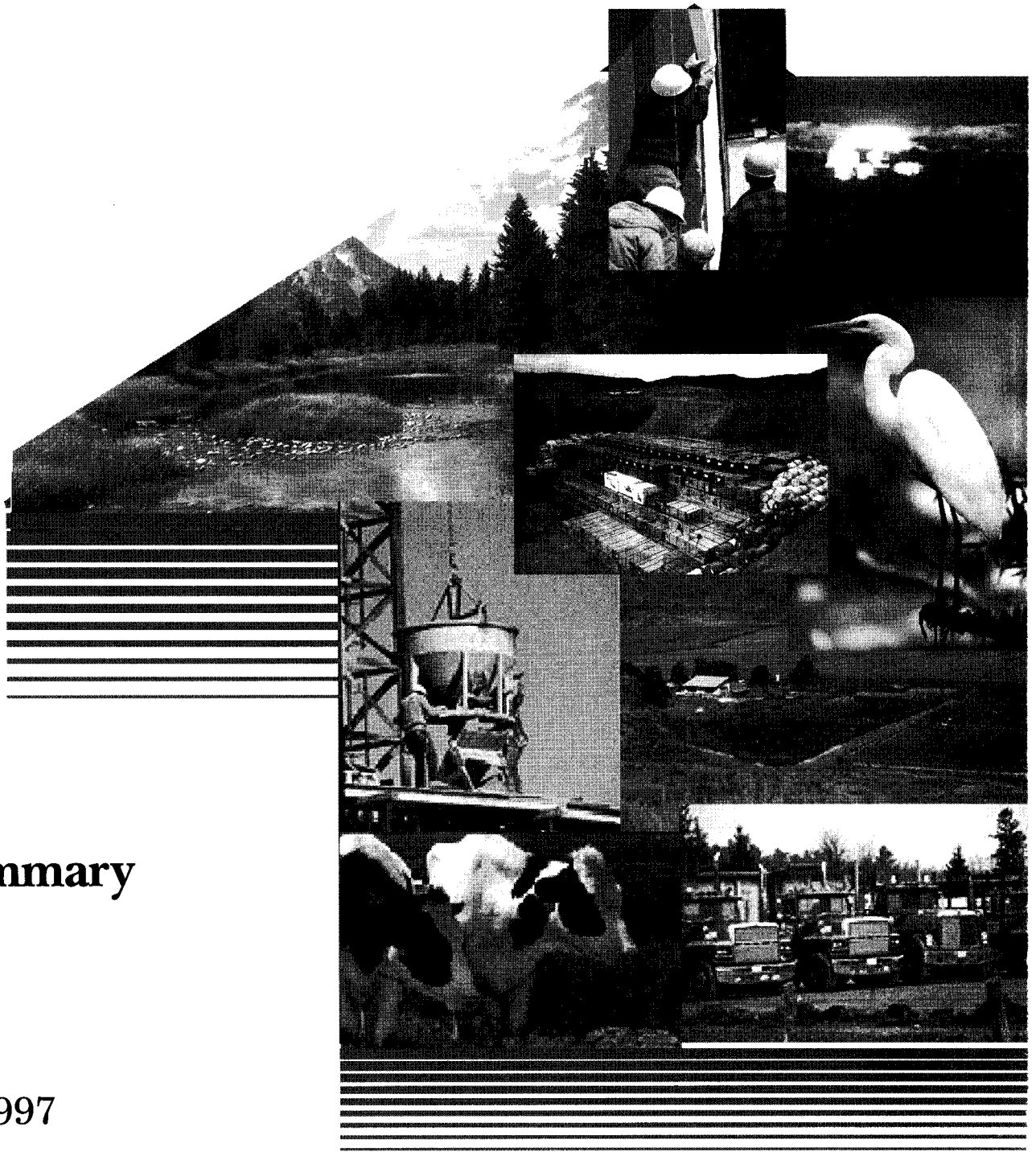
U.S. Department of Energy
Office of Environmental Management

ENTERED

Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

DOE/EIS-0200-F



Summary

May 1997

Department of Energy

Washington, DC 20585

May 1997

Dear Citizen:

This is a summary of the *Final Waste Management Programmatic Environmental Impact Statement.* The Department of Energy has prepared the final environmental impact statement in accordance with the National Environmental Policy Act, to evaluate management and siting alternatives for the treatment, storage and disposal of five types of radioactive and hazardous wastes. These waste types are: low-level radioactive waste; low-level mixed (with hazardous components) waste; transuranic waste; high-level radioactive waste; and hazardous waste. The alternatives were evaluated for waste stored, buried or to be generated from future operations over the next 20 years at 54 sites.

The study is contained in 5 volumes. Volume 1, the main body of the document, contains the analyses for each waste type and the potential health, environmental and cumulative impacts of the 36 waste management program alternatives that were considered. Volume 2 contains the detailed data for each of the Department's sites included in the study. Volumes 3 and 4 contain the supporting appendices. Volume 5 contains an indexed summary of the comments received during the 5-month public comment period on the draft environmental impact statement, along with the Department's responses to those comments.

A complete copy of the final environmental impact statement is available in public reading rooms which are located across the U.S. A list of the reading rooms, copies of this summary, the full 5-volume document, or its supporting technical reports can be obtained on request from the following address or telephone number. Information is also available on our Internet home page at http://www.em.doe.gov.

Center for Environmental Management Information
P.O. Box 23769
Washington, D.C. 20026-3769
1-800-736-3282 (in Washington, D.C.: 202-863-5084)

The Department of Energy will issue Records of Decision for each of the five waste types in a phased manner, commencing no sooner than 30 days after publication of the final environmental impact statement. While some waste treatment and storage decisions may be made soon, the Department intends to consult further with stakeholders before identifying low-level and mixed waste disposal site preferences. We will publicly announce these disposal site preferences at least 30 days prior to making disposal decisions.

Sincerely,

Alvin L. Alm
Assistant Secretary for
Environmental Management

Printed with soy ink on recycled paper

U.S. Department of Energy
Office of Environmental Management

Summary

Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

DOE/EIS-0200-F

SUMMARY

May 1997

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Acronyms and Abbreviations

AEA	Atomic Energy Act
Ames	Ames Laboratory
Am-241	americium-241
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
BCL	Battelle Columbus Laboratory
Bettis	Bettis Atomic Power Laboratory
BNL	Brookhaven National Laboratory
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH	contact-handled
Charleston	Charleston Naval Shipyard
CO	carbon monoxide
Colonie	Colonie Interim Storage Site
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ETEC	Energy Technology Engineering Center
FEMP	Fernald Environmental Management Project
Fermi	Fermi National Accelerator Laboratory
FFCAct	Federal Facility Compliance Act
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	fiscal year
GA	General Atomics
GE	General Electric Vallecitos Nuclear Center
GJPO	Grand Junction Projects Office
GTCC	greater-than-Class-C
Hanford	Hanford Site
HLW	high-level waste
HW	hazardous waste
INEL	Idaho National Engineering Laboratory
ITRI	Inhalation Toxicology Research Institute

K-25	Oak Ridge K-25 Site
KAPL	Knolls Atomic Power Laboratory
KAPL-K	Knolls Atomic Power Laboratory (Kesselring)
KAPL-N	Knolls Atomic Power Laboratory (Niskayuna)
KAPL-W	Knolls Atomic Power Laboratory (Windsor)
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
lb	pound
LBL	Lawrence Berkeley Laboratory
LDRs	land disposal restrictions
LEHR	Laboratory for Energy-Related Health Research
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
m^3	cubic meters
Mare Is	Mare Island Naval Shipyard
MEI	maximally exposed individual
Middlesex	Middlesex Sampling Plant
Mound	Mound Plant
mrem	millirem
nCi/g	nanocuries per gram
NEPA	National Environmental Policy Act
NO_2	nitrogen dioxide
Norfolk	Norfolk Naval Shipyard
NRF	Naval Reactors Facility
NTS	Nevada Test Site
O&M	operations and maintenance
O_3	ozone
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
Palos	Palos Forest
Pantex	Pantex Plant
Pb	lead
Pearl H	Pearl Harbor Naval Shipyard
PEIS	Programmatic Environmental Impact Statement
PGDP	Paducah Gaseous Diffusion Plant
Pinellas	Pinellas Plant

Acronyms and Abbreviations

PM_{10}	particulate matter of aerodynamic diameter less than or equal to 10 micrometers
PORTS	Portsmouth Gaseous Diffusion Plant
Ports Nav	Portsmouth Naval Shipyard
PPPL	Princeton Plasma Physics Laboratory
Pu-238	plutonium-238
Puget So	Puget Sound Naval Shipyard
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RH	remote-handled
RMI	RMI Titanium Company
ROI	region of influence
SLAC	Stanford Linear Accelerator Center
SNL-CA	Sandia National Laboratories (California)
SNL-NM	Sandia National Laboratories (New Mexico)
SO_2	sulfur dioxide
SRS	Savannah River Site
TRUPACT-II	Transuranic Package Transporter-II
TRUW	transuranic waste
TSCA	Toxic Substances Control Act
USC	United States Code
UofMo	University of Missouri
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant
WM	waste management
WM PEIS	Waste Management Programmatic Environmental Impact Statement
WSSR	Weldon Spring Remedial Action Project
WVDP	West Valley Demonstration Project
Y-12	Oak Ridge Y-12 Plant

1 Introduction*

This Waste Management Programmatic Environmental Impact Statement (WM PEIS) is a nationwide study examining the environmental impacts of managing five types of radioactive and hazardous wastes generated by past and future nuclear defense and research activities at a variety of sites located around the United States. The five waste types are low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), high-level waste (HLW), and hazardous waste (HW).

The U.S. Department of Energy (DOE) needs to enhance the management of its current and anticipated inventories of LLMW, LLW, TRUW, HLW, and HW in order to ensure safe and efficient control of these wastes, to comply with all applicable Federal and State laws, to protect public health and safety, and to protect the environment. Each waste type has unique physical characteristics and regulatory requirements and accordingly is managed separately. For each waste type, facilities are needed to treat, store, and dispose of the waste. For the first time, DOE has examined in an integrated fashion not only the impacts of complexwide (i.e., across the DOE complex) waste management alternatives for each waste type but also the specific cumulative impacts from all the waste facilities at a given site. In this context, management of these wastes includes:

- Pollution prevention
- Identifying/contracting with private vendors to manage waste
- Modifying existing waste management facilities or constructing new facilities at particular sites
- Operating existing, modified, or new waste management facilities at those sites
- Transporting waste among waste management facilities, as necessary
- Handling, surveillance, and maintenance

Definitions of Wastes Analyzed in the WM PEIS

Low-level mixed waste: *Low-level waste that contains hazardous waste under the Resource Conservation and Recovery Act.*

Low-level waste: *Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranics is less than 100 nanocuries per gram of waste. Low-level waste is subject to provisions of the Atomic Energy Act.*

Transuranic waste: *Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, per gram of waste, with half-lives greater than 20 years, except for (a) high-level radioactive waste; (b) waste that the Secretary has determined, with concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or (c) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.*

High-level waste: *The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines requires permanent isolation.*

Hazardous waste: *Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.*

* Vertical lines in margins and shading in tables indicate changes made since the publication of the Draft WM PEIS in August 1995.

This study provides information on the impacts of various alternatives, which DOE will use to decide at which sites to locate additional treatment, storage, and disposal capacity for each waste type. However, the location of a facility at a selected site will not be decided until completion of a sitewide or project-specific National Environmental Policy Act (NEPA) review.

To help DOE decide at which sites it should locate waste management facilities, this WM PEIS considers four categories of alternatives for each waste type: (1) a No Action Alternative that is generally consistent with current practice but with no management improvements; (2) a Decentralized Alternative that would, in general, result in wastes being managed where they are currently generated or stored; (3) a Regionalized Alternative that would consolidate waste management at fewer sites throughout the nation than under the Decentralized Alternative; and (4) a Centralized Alternative that would consolidate waste management at only one or two sites. For certain waste types, DOE considers more than one Regionalized or Centralized Alternative to present a wide variety of options on the number and location of sites that could manage wastes.

1.1 Sources of DOE Waste

At its peak, the nuclear defense complex consisted of 16 "major" sites, including large reservations in Nevada, Idaho, Washington, and South Carolina. National laboratories in New Mexico and California designed weapons that were produced in Colorado, Florida, Missouri, Ohio, Tennessee, and Washington. Like most industrial and manufacturing operations, the production of nuclear weapons generated waste. However, many problems posed by DOE's nuclear operations are unlike those associated with most other industries. Among these problems are radiation hazards; structures with radioactive contamination, such as nuclear reactors; and chemical plants that processed nuclear materials.

Nuclear weapons have played an important role in national security, and the nation continues to maintain an arsenal of nuclear weapons and some production capability. Continued support of the nation's Naval Nuclear Propulsion Program is also needed. However, since the end of the Cold War and the nuclear arms race, national priorities have shifted. Today, waste management and environmental restoration activities have become central to DOE's mission. DOE must provide for the proper management of its wastes within a complex and dynamic regulatory environment. DOE is not responsible, in general, for the management of wastes produced from commercial applications of radiation and atomic energy, and management of such wastes is not addressed in this WM PEIS.

1.2 Environmental Management Accelerating Cleanup: Focus on 2006

The DOE Environmental Management (EM) Program is continually working to accelerate cleanup schedules, increase efficiency, and foster cooperative relationships with its regulators and other stakeholders. However, there is concern whether support can be sustained for a program that may stretch beyond 70 years with an estimated cost of more than $200 billion. DOE wants to accelerate reduction of this "cleanup mortgage" of the Cold War to reduce long-term economic and environmental liabilities. DOE is working on a 2006 Plan (previously known as the Ten Year Plan) to meet this challenge. The vision of this plan is that, within the next decade, most DOE facilities will be able to treat and dispose of their backlog of nuclear materials and wastes safely and to clean up the land and buildings on site. These steps would dramatically reduce long-term costs and open a large portion of the lands and other resources controlled by DOE for other purposes.

However, some aspects of the EM Program will demand additional time and resources. For example, DOE will not be able to complete the treatment and disposal of certain wastes, such as high-level radioactive waste stored in tanks at Hanford or TRUW stored throughout the complex, within the next 10 years. In addition, there will be ongoing groundwater cleanup projects, decontamination of buildings, and

surveillance and maintenance activities. At a small number of sites, DOE will continue treatment of a few remaining waste streams beyond the next 10 years.

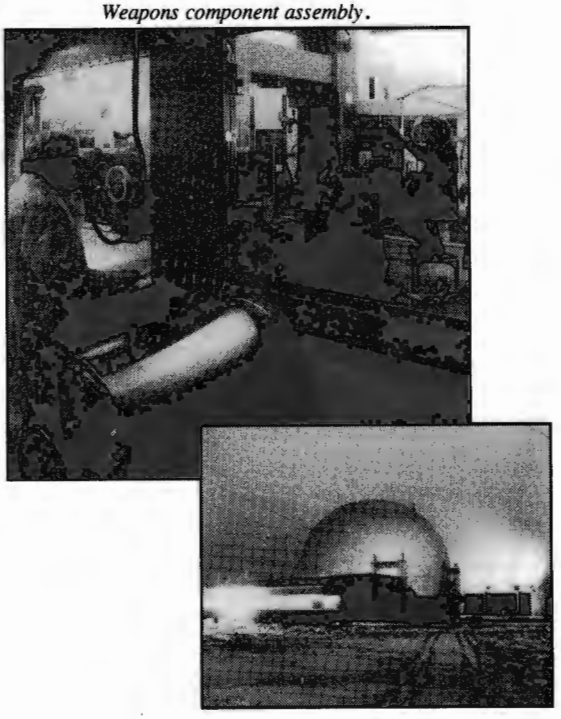
DOE will use the 2006 Plan to inform budget decisions and to sequence projects and actions to meet program objectives. EM will implement this vision in collaboration with regulators and the public. Development of the 2006 Plan will be guided by the following seven principles:

- Eliminate urgent risks
- Reduce mortgage and support costs to free up funds for further risk reduction
- Protect worker health and safety
- Reduce the generation of waste
- Create a collaborative relationship between DOE and its regulators and stakeholders
- Focus technology development on cost and risk reduction
- Integrate waste treatment and disposal within the complex

DOE's sites have already prepared initial draft site plans, and DOE is now developing a national discussion draft based upon these principles. The discussion draft will be distributed for public comment to elicit feedback on the strategic approaches for accomplishing compliance and completion goals, and on DOE's management strategies to accomplish these goals. This approach will ensure that DOE has a broad perspective when developing a draft National 2006 Plan later this year. The 2006 Plan will be a living document, evolving to reflect revised assumptions, stakeholder viewpoints, and newly obtained information.

The Final WM PEIS evaluates many waste management activities that may become components of the 2006 Plan.

Weapons component assembly.



Experimental Boiling Water Reactor at ANL-E, December 31, 1956.

1.3 Focus of the WM PEIS

DOE issued an Implementation Plan for this WM PEIS in January 1994. In that document, DOE identified the proposed action as the formulation and implementation of "an integrated environmental restoration and waste management program in a safe and environmentally sound manner and in compliance with applicable laws, regulations, and standards." However, since issuing the Implementation Plan, DOE has decided to shift the focus of the WM PEIS.

Specifically, DOE has determined that its original plan to integrate waste management and environmental restoration decisions is not appropriate, primarily because of the site-specific nature of environmental restoration decisions. These decisions, including the level of site remediation, should reflect site-specific conditions and involve local communities.

In a *Federal Register* notice issued on January 24, 1995, DOE proposed to modify the scope of the WM PEIS to eliminate the analysis of environmental restoration alternatives. Appendix A of this WM PEIS summarizes the comments received in response to the proposed change in scope and DOE's responses to those comments. Appendix A also describes various means for public involvement in planning and decision making for the Department's environmental restoration activities.

On September 22, 1995, DOE published a *Federal Register* notice announcing the release of the Draft WM PEIS and invited the public to comment on the document during the 90-day public comment period (September 22 through December 21, 1995). Opportunities to comment were provided in 13 video conference hearings held from October 17, 1995, through January 24, 1996. Several of these video conferences linked sites together with DOE Headquarters; altogether, 18 locations were involved in the hearings.

The video conference format was used to provide a wider opportunity for Headquarters' participation, support an interactive approach, and reduce costs. The public hearings were advertised through local newspapers, morning and evening drive-time radio announcements, and other DOE site-specific mechanisms, such as direct mailings to interested members of the public, meeting announcements to active groups or advisory boards, and additional advertising as deemed necessary by the DOE representatives. The specific notification approach varied by site depending on the needs of the local population. Public comments collected at the hearings were summarized in the *Draft WM PEIS Hearing Summary Report: A Compilation of Public Hearing Summaries* and placed in DOE public reading rooms in early February 1996. Comments were also received from the public and other interested parties directly through the mail.

On December 19, 1995, in response to requests from the public, congressional representatives, and major environmental groups, DOE announced an extension of the WM PEIS public comment period through February 19, 1996. Comments received throughout the comment period have been analyzed and considered in developing the Final WM PEIS, and are summarized in the Final WM PEIS Comment Response Document (Volume V of the Final WM PEIS). Documents relating to the WM PEIS are available in public reading rooms, listed in Chapter 1 (Section 1.9) of the Final WM PEIS.

During the public comment period for the Draft WM PEIS, more than 1,200 individuals, states, tribal nations, agencies, and organizations provided DOE with comments. Comments were received from virtually all of the communities near the DOE sites identified as "major" sites in the WM PEIS, and from many other interested members of the public. Many citizens and organizations submitted questions, comments, or objections regarding proposed waste management activities at particular DOE sites. Some suggested alternatives for waste management activities; others expressed their preferences for the alternatives described in the WM PEIS. A few commenters thought that DOE should prepare one comprehensive environmental impact statement on all of its activities; some expressed their support for DOE's current efforts.

Specific concerns raised during the comment period included the risk assessment methodologies (e.g., models and assumptions) used in the analysis, risks to densely populated areas and minority and low-income populations, risks associated with subsistence fishing in some communities, transportation risks, impacts on future generations, and additional exposures to populations affected by other DOE activities.

Commenters challenged DOE's designation of particular sites as major sites in the WM PEIS and requested that these sites be removed from consideration. Related to this issue were comments regarding the accuracy of current waste loads at particular sites.

DOE also received comments and questions on the relationship of the WM PEIS to other DOE programs or projects; purported inconsistencies between the

WM PEIS and other DOE documents; waste types or radioactive materials not analyzed in the WM PEIS; waste management technologies, particularly for waste treatment; the decision criteria DOE will use in making its waste management decisions; the future availability of geologic repositories at Yucca Mountain, Nevada, and the Waste Isolation Pilot Plant in New Mexico; and DOE credibility. Many commenters questioned DOE's February 1995 decision to remove environmental restoration alternatives from the scope of the WM PEIS.

Several commenters used this opportunity to raise budget concerns, especially the need to ensure the availability of funding to implement DOE's waste management activities. Some offered comments on policies or Federal programs not related to this WM PEIS, including suggestions to eliminate the production of radioactive and hazardous waste by eliminating certain DOE defense- and energy-related programs.

All comments were carefully considered by DOE. DOE made appropriate changes to the Draft WM PEIS as a result of the comments and prepared the Comment Response Document, Volume V of this Final WM PEIS, to respond to the specific comments received. In general, public comments, coupled with consultations with commenting agencies and State and tribal governments, resulted in additional analyses, clarification or correction of facts, and expanded discussion in several technical areas. The Comment Response Document provides an explanation of why certain comments did not warrant change to the WM PEIS.

In response to the comments received and in defining the preferred alternatives, the most significant changes to the WM PEIS are the following:

- DOE's preferred alternatives are identified.
- DOE modified the Decentralized Alternative for HW to replace Los Alamos National Laboratory (LANL) with Idaho National Engineering Laboratory (INEL) as a candidate site for onsite treatment of hazardous waste. This change recognizes the HW treatment capacity that exists at INEL and does not currently exist at LANL.
- With respect to revised information on waste loads, DOE prepared a new appendix, Appendix I, which presents updated waste volume inventories and projections for all waste types. Further, Appendix I allows site-specific comparisons with earlier estimates of inventories

Major Sites Analyzed in the WM PEIS

"Major" sites are those that are the focus of the WM PEIS because they meet one or more of the following criteria: (1) they are candidates to receive waste generated off site; (2) they are candidates to host disposal facilities; (3) they manage HLW; or (4) they were included to be consistent with the Federal Facility Compliance Act process. The 17 major sites are:

Argonne National Laboratory-East
Brookhaven National Laboratory
Fernald Environmental Management Project
Hanford Site
Idaho National Engineering Laboratory

Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Nevada Test Site
Oak Ridge Reservation
Paducah Gaseous Diffusion Plant
Pantex Plant

Portsmouth Gaseous Diffusion Plant
Rocky Flats Environmental Technology Site
Sandia National Laboratories-New Mexico
Savannah River Site
Waste Isolation Pilot Plant
West Valley Demonstration Project

and projections upon which the analysis in the Draft WM PEIS was based to determine whether the more recent data would substantially change any of the impacts described in the Draft WM PEIS. DOE performed new analyses using updated waste inventory data at selected sites for LLMW and for LLW and TRUW under several alternatives. The results of these additional analyses are contained in the relevant waste-type chapters of the WM PEIS.

- DOE modified its analysis of environmental justice concerns to better determine whether disproportionately high and adverse health impacts to minority or low-income populations could occur. The maps illustrating the proximity of these populations around the major DOE sites have been improved and moved from the former Appendix I (as found in the Draft WM PEIS) to Appendix C of the Final WM PEIS. DOE performed additional analyses of the potential for offsite general population risk as a result of the disposal of LLMW and LLW. With respect to transportation impacts, DOE clarified the comparison of radiological risks in truck and rail transportation and included the potential number of shipments that would enter and exit each site. DOE also emphasized that the intersite routes used in the analysis are representative of possible routes, not selections.

- DOE revised Chapter 11, "Cumulative Impacts," to provide a more comprehensive evaluation of other DOE actions (e.g., tritium supply and recycling, weapons material stockpile stewardship and management, and storage and disposition of excess fissile materials) that may affect the sites.

- With respect to environmental restoration wastes, DOE substantially modified Appendix B to include updated waste volume estimates for all sites and provided more detailed discussion about how environmental restoration wastes are generated, which of these wastes may be transferred to the Waste Management Program, and how the transferred wastes may affect the WM PEIS alternatives. Appendix B also discusses the uncertainties in estimating the volumes of environmental restoration wastes and the potential effects on waste management facilities. Section 1.7.1 of Volume I was revised and now discusses how the environmental restoration program is considered in the WM PEIS and why, given current uncertainties, a full impact analysis of environmental restoration wastes cannot be done in the WM PEIS. This section also sets forth the Department's reasons for proceeding with impact analyses using only waste management wastes. A qualitative analysis of how environmental restoration transferred wastes may affect the WM PEIS alternatives is also given in each waste-type chapter (Sections 6.15, 7.15, and 8.15 of Volume I).

Other changes to the WM PEIS include: a more detailed description of the decisions to be made by DOE (Section 1.7.3 of Volume I, which also includes a discussion of decision criteria from former Section 1.8); a statement clarifying DOE's compliance with applicable State and local laws and a narrative on relevant DOE orders (Section 1.4 of Volume I); a more comprehensive discussion of site treatment plans, pollution prevention, and other DOE actions and programs (Section 1.8.2 of Volume I); a discussion of privatization (Section 1.7.4 of Volume I); a discussion of safeguards and security (Section 4.3.12 of Volume I); and information which explains why the No Action alternatives for some waste types may appear to have smaller potential impacts than other alternatives (Sections 6.2.3, 6.16, and 8.3.1 of Volume I). DOE has also made other changes suggested by commenters to improve readability, including a short Readers' Guide at the beginning of Volume I, well-known examples to demonstrate waste volumes, and a table for converting waste volumes to both cubic feet and cubic yards. The Final WM PEIS includes an updated list of preparers in Chapter 13.

As modified, the WM PEIS focuses on waste management sites (those required to treat, store, or dispose of existing wastes and wastes that will be generated in the future as a result of DOE nuclear weapons stockpile stewardship and research programs). While this document does not analyze environmental restoration alternatives, Appendix B of the WM PEIS does contain information on the anticipated waste loads generated as a result of environmental restoration

activities (see Section 1.7) and a qualitative discussion of the extent to which those waste loads may affect waste management alternatives.

1.4 Waste Types Considered in the WM PEIS

DOE is responsible for managing large inventories of LLMW, LLW, TRUW, HLW, and HW. DOE manages each of these waste types separately because they contain different components, have different levels of radioactivity, and must meet different regulatory requirements. Updated information on waste volumes for LLW, LLMW, and TRUW at DOE's sites is included in Appendix I of this WM PEIS. DOE addressed the management of spent nuclear fuel in a separate programmatic environmental impact statement and its subsequent Records of Decision (see text box on page 12).

DOE defines its radioactive wastes based partially on how they are derived. Thus, waste types may share certain characteristics; for example, transuranic elements can be found in LLMW, LLW, TRUW, and HLW.

In addition, the wastes within each category come from diverse sources and can have different characteristics. Thus, some wastes within a waste type may need to be managed much differently from other wastes within that same waste type. For example, LLMW and LLW are categorized as either alpha or non-alpha waste, depending on whether the waste contains transuranic radionuclides with half-lives greater than 20 years and with alpha particle activity of between 10 and 100 nanocuries per gram. Because of the long-term health risks associated with the long-lived transuranic radionuclides, regulatory requirements mandate different treatment or disposal processes for alpha and for non-alpha waste. TRUW is an alpha waste with activity greater than 100 nanocuries per gram. There are typically two categories of LLMW, LLW, and TRUW—"contact-handled" (CH) and "remote-handled" (RH). The difference between the two categories is due to the concentration of radioactive materials. RH waste typically requires additional shielding and containment to protect workers and the public. Most LLMW, LLW, and HW can be disposed of by shallow burial provided that they are first treated and then placed in a properly regulated disposal facility. LLMW, HLW, HW, and some TRUW are all subject to the requirements of the Resource Conservation and Recovery Act (RCRA).

Types of Radioactivity

There are four principal types of radiation: alpha particles, beta particles, gamma rays, and neutrons. Alpha particles can be stopped by a sheet of paper and will not penetrate skin; but materials that emit alpha particles are harmful if inhaled or ingested. Beta radiation can pass through skin or an inch of water but not through a thin sheet of aluminum, plywood, or steel. Gamma rays and neutrons are the most penetrating radiation and can pass through many materials, including the human body. In passing through the human body, gamma rays generally deposit less of their energy than alpha or beta particles, which are stopped in the body. Dense materials like lead are effective for absorbing gamma rays, while hydrogenous materials like water are effective in slowing down and stopping neutrons.

The following introductory sections define and discuss each of the waste types considered in this WM PEIS, current waste volumes, and the four categories of alternatives. Figure 1.4–1 and Table 1.4–1 identify sites where wastes are generated or stored for each waste type under the alternatives evaluated in the WM PEIS.

1.4.1 Low-Level Mixed Waste

Low-level mixed waste (LLMW) contains both hazardous and low-level radioactive components. The hazardous components in LLMW are subject to RCRA, whereas the radioactive components are subject to the Atomic Energy Act (AEA). LLMW is characterized as either CH or RH and as alpha or non-alpha.

Figure 1.4–1. Waste Management Sites.

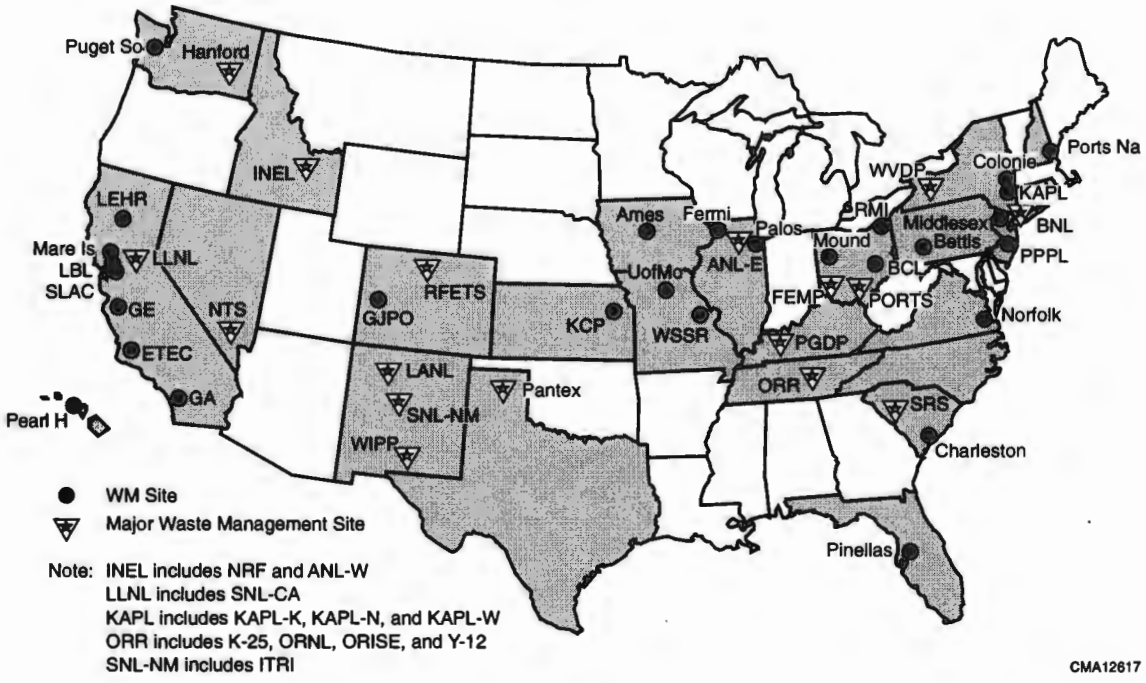


Table 1.4–1. Waste Management Sites

Sites	State	Symbol	Major Site[a]	Waste Type Managed				
				LLMW	LLW	TRUW	HLW	HW[b]
1 Ames Laboratory	IA	Ames		✓	✓			
2 Argonne National Laboratory-East	IL	ANL-E	✓	✓	✓	✓		✓
3 Battelle Columbus Laboratories	OH	BCL		✓				
4 Bettis Atomic Power Laboratory	PA	Bettis		✓	✓			
5 Brookhaven National Laboratory	NY	BNL	✓ c	✓	✓			
6 Charleston Naval Shipyard	SC	Charleston		✓	g			
7 Colonie	NY	Colonie		d				
8 Energy Technology Engineering Center	CA	ETEC		✓		✓		
9 Fermi National Accelerator Laboratory	IL	Fermi			✓			✓
10 Fernald Environmental Management Project	OH	FEMP	✓	✓	✓			
11 General Atomics	CA	GA		✓				
12 General Electric Vallecitos Nuclear Center	CA	GE		d	d			
13 Grand Junction Projects Office	CO	GJPO		✓				
14 Hanford Site	WA	Hanford	✓	✓	✓	✓	✓	✓
Idaho National Engineering Laboratory	ID	INEL	✓	✓	✓	✓	✓	✓
15 Idaho National Engineering Laboratory	ID	INEL		e	e	e	e	e
16 Argonne National Laboratory-West	ID	ANL-W		e	e	e		
17 Naval Reactor Facility	ID	NRF			e			
18 Kansas City Plant	MO	KCP		✓	✓			✓
Knolls Atomic Power Laboratory	NY	KAPL		✓	✓			
19 Knolls Atomic Power Laboratory (Kesselring)	NY	KAPL-K		e	e			
20 Knolls Atomic Power Laboratory (Niskayuna)	NY	KAPL-N		e	e			
21 Knolls Atomic Power Laboratory (Windsor)	CT	KAPL-W		e	e			
22 Laboratory for Energy-Related Health Research	CA	LEHR		✓				
23 Lawrence Berkeley Laboratory	CA	LBL		✓	✓	✓		
Lawrence Livermore National Laboratory	CA	LLNL	✓	✓	✓	✓		✓
24 Lawrence Livermore National Laboratory	CA	LLNL		e	e	e		c
25 Sandia National Laboratories (California)	CA	SNL-CA		e	e			
26 Los Alamos National Laboratory	NM	LANL	✓	✓	✓	✓		✓
27 Mare Island Naval Shipyard	CA	Mare Is		✓	g			
28 Middlesex Sampling Plant	NJ	Middlesex		d				
29 Mound Plant	OH	Mound		✓	✓	✓		
30 Nevada Test Site	NV	NTS	✓	✓	✓	✓		
31 Norfolk Naval Shipyard	VA	Norfolk		✓	g			

Table 1.4–1. Waste Management Sites—Continued

Sites	State	Symbol	Major Site[a]	Waste Type Managed				
				LLMW	LLW	TRUW	HLW	HW[b]
Oak Ridge Reservation	TN	ORR	✓	✓	✓	✓		✓
32 K-25 Site	TN	K-25		e	e			e
33 Oak Ridge Institute for Science and Education	TN	ORISE			e			
34 Oak Ridge National Laboratory	TN	ORNL		e	e	e		e
35 Y-12 Plant	TN	Y-12		e	e			e
36 Paducah Gaseous Diffusion Plant	KY	PGDP	✓	✓	✓	✓		
37 Palos Forest (Site A/Plot M)	IL	Palos		d	d			
38 Pantex Plant	TX	Pantex	✓c	✓	✓			✓
39 Pearl Harbor Naval Shipyard	HI	Pearl H		✓	g			
40 Pinellas Plant	FL	Pinellas		✓	✓			
41 Portsmouth Gaseous Diffusion Plant	OH	PORTS	✓	✓	✓			
42 Portsmouth Naval Shipyard	ME	Ports Nav		✓	g			
43 Princeton Plasma Physics Laboratory	NJ	PPPL		✓	✓			
44 Puget Sound Naval Shipyard	WA	Puget So		✓	g			
45 RMI Titanium Company	OH	RMI		✓	✓			
46 Rocky Flats Environmental Technology Site	CO	RFETS	✓	✓	✓	✓		
Sandia National Laboratories	NM	SNL-NM	✓[c]	✓	✓	✓		✓
47 Sandia National Laboratories (New Mex)	NM	SNL-NM		e	e	e		e
48 Inhalation Toxicology Research Institute	NM	ITRI		e	e			
49 Savannah River Site	SC	SRS	✓	✓	✓	✓	✓	✓
50 Stanford Linear Accelerator Center	CA	SLAC			✓			
51 University of Missouri	MO	UofMO		✓		✓		
52 Waste Isolation Pilot Plant	NM	WIPP	✓			f		
53 Weldon Spring Site Remedial Action Project	MO	WSSR		d	d			
54 West Valley Demonstration Project	NY	WVDP	✓c	✓	✓	✓	✓	
Total sites			17	37	27	16	4	11

Notes: ✓ = the facility is included in the indicated group. A site is listed under a waste type if it currently manages or is expected to manage that type of waste in the future. Joint DOE/Navy Nuclear Propulsion Program sites are: Bettis, Charleston, KAPL-K, KAPL-N, KAPL-W, Mare Is, Norfolk, NRF, Pearl H, Ports Nav, and Puget So. Former FUSRAP (Formerly Utilized Sites Remedial Action Program) sites are Colonie and Middlesex.

[a] "Major" sites are those that are the focus of the WM PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite; (2) they are candidates to host disposal facilities; (3) they manage HLW; or (4) they were included to be consistent with the Federal Facility Compliance Act process.

[b] Sites analyzed in the WM PEIS are those 11 sites that generated more than 90% of DOE's HW for the year 1992. Other DOE sites also manage HW but were not evaluated. Naval Nuclear Propulsion Program sites were not considered in the WM PEIS analysis for HW.

[c] Although this site is designated as a major site, none of the alternatives would result in wastes from other sites being shipped to this site for treatment or disposal.

[d] The site is included in the table because it is listed in data sources for LLMW; however, no programmatic waste management decision would be applicable to the site. Since it is managed as an environmental restoration site, it is excluded from the WM PEIS alternatives and waste totals.

[e] For evaluating candidate sites for waste management facilities in this WM PEIS: ANL-W and NRF have been combined with INEL; ITRI has been combined with SNL-NM; K-25, ORISE, ORNL, and Y-12 have been combined under ORR; SNL-CA has been combined with LLNL; and KAPL-K, KAPL-N, and KAPL-W have been combined under KAPL.

[f] TRUW is not currently stored or managed at WIPP. WIPP is a planned disposal site and is included because of its potential to treat TRUW.

[g] Naval shipyards may generate small quantities of LLW; however, they are not reported in the WM PEIS.

LLMW results from a variety of activities, including the processing of nuclear materials used in nuclear weapons production and energy research and development activities. The WM PEIS evaluates management of approximately 82,000 cubic meters (m^3) of LLMW that are currently stored and an estimated 137,000 cubic meters that are expected to be generated over the next 20 years (excluding LLMW that could be generated as a result of environmental restoration activities; see Table 1.7–1), for a total of approximately 219,000 cubic meters. While commercial and DOE facilities are currently insufficient to treat DOE's entire inventory of LLMW, some commercial treatment capacity does exist, and with sufficient incentives, it is assumed that commercial capacity could increase to meet demand. This WM PEIS addresses the treatment and disposal of LLMW; storage of LLMW is not addressed because RCRA prohibits storage of untreated waste except to facilitate proper recovery, treatment, or disposal. The WM PEIS addresses the transportation impacts associated with moving LLMW to treatment, storage, and disposal sites.

1.4.2 Low-Level Waste

Low-level waste (LLW) includes all radioactive waste that is not classified as HLW, spent nuclear fuel (fuel discharged from nuclear reactors), TRUW, uranium and thorium mill tailings or waste from processed ore. It does not contain HW constituents. Most LLW consists of relatively large amounts of waste materials contaminated with small amounts of radionuclides, such as contaminated equipment (e.g., gloveboxes, ventilation ducts, shielding, and laboratory equipment), protective clothing, paper, rags, packing material, and solidified sludges. LLW is further categorized as CH or RH and as alpha or non-alpha on the basis of the types and levels of radioactive emissions. However, most LLW contains short-lived radionuclides and generally can be handled without additional shielding or remote handling equipment. DOE has an inventory of approximately 67,500 cubic meters of LLW in storage, and approximately 1,440,000 cubic meters are expected to be generated during the next 20 years (excluding LLW that could be generated as a result of environmental restoration

Contact- and Remote-Handled Wastes

Radioactive waste is classified as either "contact-handled" (CH) or "remote-handled" (RH). LLMW, LLW, and TRUW can be composed of either CH or RH waste. All HLW is RH waste.

***Contact-handled** wastes are those with radiation levels less than or equal to 200 millirem per hour at the surface of a waste container and can be safely handled by direct contact.*

***Remote-handled** wastes are those with radiation levels exceeding 200 millirem per hour at the surface of a container. Such material must be handled remotely, by using such means as robots, and must have special shielding in treatment, storage, and disposal facilities.*

A millirem (one-thousandth of a rem) is a unit of measure of absorbed ionizing radiation used to assess the biological effects of a given dose of any type of radiation.

Various low-level, mixed, and hazardous waste.

activities), for a total of approximately 1,500,000 cubic meters. This WM PEIS also addresses the transportation impacts associated with moving LLW to treatment, storage, and disposal sites.

1.4.3 TRANSURANIC WASTE

TRUW is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years (atomic number greater than 92), except for (a) HLW, (b) waste that DOE has determined, with the concurrence of the Administrator of the EPA, does not need the degree of isolation required by 40 CFR 191, or (c) waste that the U.S. Nuclear Regulatory Commission (NRC) has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.[1] TRUW is generated during research, development, nuclear weapons production, and spent nuclear fuel reprocessing.

Metric Units

Volumes in this document are given in the metric unit of cubic meters (m^3). One cubic meter is equal to approximately 35 cubic feet, or 264 gallons.

TRUW, some of which also contains hazardous chemicals, has radioactive elements such as plutonium, with lesser amounts of neptunium, americium, curium, and californium. These radionuclides generally decay by emitting alpha particles. Like LLMW and LLW, TRUW also contains radionuclides that emit gamma radiation, requiring TRUW to be managed as either CH or RH. Approximately half of the TRUW analyzed is mixed waste containing both radioactive elements and hazardous chemicals regulated under RCRA.

Spent Nuclear Fuel

"Spent nuclear fuel" is fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

Initially, the management of spent nuclear fuel was to be analyzed in this WM PEIS. However, spent nuclear fuel has been analyzed in a separate PEIS—"Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement"—published in April 1995. The impacts of managing spent nuclear fuel are included in the cumulative impacts of this WM PEIS.

DOE has approximately 68,000 cubic meters of stored TRUW that can be retrieved and expects to generate about 64,000 cubic meters over the next 20 years (excluding TRUW that could be generated as a result of environmental restoration activities), for a total of about 132,000 cubic meters. DOE is currently proceeding with plans for TRUW disposal at a proposed geologic repository called the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. To evaluate whether to dispose of TRUW at WIPP and what level of treatment is needed for WIPP to perform as designed, DOE is preparing the WIPP Disposal Phase Supplemental EIS (SEIS-II) (draft issued Nov. 1996). Therefore, this WM PEIS addresses only the selection of DOE sites for treatment and storage facilities for TRUW. It also addresses the transportation impacts associated with moving TRUW to treatment, storage, and disposal sites.

[1] LLW and LLMW may also contain these transuranic isotopes, but with concentrations less than 100 nanocuries per gram of waste.

1.4.4 High-Level Waste

High-level waste (HLW) is the highly radioactive waste resulting from reprocessing spent nuclear fuel and irradiated targets from reactors. HLW is liquid before it is treated and solidified. Some of its elements will remain radioactive for thousands of years. HLW is also a mixed waste if it contains hazardous components that are regulated under RCRA. DOE has or will have generated about 378,000 cubic meters of HLW stored in large tanks.

Access to waste panel 1 in WIPP's underground facility. Continuous air monitors in foreground.

High-level waste tanks at SRS.

DOE is proceeding with plans to treat HLW by processing it into a solid form that would not be readily dispersible into air or leachable into groundwater or surface water. This treatment process is called vitrification. The environmental impacts of vitrifying HLW have been analyzed in previous DOE environmental impact statements. Vitrification would generate approximately 21,600 canisters from the current inventory of HLW. Canisters are assumed to vary in volume between 0.85 cubic meter and 1.26 cubic meters. DOE plans to dispose of the HLW canisters in a geologic repository. This WM PEIS addresses only the storage of treated HLW prior to its ultimate disposal in such a repository. It also addresses the transportation impacts associated with moving HLW to storage sites.

1.4.5 Hazardous Waste

Hazardous waste (HW) is defined under RCRA as a solid waste, or a combination of solid wastes, that may (a) significantly contribute to an increase in mortality because of its quantity, concentration, or physical, chemical, or infectious characteristics or (b) pose a potential hazard to human health or the environment when improperly treated, stored, or disposed of. RCRA defines a "solid" waste to include solid, liquid, semisolid, or contained gaseous material.

The quantities and types of HW generated by DOE's activities vary considerably and include acids, metals, solvents, paints, oils, rags contaminated with hazardous cleaning compounds, and other hazardous materials that are byproducts of routine maintenance, degreasing, and machine shop operations. Almost 99% of DOE's HW is wastewater and is treated at DOE sites. The remaining 1%, predominantly solvents and cleaning agents, is treated at commercial facilities. The WM PEIS evaluates the treatment of the 1% of HW that is not wastewater (Chapter 10, Volume I).

*Quantities of Waste**

Low-Level Mixed Waste. *The WM PEIS addresses approximately 82,000 cubic meters of LLMW that are currently stored and an estimated 137,000 cubic meters that are expected to be generated over the next 20 years (100,000 cubic meters has about the same volume as a seven-story building the size of a football field).*

Low-Level Waste. *Approximately 67,500 cubic meters of LLW are stored, and an estimated 1,440,000 cubic meters are expected to be generated over the next 20 years.*

Transuranic Waste. *Approximately 68,000 cubic meters are retrievably stored, and an estimated 64,000 cubic meters are expected to be generated over the next 20 years.*

High-Level Waste. *Approximately 378,000 cubic meters of HLW are stored and, when treated through vitrification, will generate approximately 21,600 HLW canisters.*

Hazardous Waste. *Approximately 69,000 cubic meters of nonwastewater HW are expected to be generated in the next 20 years.*

** Volumes do not include environmental restoration wastes.*

Over the next 20 years, DOE expects to generate approximately 69,000 cubic meters of nonwastewater HW. The WM PEIS addresses only the impacts of treating HW and the impacts associated with moving HW to treatment sites.

1.5 Decisions

Table 1.5–1 summarizes decisions DOE needs to make with respect to the treatment, storage, or disposal of these five types of waste. The alternatives describe the roles of the different sites where waste management facilities could be located.

1.6 Decision Criteria

Table 1.6–1 lists factors and criteria DOE used to evaluate alternatives in order to select a preferred alternative for each waste type considered in the WM PEIS. DOE also considered public comments in evaluating each of the alternatives.

1.7 Environmental Restoration Wastes

The term "environmental restoration" (ER) refers to the remediation of contaminated media and facilities at DOE sites. Contaminated media consist of contaminated soils, water, debris, and buildings; the volumes of such materials can be large at some sites. DOE continues to pursue environmental restoration at its sites; however, environmental restoration is not included in the scope of the WM PEIS. The decisions DOE must make about environmental restoration generally are not programmatic but instead are site specific.

Certain wastes generated during environmental restoration activities will be transferred to the waste management program for further treatment or

Table 1.5–1. Decisions DOE Will Make Based on Evaluations in the WM PEIS

Decisions	Type of Waste and Whether DOE Will Decide on Basis of WM PEIS (Yes or No)				
	Low-Level Mixed Waste	**Low-Level Waste**	**Transuranic Waste**	**High-Level Waste**	**Hazardous Waste**
Where to treat?	**YES** LLMW could be treated at 1 to 37 DOE sites.	**YES** LLW volume reduction and treatment could be conducted at 1 to 11 DOE sites. Minimum treatment could occur at all sites.	**YES** TRUW could be treated at 3 to 16 DOE sites.	**NO** HLW will be treated at 4 DOE sites where it was generated.	**YES** HW could be treated at DOE sites, or DOE could rely on commercial treatment.
Where to store?	**NO** LLMW will be stored at sites where generated until treatment and disposal.	**NO** LLW will be stored at sites where generated until treatment and disposal.	**YES** TRUW could be stored at 3 to 16 sites, pending final disposition.	**YES** HLW canisters containing treated HLW could be placed into storage at 1 to 4 DOE sites.	**NO** HW sent to commercial facilities will be stored for less than 90 days unless there is a permitted storage facility.
Where to dispose of?	**YES** LLMW could be disposed of at 1 to 16 DOE sites.	**YES** LLW could be disposed of at 1 to 16 DOE sites.	**NO** Separate evaluation of Waste Isolation Pilot Plant (WIPP) Disposal Phase is being prepared.	**NO** Separate evaluations to be prepared pursuant to the Nuclear Waste Policy Act as amended.	**NO** Commercial HW disposal facilities will continue to be used.

disposal. These wastes are referred to as ER transferred wastes. The volume of ER transferred waste depends on the extent of environmental restoration at a site, which then depends on several factors, including decisions regarding the use of the site in the future and the amount of cleanup necessary to permit that use; the balance between containment and removal strategies at a site; and the availability of commercial or DOE facilities to treat or dispose of waste. Current ER waste estimates are derived from a base-case scenario for environmental response actions at DOE sites.

Of the total volume of contaminated material from more than 10,000 contaminated areas at DOE sites (estimated to be approximately 58 million cubic meters), approximately 90% is contaminated soils. *In situ* remediation activities—such as capping contaminated soils in a landfill or entombing processing facilities, buildings, and reactors—would generate relatively small volumes of waste requiring further management.

However, environmental restoration activities that involve removing contaminants from environmental media can produce HW, LLW, LLMW, and TRUW. Although DOE has made preliminary estimates about how much of each of these wastes environmental restoration may generate at a particular site, it has almost no information on how chemical or radiological contaminants vary within each of these broad types of environmental restoration wastes. Without this basic information on the nature and composition of these wastes, DOE cannot determine the facilities needed to manage them or the impacts that the operation of those facilities might have on the environment.

Potential impacts of the addition of ER transferred waste on the WM PEIS alternatives are determined by such factors as waste management facility capacity, operational costs, and risks to workers and offsite populations. At most DOE sites, the treatment of ER transferred wastes is not expected to affect comparisons regarding the WM PEIS alternatives. Management of ER transferred

Table 1.6–1. Factors and Criteria DOE Uses in WM PEIS Decision Making

Factor	Criterion
• Consistency	Favors alternatives that are consistent with other complexwide studies using methodologies that allow valid comparisons across sites.
• Cost	Favors alternatives that have the potential to minimize overall cost for implementation of selected waste management strategies.
• Cumulative impact	Favors selection of alternatives and sites that minimize adverse cumulative environmental impacts.
• DOE mission	Favors alternatives that further the Department's mission to safely and efficiently treat, store, and ultimately dispose of wastes.
• Economic dislocation	Favors alternatives that tend to minimize economic dislocation, such as job losses.
• Environmental impact	Favors selection of alternatives and sites that would minimize adverse environmental impacts.
• Equity	Favors alternatives that distribute waste management facilities in ways that are considered equitable.
• Human health risk	Favors alternatives that reduce human health risk to both workers and the public. Human health risks depend not only on the magnitude of releases of radionuclides and hazardous chemicals but also on parameters such as population surrounding the sites, the hydrogeology of disposal sites, and the number of vehicle accidents that are expected to occur during transportation of waste.
• Implementation flexibility	Favors alternatives that maximize DOE's ability to modify activities at selected sites as circumstances change (e.g., to potentially manage large volumes of ER waste).
• Mitigation	Favors alternatives that increase DOE's ability to mitigate adverse impacts and that reduce the cost of mitigation.
• Regulatory compliance	Favors alternatives that comply with regulatory requirements, DOE Orders, and commitments made under the Federal Facility Compliance Act or with States and other regulators.
• Regulatory risk	Considers the potential for changes in statutes and regulations when evaluating alternatives and siting options.
• Site mission	Favors alternatives that are consistent with site capabilities and feasible for each waste type, particularly capacities and availability of technologies for treatment, storage, and disposal.
• Transportation	Favors alternatives that balance the amount of transportation needed to transport wastes to the sites considered in the alternatives with potential environmental risks, health risks, vehicle accidents, public concerns, mission needs, and costs.

waste could be accomplished by using available operational capacity for up to 30 years at waste management facilities, providing additional waste management facilities, or upgrading the planned facilities to accept increased amounts of wastes. Table 1.7–1 provides estimates of the volumes of transferred wastes that would be treated at waste management facilities. Because DOE does not have sufficient information about the ER transferred wastes, it cannot evaluate their impacts in the same manner as the impacts of wastes evaluated in the WM PEIS. DOE does not have enough information on the volume or contaminant composition of these wastes to perform an analysis of the impacts of treating, storing, or disposing of these wastes.

Appendix B and the cumulative impact analysis describe the DOE Environmental Restoration Program, provide estimates of waste volumes, and identify the potential effects of the addition of ER transferred waste on the WM PEIS analysis. Assumptions and uncertainties involved in the analysis are also provided.

1.8 Pollution Prevention Program Plan

Pollution prevention is defined as the use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and wastes into land, water, and air. To demonstrate DOE's commitment to pollution prevention, the Secretary of Energy has established goals, to be achieved by December 31, 1999, that will reduce DOE's routine generation of radioactive, mixed, and hazardous wastes and will reduce total releases and transfers of toxic chemicals by at least 50%.

Table 1.7–1. Estimated Waste Volumes Requiring Treatment or Disposal at Waste Management Facilities[a]

Waste Type and Activity	Environmental Restoration Transferred Waste (m^3)	Waste Management Waste (m^3)
LLMW	200,000	219,000
LLW	1,900,000	1,500,000
TRUW	80,000	132,000

[a] No HLW or HW requiring treatment or disposal in waste management facilities will be generated as a result of environmental restoration activities.

To provide a conservative analysis of DOE's future waste management program, the projections of waste volumes given in Chapters 6–10 did not assume that pollution prevention practices would significantly reduce current waste generation. However, Appendix G estimates how DOE's departmentwide reduction of 50% in annual generation of waste from DOE's pollution prevention practices may affect waste loads, costs, and human health impacts.

2 Alternatives

In this WM PEIS, the term "alternative" refers to a configuration of sites for treating, storing, or disposing of a specific waste type. Analysis of the range of reasonable configurations provides information on their potential environmental impacts that can be compared by decision makers. The alternatives analyzed in this WM PEIS for each waste type fall within four broad categories: the no action alternative and the decentralized, regionalized, and centralized alternatives.

2.1 Four Categories of Alternatives

No Action Alternative: This alternative involves using only currently existing or, in the case of HW, planned waste management facilities at DOE sites, or commercial vendors. In the NEPA process a no action alternative, or "status quo" alternative, may not necessarily comply with applicable laws and regulations, but it provides an environmental baseline against which the impacts of other alternatives can be compared.

Decentralized Alternatives: These alternatives involve managing waste where it is or will be generated. Unlike the no action alternative, the decentralized alternatives may require the siting, construction, and operation of new facilities or the modification of existing facilities. Under the decentralized alternatives, waste management facilities would be located at a larger number of sites than under the regionalized or centralized alternatives.

Regionalized Alternatives: These alternatives involve transporting wastes to a number of sites (fewer than the number of sites considered for the decentralized alternatives but greater than the number of sites considered for the centralized alternatives). In general, sites with the largest volumes of a given waste were considered as regional sites for treatment, storage, or disposal. DOE evaluated two or more regionalized alternatives for all waste types.

Centralized Alternatives: These alternatives involve transporting wastes to one or two sites for treatment, storage, or disposal. As was the case for the regionalized alternatives, those sites that have the largest volumes of a given waste were generally considered as sites for centralized management.

These four broad categories of alternatives encompass the range of reasonable alternatives available to DOE for siting facilities to manage the five waste types considered in this WM PEIS. Commercial or private facilities could potentially be used within each

NEPA Regulations

The Council on Environmental Quality (CEQ) regulations implementing NEPA (40 CFR Parts 1500–1508) require Federal agencies to evaluate all reasonable alternatives to the proposed action in an environmental impact statement (EIS). An agency must provide sufficient information for each alternative so that reviewers may evaluate the comparative merits of those alternatives.

For alternatives that were eliminated from detailed study, the agency must briefly discuss the reasons for their elimination. Further, the agency must identify its preferred alternative or alternatives, if one exists, in the draft EIS, and the agency must identify the preferred alternative in the final EIS unless another law prohibits the expression of such a preference. After completing the final EIS, the agency prepares a Record of Decision that announces the decision it made and identifies the alternative it considered to be environmentally preferable.

What Is Privatization?

For purposes of this WM PEIS, privatization refers to having a private entity operate, maintain, and decommission a waste management facility on a DOE site for the exclusive use of DOE. The private entity is reimbursed by DOE on a competitive basis. Privatization also includes the construction and subsequent operation of a waste management facility (including financing and obtaining necessary permits) by a private entity on a DOE site.

What Is Commercialization?

For purposes of this WM PEIS, a "commercial" waste management facility is defined as one that is owned or operated by a private entity (or a state) and that treats, stores, or disposes of waste from a variety of sources for a fee. DOE routinely uses commercial facilities for disposal of some of its LLMW and LLW.

alternative. The programmatic decisions that DOE ultimately makes are not necessarily limited to one of the four categories of alternatives. For example, DOE could select a hybrid alternative that would incorporate actions from one or more of the four categories of alternatives analyzed. Furthermore, under each category of alternatives, there are many possible combinations for the number and location of sites for management facilities. To narrow these combinations to a reasonable range for meaningful analyses, DOE selected representative alternatives under each category. Table 2.1–1 presents the alternatives that are analyzed for each of the waste types considered in the WM PEIS.

2.2 Developing the WM PEIS Alternatives

To determine those sites that would be reasonable locations for waste management facilities, DOE identified the sites with the largest waste volumes and the ones where transportation requirements would be minimized. The impacts of waste management facilities were then analyzed at those sites.

Other criteria were used to select additional sites. Waste characteristics, specialized treatment requirements, and existing facilities were taken into consideration. Some wastes that require special treatment were analyzed separately, and treatment sites were selected for analysis on the basis of volumes requiring special treatment rather than on total volumes.

Table 2.1–1. Number of Alternatives Analyzed by Waste Type

Alternatives	LLMW	LLW	TRUW	HLW*	HW	Total
No Action	1	1	1	1	1	**5**
Decentralized	1	1	1	1	1	**5**
Regionalized	4	7	3	2	2	**18**
Centralized	1	5	1	1	0	**8**
Total	**7**	**14**	**6**	**5**	**4**	**36**

* HLW alternatives are analyzed both in terms of final disposal beginning in 2015 and final disposal beginning at some later date. However, the decision of when HLW disposal will begin is not part of the WM PEIS. A separate NEPA document will be prepared for the HLW geologic repository.

2.3 WM PEIS Preferred Alternatives

The site profiles at the end of this Summary briefly describe the roles each site may play in the national waste management programs for each waste type under the preferred alternatives. No decisions will be made until at least 30 days after publication of the WM PEIS. DOE will make separate decisions on each waste type beginning early in calendar year 1997.

DOE selected its preferred alternatives after considering the analyses presented in the WM PEIS, the decision criteria presented in Table 1.6–1 and all of the comments submitted on the Draft WM PEIS. Table 2.3–1 summarizes the preferred alternatives for all of the major sites analyzed in the WM PEIS, and Tables 2.3–2 through 2.3–6 identify the waste management activities that each of the major sites would conduct under the preferred alternative. The preferred alternatives for each waste type are as follows.

Treatment of LLMW: A number of the Department's sites (generally sites with small amounts of LLMW) would send their LLMW to other sites for treatment. The sites that would receive these wastes and treat them under the DOE's preferred alternative are Hanford, INEL, ORR, and SRS. ANL-E, FEMP, LLNL, LANL, Pantex, PORTS, RFETS, and SNL-NM would treat LLMW onsite.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several Regionalized Alternatives as shown in Table 2.3–1. The potential environmental impacts of all alternatives for treatment of LLMW evaluated in the WM PEIS are small. DOE's preferred alternative is generally consistent with the Site Treatment Plans prepared under the FFCAct; these plans include the use of commercial facilities to treat some LLMW. DOE realizes that the compliance orders issued by State and Federal regulators on the basis of these Site Treatment Plans establish the requirements for treatment of DOE's LLMW.

Disposal of LLMW: The Department's preferred alternative at this time is to send its LLMW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW or LLMW disposal operations and, except for NTS and LANL, each has relatively large LLMW volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLMW the Department will need to dispose of, there is no need for additional candidate sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLMW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLMW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Table 2.3–1. Summary of Preferred Alternatives

Waste Type	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR
LLMW	Treatment	D	R1[a]	D	R1	R4	D	D	R1[a]	R2
	Disposal[b]	R	R	R	R	R	R	R	R	R
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	R3	R3
	Disposal[b]	R	R	R	R	R	R	R	R	R
TRUW	Treatment	D			D	R3	D	D	D	R1
HLW	Storage				D	D				
HW	Treatment	N	–	–	N	N	N	N	–	N

Waste Type	Decision	PGDP	Pantex	PORTS	RFETS	SNL–NM	SRS	WVDP	WIPP
LLMW	Treatment	R2	D	D	D	D	R1	R1[a]	
	Disposal[b]	R	R	R	R	R	R	R	
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	
	Disposal[b]	R	R	R	R	R	R	R	
TRUW	Treatment	D	**		D	R1	R1	D	*
HLW	Storage						D	D	
HW	Treatment	–	N	–	–	N	N	–	

Notes: N = No Action; D = Decentralized; R1, R2, R3, R4 = Regionalized; – = site not analyzed as a major generating site; * = no impacts from treatment or storage; ** = the very small amount of TRUW at Pantex would be shipped to LANL for treatment and storage. A blank cell indicates that the waste type is not found at the site.
[a] Wastes from these sites (BNL, NTS, and WVDP) are shipped offsite to regional treatment centers.
[b] DOE prefers to further narrow its configuration of LLMW and LLW disposal sites to two to three sites. The selection of sites would be made following consultation with regulatory authorities, State and Tribal governments, and other interested stakeholders.

Table 2.3–2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Ames	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
ANL-E	Treatment	Onsite		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
BCL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]

Table 2.3–2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW—Continued

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Bettis	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
BNL	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Charleston	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
ETEC	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
FEMP	Treatment	Onsite[d]		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
GA	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
GJPO	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
Hanford	Treatment	Onsite	Regional treatment site[b]	
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
INEL	Treatment	Onsite	Regional treatment site[b]	Some INEL waste may be shipped to another regional treatment site[b]
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
KCP	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
KAPL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LEHR	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LBL	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LLNL	Treatment	Onsite		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LANL	Treatment	Onsite		
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
Mare Island	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Mound	Treatment	Onsite[e]		Regional treatment site[b,e]
	Disposal	Offsite		Regional disposal site[c]
NTS	Treatment	Offsite		Regional treatment site[b]
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
Norfolk	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]

Table 2.3–2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW—Continued

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
ORR	Treatment	Onsite	Regional treatment site[b]	
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
PGDP	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Pantex	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
Pearl Harbor	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Pinellas	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
PORTS	Treatment	Onsite[f]		Regional treatment site[b,f]
	Disposal	Offsite		Regional disposal site[c]
Ports Nav	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
PPPL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Puget So	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
RMI	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
RFETS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
SNL-NM	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
SRS	Treatment	Onsite	Regional treatment site[b]	Some SRS waste may be shipped to another regional treatment site
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
UofMO	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
WVDP	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]

Note: A blank cell indicates that a site either does not receive LLMW from other sites or does not ship LLMW to other sites.

[a] A site is listed if it currently manages LLMW or is expected to manage it in the future.

[b] The regional treatment sites would be Hanford, INEL, ORR, or SRS, depending upon which site is shipping waste. The configuration analyzed in the WM PEIS for Hanford, INEL, ORR, and SRS is not exactly the same as those in the Site Treatment Plans; under the Site Treatment Plans:

- Hanford receives LLMW from BCL;
- INEL receives LLMW from Bettis, Charleston, ETEC, KAPL, LBL, LLNL, Mare Island, NTS, Norfolk, Pearl Harbor, PORTS, Puget So, SRS, and UofMO;
- ORR receives LLMW from ANL-E, BNL, FEMP, INEL, LBL, Mound, NTS, PGDP, PORTS, RMI, and WVDP; and
- SRS receives LLMW from Bettis, Charleston, KAPL, and Norfolk.

The evaluation of impacts at each of the major sites under the Preferred Alternative provides similar results as the configurations specified in the Site Treatment Plans. DOE realizes that the Site Treatment Plans, unless modified by the appropriate regulatory agency, establish the requirements for treatment of DOE's LLMW.

[c] The selection of two or three regional disposal sites will be made following further consultation with regulatory agencies, State and Tribal Governments, and other interested stakeholders.

[d] Site Treatment Plan indicates some waste may be treated onsite.

[e] Site Treatment Plan indicates some waste may be treated offsite at ORR.

[f] Site Treatment Plan indicates some waste may be treated offsite at INEL and ORR.

Table 2.3–3. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Ames	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
ANL-E	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Bettis	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
BNL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Fermi	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
FEMP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Hanford	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
INEL	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
KCP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
KAPL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
LBL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
LLNL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
LANL	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
Mound	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
NTS	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
ORR	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
PGDP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Pantex	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Pinellas	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]

Table 2.3–3. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLW—Continued

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
PORTS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
PPPL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
RFETS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
RMI	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
SNL-NM	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
SRS	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
SLAC	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
WVDP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]

Note: A blank cell indicates that a site either does not receive LLW from other sites or does not ship LLW to other sites.
[a] A site is listed if it currently manages LLW or is expected to manage it in the future.
[b] The selection of two or three regional disposal sites will be made following further consultation with regulatory agencies, State and Tribal governments, and other interested stakeholders.

Table 2.3–4. Waste Management Activities Under the Preferred Alternative for Treatment and Storage of TRUW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to[c]
ANL-E	Treatment	Onsite		
	Storage	Onsite		
ETEC	Treatment	Onsite		
	Storage	Onsite		
Hanford	Treatment	Onsite		
	Storage	Onsite		
INEL	Treatment	Onsite	RFETS	
	Storage	Onsite	RFETS	
LANL	Treatment	Onsite	Pantex, SNL-NM	
	Storage	Onsite	Pantex, SNL-NM	
LBL	Treatment	Onsite		
	Storage	Onsite		

Table 2.3–4. Waste Management Activities Under the Preferred Alternative for Treatment and Storage of TRUW—Continued

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to[c]
LLNL	Treatment	Onsite		
	Storage	Onsite		
Mound	Treatment	Onsite		
	Storage	Onsite		
NTS	Treatment	Onsite		
	Storage	Onsite		
ORR[b]	Treatment	Onsite/offsite	SRS	CH-TRUW to SRS
	Storage	Onsite/offsite	SRS	CH-TRUW to SRS
Pantex	Treatment	Offsite		LANL
	Storage	Offsite		LANL
PGDP	Treatment	Onsite		
	Storage	Onsite		
RFETS	Treatment	Onsite/offsite		INEL
	Storage	Onsite/offsite		INEL
SNL-NM	Treatment	Offsite		LANL
	Storage	Offsite		LANL
SRS[b]	Treatment	Onsite/offsite	ORR	RH-TRUW to ORR
	Storage	Onsite/offsite	ORR	RH-TRUW to ORR
UofMO	Treatment	Onsite		
	Storage	Onsite		
WVDP	Treatment	Onsite		
	Storage	Onsite		

Notes: CH-TRUW = contact-handled TRUW; RH-TRUW = remote-handled TRUW. A blank cell indicates that a site either does not receive TRUW from other sites or does not ship TRUW to other sites.
[a] A site is listed if it currently manages TRUW or is expected to manage it in the future.
[b] Under the Preferred Alternative, ORR is a regional treatment center for RH-TRUW, and SRS is a regional treatment center for CH-TRUW.
[c] Storage of treated TRUW pending final disposition.

Table 2.3–5. Waste Management Activities Under the Preferred Alternative for Storage of Treated HLW

Generating Site[a]	Stores Waste at	Receives Waste	Ships Waste to[b]
Hanford	Hanford		
INEL	INEL		
SRS	SRS		
WVDP	WVDP		

Note: A blank cell indicates that a site either does not receive HLW from other sites or does not ship HLW to other sites.
[a] A site is listed if it currently manages HLW or is expected to manage it in the future.
[b] Storage pending ultimate disposition.

Table 2.3–6. Waste Management Activities Under the Preferred Alternative for Treatment of HW

Generating Site[a]	Treats Waste at	Receives Waste	Ships Waste to
ANL-E	Offsite commercial facility		Offsite commercial treatment facility
Fermi	Offsite commercial facility		Offsite commercial treatment facility
Hanford	Offsite commercial facility		Offsite commercial treatment facility
INEL	Organic HW onsite, other HW at offsite commercial facility		Offsite commercial treatment facility
KCP	Offsite commercial facility		Offsite commercial treatment facility
LANL	Offsite commercial facility		Offsite commercial treatment facility
LLNL	Offsite commercial facility		Offsite commercial treatment facility
ORR	Organic HW onsite, other HW at offsite commercial facility		Offsite commercial treatment facility
Pantex	Offsite commercial facility		Offsite commercial treatment facility
SNL-NM	Offsite commercial facility		Offsite commercial treatment facility
SRS	Offsite commercial facility		Offsite commercial treatment facility

Note: A blank cell indicates that a site either does not receive HW from other sites or does not ship HW to other sites.
[a] Sites analyzed in the WM PEIS are those 11 sites that generated more than 90% of DOE's HW in 1991.

Treatment of LLW: Each site with LLW would treat its waste onsite. Each site would perform minimum treatment on its wastes to prepare them for disposal, although DOE would allow each of its sites the flexibility to perform additional treatment if it would decrease costs and requirements for transportation by significantly reducing the volume of LLW requiring disposal. The potential environmental impacts of all alternatives for treatment of LLW evaluated in the WM PEIS are small. The impacts of DOE's preferred alternative for LLW are identified in Regionalized Alternative 3 as shown in Table 2.3–1, under which the potential impacts associated with minimum treatment of LLW at each site were analyzed, assuming regionalized disposal, as discussed below.

Disposal of LLW: The Department's preferred alternative at this time is to send its LLW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW disposal operations and, except for NTS, each has large waste volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLW the Department will need to dispose of, there is no need to establish additional sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, with correspondingly higher traffic accident fatalities, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation

costs that would not be needed at more arid sites. However, a disposal configuration that included at least one eastern site and one western site would require less transportation and produce fewer fatalities from traffic accidents than an eastern-only or western-only configuration. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Treatment and Storage of TRUW: Most of the DOE's sites with TRUW would treat and store it onsite. Five sites would ship TRUW to other sites for treatment under the preferred alternative: Pantex would ship its very small amount of TRUW to LANL for treatment; RFETS would ship some of its TRUW to INEL for treatment; ORR would send its CH-TRUW to SRS for treatment; SRS would send its RH-TRUW to ORR for treatment; and SNL-NM would send its small amount of TRUW to LANL for treatment. This preference assumes that WIPP will require treatment to the waste acceptance criteria the Department has proposed to EPA for this geologic repository. DOE's preference could change if WIPP requires a different level of treatment. The Department would store its TRUW where it is treated pending a decision on its disposal or other disposition.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several of the Regionalized Alternatives as shown in Table 2.3-1. It provides for cost-effective management of TRUW, poses low potential risks to the public, and has relatively small environmental impacts. DOE's preference is consistent with the preferred alternative identified in the *Waste Isolation Pilot Plant Disposal Phase Draft Supplemental Environmental Impact Statement* (WIPP SEIS-II).

Storage of HLW: The Department's preferred alternative at this time is to store its HLW where the waste is treated pending a decision on its disposal or other disposition. Because it is impractical to ship liquid HLW for treatment, DOE had previously decided that each of the four sites with HLW (Hanford, INEL, SRS, and WVDP) will treat its own waste onsite.

The potential impacts of DOE's preferred alternative are presented under the Decentralized Alternative for HLW. This alternative minimizes the transportation of treated HLW, makes use of existing storage capacity at WVDP and SRS, and would cost less than regionalized or centralized storage. The potential environmental impacts of all alternatives for HLW evaluated in the WM PEIS are small.

Treatment of HW: DOE's preferred alternative for HW is the No Action Alternative, which means the Department would continue to use commercial facilities to treat most of its non-wastewater HW. The transportation and environmental impacts are low for all of the alternatives for HW evaluated in the WM PEIS; however, the No Action Alternative costs less than the Decentralized or Regionalized Alternatives for HW treatment.

3 Analysis

To evaluate the potential environmental impacts of the alternatives, DOE first identified the characteristics, quantity, and special requirements (e.g., handling requirements) of each waste type. To frame the analysis within reasonable bounds and to make the analytical process more manageable, DOE developed and applied specific assumptions to the alternatives. DOE then determined the health risks, environmental impacts, and costs of implementing each alternative for each waste type. Figure 3.1–1 depicts this framework.

3.1 The Analytical Process

The management impacts of the five waste types were evaluated using an analytical process with three phases, as shown in Figure 3.1–2, for each of the alternatives. This three-phase approach was applied in the analysis of treatment, transportation, storage, and disposal activities.

In Phase I, DOE made certain assumptions concerning the physical, chemical, and radiological characteristics of the waste streams and the volume of each waste type. The physical, chemical, and radiological characteristics of the thousands of inventoried waste streams were aggregated into a smaller number of waste treatability groups for each waste type (e.g., 9 treatability groups for LLW, 23 for LLMW, and 19 for TRUW). Generic treatment system designs were developed for each of the treatability groups by using currently accepted treatment technologies.

Conceptual treatment facilities were then modeled that could process the volume of waste.

Figure 3.1–1. Waste Management System.

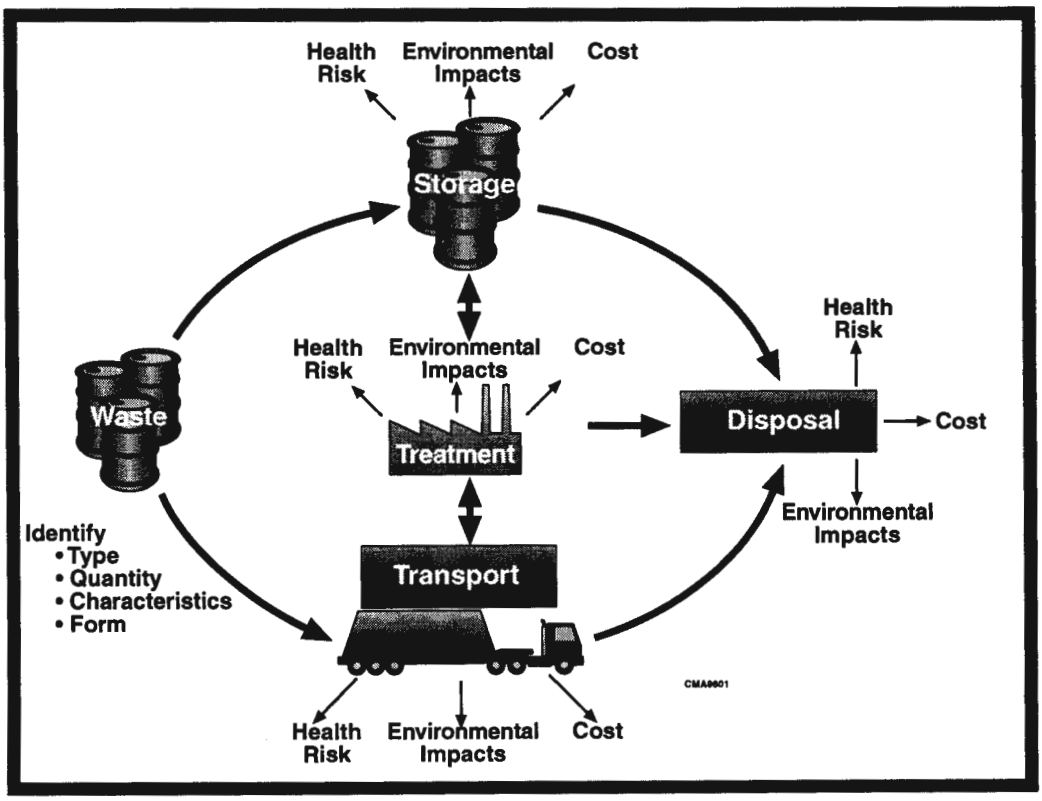
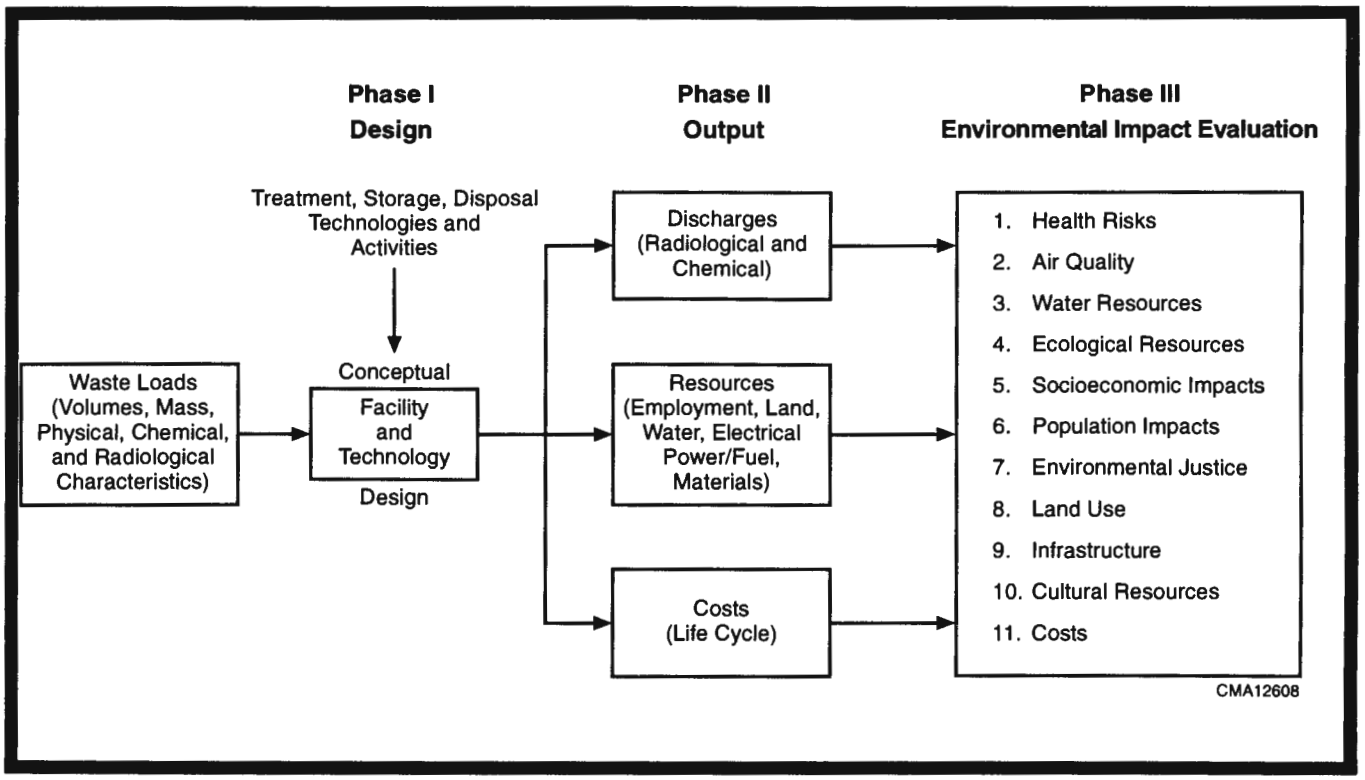


Figure 3.1-2. WM PEIS Analytical Process.



Initially the waste types were grouped into six physical categories on the basis of common engineering criteria. DOE then used standard radiological profiles for each site and made assumptions about the concentrations of contaminants in each treatability group on the basis of available data. Hazardous constituents were assigned to the treatability groups by using an average composition for all DOE sites. The assumptions for both radioactive and hazardous constituents vary by waste type assigned.

To develop conceptual facilities for the analysis, DOE considered all types of waste management facilities needed to process and transport each waste type and also examined the various technologies available for managing the specific type of waste.

The generic waste management facilities were assumed to be placed at selected locations on a DOE site—an existing waste management location or the geographic center of the DOE site—so that actual environmental data could be used in the analysis (e.g., data regarding distance to receptors and prevailing winds). The use of a specific location permitted the analysis of impacts by providing actual environmental settings for a facility; placement of facilities at sites was done only for analysis purposes. Decisions regarding the actual location of waste management facilities at DOE sites will not be made on the basis of this WM PEIS, but will be the subject of site-specific NEPA reviews.

In Phase II, the engineering features of the conceptual facility and the waste volumes "processed" through the facility formed the basis for the estimates of resources required, effluents released, and cost. In Phase III, Environmental Impact Evaluation, the releases, resources, and costs became the input for evaluating health risks, environmental impacts, and socioeconomic impacts.

To conduct the analysis, DOE had to define the "affected environment." The affected environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." DOE described the affected environment to establish the baseline conditions at each of the major sites before evaluating the components of the WM PEIS alternatives. The baseline can then be compared with the level of impacts directly related to a given alternative. Because of the national scope of this WM PEIS, DOE not only examined specific site characteristics but also examined broad regions of influence surrounding the sites, as well as the interconnecting roadway and rail corridors between sites. The WM PEIS analyzes the environmental impacts of operating waste management facilities for 10 years. Although the facilities could operate for up to 30 years, DOE expects that most of the annual impacts after 10 years of operation would be similar to or less than those predicted by the WM PEIS. The remainder of this section highlights the analysis performed for each of the impact areas considered.

3.2 *Types of Impacts*

Ten types of environmental impacts were evaluated in the WM PEIS: Health Risk, Air Quality, Water Resources, Ecological, Economic, Population, Environmental Justice, Land Use, Infrastructure, and Cultural Resources. Costs were also evaluated.

3.2.1 HEALTH RISKS

Health risk impacts can result from exposure to radiation and chemicals and from physical trauma (i.e., accidents) associated with constructing and operating treatment and disposal facilities or transporting waste. The WM PEIS evaluates risks associated with activities that occur over a 20-year period (10 years of construction followed by 10 years of operations).

Waste Treatability Groups

- ***Aqueous liquids.*** *Primarily water with organic content less than 1% (such as wastewater)*
- ***Organic liquids.*** *Liquids and slurries with organic content greater than 1% (such as solvents)*
- ***Organic and inorganic sludge and particulates.*** *Solid and semisolid material other than debris (such as sludge from treatment plants, resins, and solids less than 1-centimeter-diameter particle size)*
- ***Soils.*** *Contaminated soils (such as contaminated earth requiring remediation)*
- ***Debris.*** *Solid material exceeding 1-centimeter-diameter particle size that is either (1) manufactured, (2) plant or animal matter, or (3) discarded natural or geologic material*
- ***Other.*** *Special waste streams (such as batteries, laboratory packs, reactive metals, and toxic metals, which include mercury, lead, and beryllium)*

This basic framework analysis was used for four waste types: LLMW, LLW, TRUW, and HW. For purposes of the WM PEIS analysis, HLW is assumed to have been treated (vitrified) before it would be stored. The WM PEIS only addresses the environmental consequences of storing and transporting vitrified HLW.

For routine operations involving treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in treatment, and waste management workers directly involved in treatment. Risks were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts.

Population health risks focus on the *total number* of people in each population who would experience adverse health impacts if a particular alternative is implemented. These impacts include fatalities from physical hazards, cancer fatalities, cancer incidences, and genetic effects.

Individual impacts focus on the *probability* that the "maximally exposed individual" (MEI) within each receptor population would experience an adverse health impact. These impacts include the probabilities of a cancer fatality, cancer incidence, and genetic effects. Because the focus is on the MEI, the risk is presented as a probability (e.g., one-in-one-million chance) of that individual experiencing an adverse health impact, rather than the total number of impacts for an affected population.

Health risks resulting from disposal were evaluated for LLMW and LLW. The analysis considered risk to workers handling the treated waste, risk to an onsite "hypothetical farm family" living 300 meters from the center of the disposal facility, and risk to a hypothetical "intruder" into the disposal facility after the facility has been closed. The risks to the hypothetical farm family were estimated over a 10,000-year period because the maximum exposure would occur in the future after the disposal unit breaks down and potential contaminants leak into groundwater. The 10,000-year period was selected for the analysis to maintain consistency with the "Guidelines for Radiological Performance Assessment of DOE Low-Level Radioactive Waste Disposal Sites" that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance

Maximally Exposed Individual

In keeping with standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours per day, 7 days per week, for the 10-year period of treatment operations analyzed in the WM PEIS.

Hypothetical Farm Family and Intruder

The "hypothetical farm family" is an imaginary family assumed to live 300 meters downgradient of the center of a waste disposal unit. The family engages in farming activities, such as growing and consuming its own crops and livestock, and uses groundwater for watering the crops and animals. This is an estimated maximum exposure scenario taking place in the future at a time when institutional controls no longer exist. The scenario is analyzed to determine potential maximum exposures from ingestion of contaminated groundwater.

The hypothetical "intruder" is an imaginary adult who drills a well directly through a disposal unit to the groundwater. As a result of the drilling, contaminated soil from within the unit is brought to the surface, where it mixes with the top layers of the surface soil. The individual farms the land and eats the crops. The intruder scenario occurs after the failure of institutional control over the disposal facility. This scenario is consistent with the analysis required for disposal facilities under DOE Order 5820.2A.

assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A.

In addition to risks from construction and routine operations, health impacts from potential treatment and storage facility accidents were also evaluated. Data in safety analysis reports and site EISs were used as indicators of the consequences for a range of storage facility accidents of varying probabilities. For LLMW, LLW, TRUW, and HW treatment, the accident analysis focused on thermal treatment (specifically, incineration), because there is a significant amount of incineration data available, impacts of accidents associated with incineration are thought to be representative of and to encompass those accidents associated with other treatment technologies, and the public is very interested in incineration technology.

Transporting the wastes for treatment, storage, and disposal may affect the health of the public along the transportation route and the truck drivers or rail crew. Impacts evaluated included radiation exposure during normal operations, accidents in which the waste containers are assumed to open, exposure to vehicle exhaust during transport, and physical injury from vehicle accidents.

3.2.2 Air Quality Impacts

DOE evaluated air quality impacts at each proposed management site on the basis of estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (which include radionuclides), and toxic air pollutants when applicable. Pollutant emission estimates were made for construction and for operations and maintenance (O&M) activities of the waste facilities.

Criteria air pollutants can be emitted from construction equipment or from vehicles that workers use to drive to waste management facility construction sites. Both are considered to be "mobile sources" and thus subject to certain regulations. Criteria air pollutants can also be emitted during operation and management of LLMW, LLW, HW, and TRUW facilities (considered "stationary sources") and by vehicles that are driven by workers to the waste management facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated releases for each alternative with the allowable emission limits.

For all wastes except HLW and HW, DOE also evaluated impacts from radionuclide emissions by comparing the dose to the offsite MEI with the 10-millirem-per-year standard under the National Emission Standards for Hazardous Air Pollutants. Concentrations of hazardous or toxic air pollutants were compared with Federal, State, or local air quality standards and guidelines.

3.2.3 Water Resources Impacts

DOE analyzed the impacts on onsite water resources from management activities. DOE evaluated the effects on water availability from constructing and operating waste management facilities. Increases of greater than 1% over the current water use were identified and the impacts analyzed.

DOE also evaluated the impacts to groundwater quality caused by the migration of radionuclides and chemicals that leach from disposal facilities over time. DOE calculated concentrations of radionuclides and hazardous components at a hypothetical well located

Major Types of Air Pollutants

***Criteria Air Pollutants**: carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 microns in diameter (PM_{10})*

***Hazardous Air Pollutants**: 189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

***Toxic Air Pollutants**: Other toxic compounds regulated by EPA and State or local governments*

300 meters from the center of the disposal facility and compared these to drinking water standards.

3.2.4 Ecological Resources Impacts

DOE analyzed the effects of both construction site clearing (to build waste management facilities) and of airborne releases of contaminants from these facilities on ecological resources. DOE also considered the effects of accidental spills of waste during transportation. Sites where proposed construction would disturb more than 1% of the available management area were identified.

Although DOE intends to use the WM PEIS as a tool to help select sites for waste management, it will not select the specific location for a waste management facility at a site on the basis of this WM PEIS. Specific locations will be selected on the basis of subsequent sitewide or project-specific NEPA reviews. Potential impacts to sensitive species or habitats at particular locations within a site would be analyzed in those reviews.

3.2.5 Economic Impacts

DOE estimated the effects of expenditures for waste management activities on the local and national economies. Local economic effects were determined on the basis of direct expenditures at each site for construction, O&M, and decontamination of waste management facilities. The region of influence (ROI), where local effects were evaluated, consists essentially of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data for the ROI counties. Local increases in jobs and personal income were considered to be substantial benefits in cases where the increases were 1% or more above the 1990 baseline. Transportation expenditures were considered at the national level only.

3.2.6 Population Impacts

The analysis also examined the potential for the waste management alternatives to cause the types of social impacts that could result when any large industrial or public works project attracts workers and their families to an area. Potential population changes in the ROI were estimated by using the direct labor requirement to calculate potential worker migration into the region.

3.2.7 Environmental Justice

Federal agencies have been directed by Executive Order to incorporate considerations of environmental justice into their missions. As such, Federal agencies are specifically directed to identify and address, as appropriate, disproportionately high and adverse health or environmental effects of their programs, policies, and activities on minority and low-income populations.

To perform this assessment for the WM PEIS, DOE used a geographic information system and Census Bureau data at the tract level to identify minority and low-income populations within 50 miles of the 17 major sites. Native American lands within 50 miles of any site were also identified and mapped. DOE then reviewed the potential health risks and environmental impacts associated with alternatives for the five waste types. The potential inequities from the waste management alternatives were analyzed in terms of the proportion of minority and low-income populations that reside within the 50-mile zone of impact at each site. Only in cases where a specific impact was high near a particular site would there be a potential for disproportionately high and adverse impacts to minority or low-income groups. Sites where risks or environmental impacts were estimated to be potentially high or adverse are identified.

3.2.8 Land Use Impacts

DOE examined the impacts on land use that could result from the alternatives for each waste type by comparing the acreage required for new management facilities with the acreage either designated for waste operations or suitable for development at a site. Suitable land is the total site acreage, minus the acreage required for existing structures, known cultural resource areas, sensitive habitats (including

wetlands and wildlife management areas), prohibitive topographic (surface) features, and surface waters. Where the acreage comparison showed a 1% or greater land requirement (of the designated or suitable land area) for new facilities, further evaluation of impacts was conducted. Available site development plans were also used to identify potential conflicts among the proposed facilities required under each alternative and plans for future site uses.

INEL central facilities area.

3.2.9 Infrastructure Impacts

DOE evaluated the impacts on site infrastructure by comparing requirements for water, wastewater treatment, and electrical power that result from implementing the WM PEIS alternatives with existing onsite capacities. Site transportation infrastructure and offsite infrastructure impacts were evaluated by using estimates of increased population resulting from the proposed activities as an indicator of increased demand on the community infrastructure.

ORR Y-12 Plant looking west.

Impacts were considered possible where increases in onsite infrastructure requirements were 5% or greater. Major impacts were considered possible where new requirements caused system capacity to be approached or exceeded. Therefore, any increase of 5% or greater that caused the total site use rate to exceed 90% of available capacity, was considered to have the potential to cause a major infrastructure impact.

Site transportation infrastructure impacts and offsite community infrastructure impacts were evaluated indirectly by comparing new site employment to existing site employment as an indicator of increased stress on site transportation systems and offsite infrastructure. New site employment of less than 5% of current employment was considered likely to have negligible or minor impacts. Site employment increases from 5% to less than 15% were considered to have the potential to cause moderate impacts, and increases of 15% or greater were considered to have the potential to cause major impacts.

Savannah River Site.

3.2.10 Cultural Resources Impacts

Cultural resources, including prehistoric, historic, Native American, and paleontological resources, may be affected at sites where waste management facilities are proposed to be built. However, the impacts of the construction of waste management facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site. These impacts will be examined in sitewide or project-specific NEPA reviews.

3.2.11 Geology and Soils Impacts

As indicated in Chapter 4, Affected Environment, DOE's review of the geology and soils at the 17 major sites indicated that it is unlikely that impacts to these resources would affect the selection of alternatives for any waste type. While geology and soils are important determinants of where on a particular site a facility could be located, such determinations are not being made at the programmatic (i.e., Departmentwide) level. Exact locations of facilities and impacts to geology and soils will be addressed in sitewide or project-level NEPA reviews.

3.2.12 Noise Impacts

Noise from construction and operation of waste management facilities and increased vehicle traffic may cause adverse impacts. Noise impacts, however, are especially dependent on the technology employed and the siting, which the WM PEIS does not specify. Therefore, noise impacts cannot be evaluated. Exact locations of facilities and related noise levels will be addressed in sitewide or project-level NEPA reviews.

3.2.13 Costs

DOE evaluated estimated costs for building and operating waste management facilities and for transportation from both a life-cycle and process perspective, using 1994 dollars.

DOE evaluated facility costs for four phases representing the life cycle of a facility and its operations over a 20-year period: construction, preoperations, O&M, and decontamination and decommissioning.

The only exception was HLW, which was costed by using a two-phased life-cycle approach (construction and O&M) for the storage facilities.

Examples of life-cycle costs include:

- Costs for preoperation activities: technology and site adaptation, permitting, plant setup, and related conceptual design
- Facility construction costs: building construction, equipment purchase and installation, construction and project management
- Operations and maintenance costs: annual operations costs for labor and materials, equipment, utilities, and overhead
- Decontamination and decommissioning costs: facility decontamination and demolition, postclosure, and environmental monitoring

For process costs, DOE also analyzed costs for treatment, storage, and disposal activities. Treatment costs include costs to build and operate treatment facilities and common support facilities. For most waste types, current storage capacity was assumed to be sufficient, except for the No Action Alternative, where DOE estimated the costs to build and operate sufficient storage capacity. Disposal costs include costs to build and operate front-end administration and receiving facilities and the actual disposal units. Transportation costs include the costs associated with the movement of the waste among sites. Transportation costs were evaluated for both truck and rail shipments.

At a Glance:

Low-Level Mixed Waste

No Action Alternative:

- Continue treatment at existing facilities with indefinite storage.
- Does not include disposal and does not comply with RCRA.

Decentralized Alternative:

- Treatment at all 37 sites and disposal at 16.

Four Regionalized Alternatives:

- Treatment at 11, 7, or 4 sites with disposal at 12, 6, or 1 site(s).

Centralized Alternative:

- Treatment and disposal at one site.

Preferred Alternative:

- Sites with small amounts would send their waste to Hanford, INEL, ORR, or SRS for treatment. Eight major sites would treat onsite.
- Regionalized disposal at two or three sites to be selected after consultation with stakeholders from among the following six sites: Hanford, INEL, NTS, LANL, ORR, and SRS.

LLMW Data and Major Assumptions:

- 37 sites generate or store LLMW.
- DOE will need to manage an estimated 219,000 cubic meters of LLMW over the next 20 years.
- All LLMW treatment facilities would be designed to treat waste to meet RCRA requirements.
- New facilities would be constructed during a 10-year period; LLMW currently in inventory and newly generated would be treated during the 10-year period following construction of facilities.
- Wastewater treatment would continue at every site.
- No waste acceptance criteria were imposed on disposal sites.

What Did We Learn From the Results?

- Risks from LLMW action alternatives are generally low, with the greatest risks occurring for workers from physical accidents normally expected in any industrial activity.
- Costs range from $5.2 billion for the No Action Alternative to $12.3 billion for the Decentralized Alternative.
- Limits on radionuclides and hazardous constituents as well as other waste acceptance criteria would be required for disposal at most sites.

4 Low-Level Mixed Waste

- *LLMW contains both radioactive and hazardous components.*
- *LLMW is generated, projected to be generated, or stored at 37 DOE sites as a result of research, development, production, testing, and dismantlement of nuclear weapons.*
- *DOE will need to manage an estimated 219,000 cubic meters of LLMW over the next 20 years.*
- *DOE must select treatment and disposal sites for LLMW.*

4.1 Analysis

The challenge in managing LLMW arises from its dual nature—it contains RCRA-classified hazardous components (or characteristics) and is radioactive. Because of the complex regulatory requirements governing the management of LLMW, DOE must define a waste management system focused on treating and disposing of LLMW and minimizing the amount in storage.

LLMW is generated, projected to be generated, or stored at 37 DOE sites. According to DOE estimates, 219,000 cubic meters of LLMW will need to be managed over the next 20 years. Figure 4.1–1 presents the estimated total volume of LLMW from waste management activities at each of the 37 sites and illustrates its distribution across the country at the 16 major LLMW sites analyzed in the WM PEIS. WIPP, the 17th major site, will manage only TRUW.

In addition to analyzing the impacts from treatment and disposal, DOE analyzed the transportation impacts associated with each alternative. Both truck and rail transportation were analyzed by using routing models following the general principle of minimizing transportation time and shipping distance. The routes were selected to be consistent with existing routing practices and all applicable regulations and guidelines; however, because the routes were determined for the purposes of risk assessment, they do not necessarily represent actual routes that DOE would use to transport waste in the future.

4.2 Alternatives

DOE analyzed seven alternatives for CH LLMW within the four categories of alternatives: no action, decentralized, regionalized, and centralized. Treatment and disposal activities vary by alternative and by site. Table 4.2–1 illustrates by site where LLMW would be treated and disposed of under each alternative.

The LLMW analysis considered treatment and disposal separately, first focusing on treatment and then using treatment residues (waste remaining after treatment) as the input volumes for the disposal analysis. Each alternative was developed to assess environmental impacts, health risks, and costs associated with the range of LLMW treatment and disposal options, and to provide input for programmatic decisions about where to locate LLMW treatment and disposal facilities.

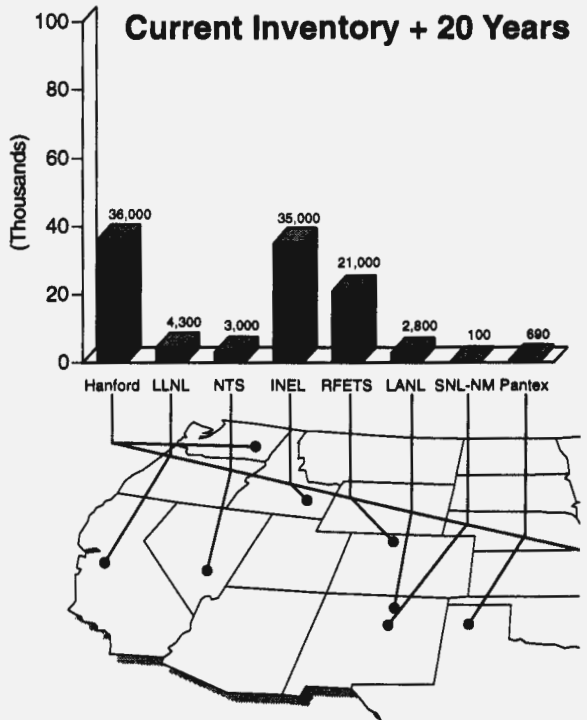
Although alpha LLMW is not a concern to workers or the public as a source of external radiation, precautions must be taken when treating alpha LLMW in order to minimize the likelihood of inhalation or ingestion of radionuclides that emit alpha particles. Alpha LLMW exists at 10 sites. Sites where alpha LLMW would be treated or disposed of are indicated in Table 4.2–1 by the alpha symbol (α).

Remote-handled waste requires special handling facilities for treatment and disposal. Under all alternatives, RH LLMW would be treated and disposed of at the same four sites where the majority of RH LLMW is located: Hanford, INEL, ORR, and SRS.

LLMW Volumes

DOE Sites	Total Volumes (m^3)
1. Ames	0.4
2. ANL-E	160
3. BCL	0.1
4. Bettis	48
5. BNL	190
6. Charleston	3
7. ETEC	17
8. FEMP	2,600
9. GA	43
10. GJPO	1.5
11. Hanford	36,000
12. INEL	35,000
13. KCP	0.8
14. KAPL	220
15. LEHR	7
16. LBL	280
17. LLNL	4,300
18. LANL	2,800
19. Mare Is	52

Figure 4.1-1 LLMW Total

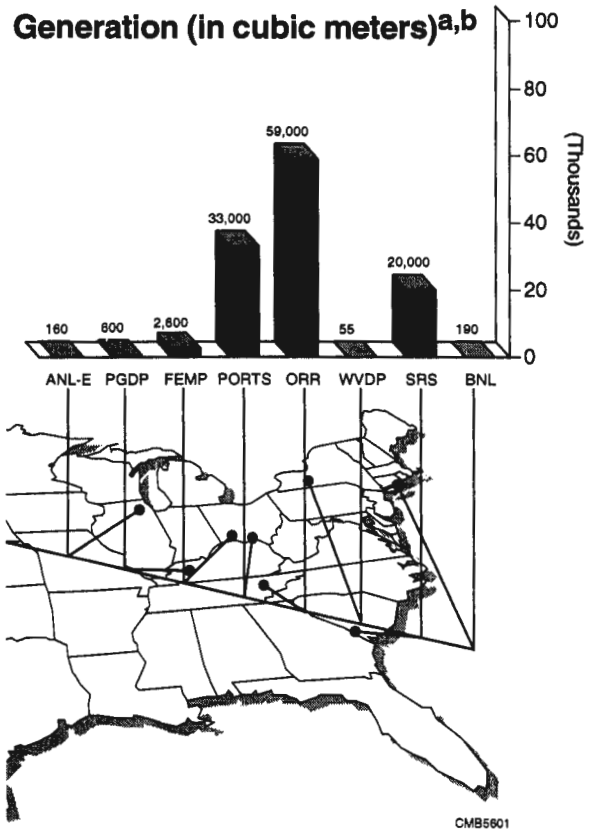


[a] WIPP, the seventeenth major DOE site, would manage only TRUW. Approximately 1,100 m^3 of LLMW exists at other sites within the complex. Hanford's total volume excludes 114,600 m^3 of wastewater to be generated and managed under the HLW program. ORR's total volume excludes 16,000 m^3 of pond sludge shipped for commercial disposal.

[b] Updated inventories and waste generation rates are summarized in Appendix I.

Source: DOE (1994).

Volumes at the 16 Major Sites.



LLMW Volumes—Continued*

DOE Sites	Total Volumes (m^3)
20. Mound	80
21. NTS	3,000
22. Norfolk	6
23. ORR	59,000
24. PGDP	600
25. Pantex	690
26. Pearl H	6
27. Pinellas	0.02
28. PORTS	33,000
29. Ports Nav	1
30. PPPL	0.02
31. Puget So	230
32. RMI	30
33. RFETS	21,000
34. SNL-NM	100
35. SRS	20,000
36. UofMO	2
37. WVDP	55
Total	**219,000**

*Estimated LLMW volumes from waste management activities include current inventory plus 20 years of anticipated generation. Waste volumes used for WM PEIS analysis may vary from latest estimates. Waste volumes at individual sites have been rounded to one or two significant figures. Updated inventories and waste generation rates are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW."

4.2.1 No Action Alternative

The No Action Alternative provides a baseline for the analysis by considering treatment of LLMW at sites with facilities that are currently capable of treating waste to meet the EPA's hazardous waste LDRs. The No Action Alternative also analyzes the indefinite storage of the waste on site at all LLMW sites. Three sites are currently capable of treating LLMW to meet LDRs: INEL, ORR, and SRS. Other sites may experience impacts from the construction of expanded storage, onsite shipping, or certification facilities (where the waste would be examined, characterized, and certified for shipment).

Under this alternative, no new treatment facilities would be built. The No Action Alternative would not comply with RCRA because all the waste would not be treated to meet LDRs and would be placed in storage for an indefinite period of time rather than in disposal facilities.

4.2.2 Decentralized Alternative

The Decentralized Alternative considers treatment of waste to meet RCRA requirements at all 37 LLMW sites. For purposes of this analysis, DOE examined the impacts from treatment at the 16 major LLMW sites. Two of these 16 sites (BNL and SNL-NM) have relatively small amounts of LLMW (less than 200 cubic meters). Most of the other 21 sites that are not major sites have less than 200 cubic meters of LLMW; therefore, DOE assumed that their health and environmental impacts would be similar to those seen at BNL and SNL-NM. However, costs were calculated by using data from all 37 sites.

4.2.3 Regionalized Alternatives

Consolidation of LLMW for treatment and disposal was considered under the four LLMW regionalized alternatives. The regionalized alternatives were

Table 4.2–1. Low-Level Mixed Waste Alternatives

Alternatives	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	3	0	S	S	S	S	TS	S	S	S	TS	S	S	S	S	S	TS	S
Decentralized	37	16	TD	TD	TD	TD	TDα	TDα	TDα	TDα	TD	TD	TD	TD	TDα	TD	TDα	TD
Regionalized 1	11	12			TD	TD	TDα	TDα	TDα	Dα	TD	TD	TD	TD	TDα		TDα	
Regionalized 2	7	6				TD	TDα	TDα		Dα	TD			T	Tα		TDα	
Regionalized 3	7	1				T	Tα	T		Dα	T			T	Tα		Tα	
Regionalized 4	4	6				TD	TDα	Dα		Dα	TD						TDα	
Centralized	1	1				TDα												

Notes: T = treatment to meet land disposal restrictions; D = disposal; S = indefinite storage. A blank indicates that a site does not treat, store, or dispose of waste under the alternative specified. All sites have wastewater treatment capability as needed. Remote-handled (RH) wastes would be treated and disposed on site at Hanford, INEL, ORR, and SRS in all alternatives except No Action. RH waste is stored under No Action. Facilities with the α symbol treat or dispose of contact-handled (CH) alpha waste in addition to non-alpha waste.

LLMW sampling at ORR.

developed to include a reasonable range of intermediate levels of consolidation for treatment and disposal. Regionalized Alternative 1 considers treatment of wastes at 11 sites and disposal at 12 (the 11 treatment sites and NTS). Regionalized Alternative 2 analyzes the impacts of treatment at seven sites with disposal at six sites. Under this alternative, two of the treatment sites (RFETS and PORTS) are not considered for disposal, and NTS is considered for disposal only. Regionalized Alternative 3 analyzes the same seven treatment sites as Regionalized Alternative 2, but it considers disposal only at NTS. Regionalized Alternative 4 considers treatment at four sites—Hanford, INEL, ORR, and SRS—and disposal at six sites (the four treatment sites plus LANL and NTS).

4.2.4 Centralized Alternative

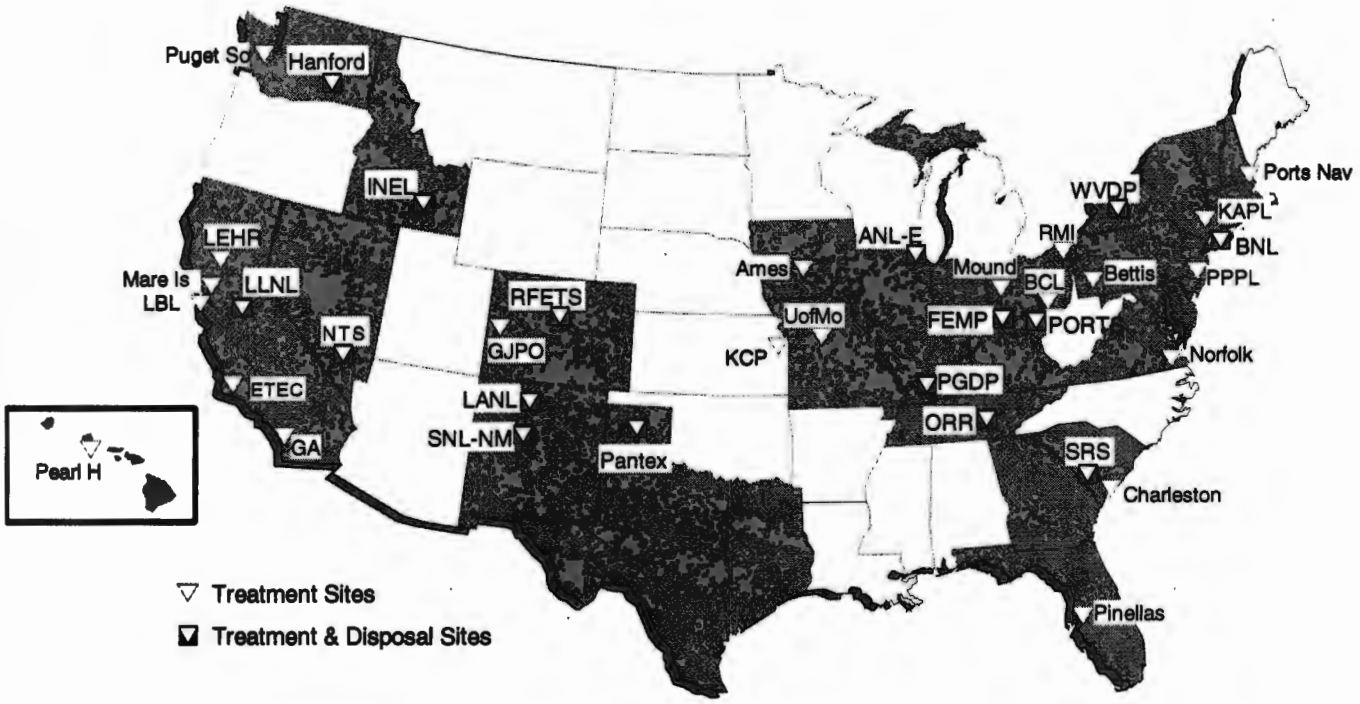
The Centralized Alternative considers LLMW treatment and disposal at a single site within the complex, the Hanford Site. However, other sites around the country may experience impacts from the construction of facilities where the waste would be examined, characterized, certified, and prepared for shipment. The impacts of centralizing disposal at NTS were also analyzed under Regionalized Alternative 3.

4.2.5 Rationale for Treatment and Disposal Alternatives

The seven LLMW treatment alternatives were developed to cover the range of reasonable alternatives. Up to 37 sites as illustrated in Figure 4.2–1 are available for treatment (the centralized and decentralized alternatives, respectively). DOE identified four intermediate alternatives for treating LLMW at 4 to 11 sites (the regionalized alternatives). To develop the variations of the regionalized alternatives, DOE focused on the sites where the largest volumes of LLMW are located. Alpha CH and all RH LLMW would be sent to the closest facility capable of treating those wastes. For all alternatives, DOE assumed that some treatment capabilities would be available at every site for initial treatment of onsite aqueous liquids by means of techniques such as evaporation, neutralization, precipitation, filtration, coagulation, or limited solidification.

The regionalized alternatives consider the impacts of consolidating treatment to meet LDRs at selected sites. Regionalized Alternative 1 considers treatment at 11 sites. This alternative was developed by identifying the location of most of DOE's LLMW and looking for optimal site groupings.

Figure 4.2–1. Locations of the 37 LLMW Sites.



Note: Maps display CH LLMW. RH LLMW is treated and disposed of onsite at the Hanford site, INEL, ORR, and SRS.

Under Regionalized Alternatives 2 and 3, seven sites are considered as potential treatment locations. DOE chose the six sites with the highest waste volumes, and then added LANL. Because a large volume of TRUW at LANL may be reanalyzed and subsequently reclassified as alpha LLMW on the basis of its radionuclide concentration, the volume of LLMW at LANL might significantly increase.

Regionalized Alternative 4 consists of the sites with the three highest volumes (Hanford, INEL, and ORR), as well as SRS, which is the sixth largest in terms of volume. SRS was chosen because it has large volumes of alpha LLMW and TRUW, some of which eventually may be reclassified as LLMW. In addition, an incinerator with an annual LLMW treatment capacity of 8,200 cubic meters of LLMW is scheduled for SRS.

In the Centralized Alternative, all LLMW would be shipped to Hanford for treatment. Hanford currently has the second largest volume of LLMW. However, as Hanford's HLW is treated, a substantial portion of the resulting waste would become LLMW, thereby making the Hanford Site the largest LLMW site.

Candidate disposal sites were selected to reflect the reasonable range of alternatives. However, unlike the treatment analysis, the disposal analysis did not evaluate every site for disposal. Instead, 16 candidate sites were selected as the reasonable upper limit on the basis of screening performed by DOE in coordination with the States under the Federal Facility Compliance Act (FFCAct). The screening applied three exclusionary criteria to the 37 sites with LLMW: (1) sites could not be within a designated 100-year floodplain, (2) sites could not be located

within 61 meters of a seismic fault, and (3) sites had to have sufficient area for a 100-meter buffer zone between the disposal facility and the site boundary. Sites were also removed for other technical and practical reasons.

The Decentralized Alternative looked at disposal at all 16 candidate sites, and the Centralized Alternative looked at disposal at one site—Hanford. Hanford was analyzed because it is expected to have the largest volume of LLMW.

DOE analyzed two of the intermediate alternatives—disposal at 12 sites and at 6 sites—as regionalized alternatives. To define these regionalized alternatives, DOE selected the 11 sites with the largest volume of LLMW and added NTS because it has an LLMW disposal facility with a pending permit. The alternative defined for LLMW disposal included the six sites with currently operating LLW disposal facilities—Hanford, INEL, LANL, NTS, ORR, and SRS. NTS was considered as the single disposal site in Regionalized Alternative 3 to provide a comparison and an alternative to the single disposal location selected under the Centralized Alternative.

4.3 Impacts of Managing LLMW

Although some factors, such as cost, exhibited clear trends across the LLMW alternatives, most did not. Rather, the analysis of the impacts revealed sensitivities at particular sites regardless of the alternative.

When reviewing the impacts and cost identified for the No Action Alternative, it is important to realize that the results for indefinite storage are based on the initial 20 years of that indefinite period. This is consistent with the period of analysis for the other alternatives; however, the analysis of the No Action Alternative does not present the expected impacts from storage beyond this 20-year time frame. The longer-term storage impacts and costs are likely to exceed those for the first 20 years, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of LLMW, where direct risks to workers and the offsite population, and other impacts and costs, are greatly reduced following disposal. The No Action Alternative does not reduce or avoid impacts and costs; rather, it extends impacts and costs for an indefinite period of time.

The following discussion focuses on the impact areas that would be affected by the management of LLMW under the WM PEIS alternatives, identifying trends when appropriate and highlighting noteworthy findings at particular sites.

4.3.1 Health Risks

Risks at sites treating or disposing of LLMW are principally to workers involved in managing LLMW, rather than to noninvolved workers or the public, primarily as a result of physical hazards associated with industrial operations (see Table 4.3–1). As the number of treatment and disposal sites decreases,

Toxic Substances Control Act incinerator at ORR treats LLMW and PCB-contaminated wastes.

Table 4.3–1. Some of the Projected Risks to Workers and the Public From Managing LLMW

Alternative	Number of Sites		Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Disposal Worker Physical Hazard Fatalities	Disposal Worker Cancer Fatalities	Truck[a] Radiation Fatalities	Truck[b] Non-Radiation Fatalities	Rail Radiation Fatalities	Rail Non-Radiation Fatalities
	T	D									
No Action[c]	3	-	2	1	*	NA	NA	NA	NA	NA	NA
Decentralized	37	16	4	1	*	*	1	*	*	*	*
Regionalized 1	11	12	4	1	*	*	1	*	*	*	*
Regionalized 2	7	6	3	1	*	*	1	*	*	*	*
Regionalized 3	7	1	3	1	*	*	*	*	1	*	*
Regionalized 4	4	6	3	1	*	*	1	*	*	*	*
Centralized	1	1	3	1	*	*	*	*	1	*	*

Notes: T = treatment; D= disposal; * = greater than 0 but less than 0.5; NA = not applicable.
[a] Fatalities are from radiation-induced cancer.
[b] Greatest number of fatalities are from physical hazards such as traffic accidents that occur within a 10-year analysis period.
[c] Treatment results under the No Action Alternative include the risks from only the first 20 years of indefinite storage of LLMW.

facilities at the remaining sites become larger and the number of total physical injuries decreases, reflecting an economy of scale due to fewer total workers. There are no notable national trends for offsite population risks from treatment; however, some sites could require alternate organic treatment technologies to minimize risks from thermal treatment of LLMW containing tritium. Under the No Action Alternative, treated waste would be stored indefinitely, with relatively large, potentially adverse consequences.

For disposal, concentrations of some radionuclides and chemicals in the groundwater near disposal facilities could exceed applicable standards at several sites. This would occur in the absence of waste acceptance criteria and other controls, thereby demonstrating the need for performance-based waste acceptance criteria if the sites were selected to manage LLMW. Pretreatment of chemicals and careful management of radionuclide concentrations and waste forms may be required to assure acceptable water quality and to reduce possible human exposures. Intruder risks (see text box, page 32) are generally higher at sites where the waste would have both high radioactivity and long-lived radionuclides. Intruder radiation exposure risks generally decrease with time, reflecting the decay of short-lived radionuclides. Treatment facility accident risks were low under all alternatives, with no sites experiencing cancer fatalities equal to or greater than one in the exposed worker or offsite populations over the 10-year period analyzed. Transportation risks were also low under all alternatives, reflecting relatively low transportation requirements. Table 4.3–1 presents projections of some risks for the LLMW alternatives.

4.3.2 Air Quality Impacts

The management of LLMW would not cause air quality standards to be approached or exceeded at most sites. However, centralization of treatment at Hanford and disposal at NTS could cause adverse air quality impacts requiring special emission control measures for criteria air pollutants. Vehicular emissions during construction at RFETS could require additional control measures to reduce emissions to acceptable levels if waste at these sites were stored, treated, or disposed of on site. Emissions of hazardous air pollutants, including radionuclides, were estimated to be below the applicable standards at every site.

4.3.3 Water Resources Impacts

Impacts to water availability tend to decrease as the LLMW management facilities are centralized. Major impacts on water availability from increased use at the sites are unlikely, although there is the potential for adverse impacts at LLNL Site-300, under all alternatives analyzed.

4.3.4 Economic and Population Impacts

Nationwide, the largest economic benefits resulting from LLMW management would occur under the Decentralized Alternative and generally decrease as the alternatives become more centralized. The greatest economic benefit at any site occurs when LLMW is managed at that site. The greatest number of new jobs created by LLMW management would occur in the region containing Hanford under the Centralized Alternative and in the region containing INEL under Regionalized Alternative 4. The national economy would not be affected by total project expenditures for the construction, operation, or transportation associated with any of the LLMW alternatives. No region would experience a population increase of 1% or greater.

4.3.5 Infrastructure Impacts

Although no offsite infrastructure impacts are expected to occur, proposed LLMW activities would affect the onsite infrastructure at 14 sites. Nine sites would experience increased requirements for water, wastewater treatment, or electrical power of 5% or more of current system capacity. The greatest increases would occur at RFETS under the Decentralized Alternative and Regionalized Alternative 1 and at Hanford under the Centralized Alternative, when waste is consolidated for treatment and disposal at these sites. Construction of additional storage under the No Action Alternative would also impact RFETS and INEL. However, only the projected volume of wastewater at Hanford (under the Centralized Alternative) is estimated to exceed the existing treatment capacity. Onsite transportation infrastructure would be affected at 12 sites because of site employment increases of 5% or more above current levels.

4.3.6 Costs

Costs decrease as the number of treatment and disposal sites decreases, ranging from $12.3 billion under the Decentralized Alternative to $5.2 billion under the No Action Alternative. Transportation costs are much lower than facility costs, making shipment to facilities at another site generally less expensive than building a new facility at that site. Table 4.3–2 provides the estimated cost to manage LLMW for each of the LLMW alternatives over the next 20 years.

4.3.7 Ecological Resources, Environmental Justice, Land Use, and Cultural Resources Impacts

The WM PEIS analysis did not reveal significant differences among the alternatives in these four impact areas, nor did it reveal any major impacts under any alternative. However, impacts to ecological and cultural resources depend to some degree on the treatment and disposal technologies selected and their location at each site and would be evaluated in site- or project-specific NEPA reviews. An assessment of potential environmental justice concerns from management of LLMW indicated that minority and low-income populations near the LLMW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the LLMW alternatives. Land use is not a good criterion for differentiating among alternatives because the alternatives do not use much land when compared with the amount available at every site.

Table 4.3–2. LLMW Estimated Life-Cycle Costs (Billions of 1994 Dollars)

Alternative	Number of Sites		Total (Including Truck Transport)	Transportation Costs	
	T	D		Truck	Rail
No Action[a]	3	0	5.2	0	0
Decentralized	37	16	12.3	0.001	0.0007
Regionalized 1	11	12	11.0	0.004	0.002
Regionalized 2	7	6	9.5	0.02	0.005
Regionalized 3	7	1	8.4	0.06	0.02
Regionalized 4	4	6	8.4	0.006	0.005
Centralized	1	1	7.7	0.03	0.01

Notes: T = treatment; D = disposal.
[a] Costs under the No Action Alternative include those from only the first 20 years of indefinite storage.

At a Glance:
Low-Level Waste

No Action Alternative:

- Disposal at six sites under current arrangements. Sites use existing treatment facilities.

Decentralized Alternative:

- Disposal at 16 sites. A minimum level of treatment at each site is assumed.

Seven Regionalized Alternatives:

- Disposal at 12, 6, or 2 sites. In three alternatives, treatment to reduce volumes is also assumed, with treatment at 11, 7, or 4 regional sites.

Five Centralized Alternatives:

- Disposal at one site (either Hanford or NTS). In three alternatives, treatment to reduce volumes is also assumed.

Preferred Alternative:

- Each site would conduct minimum treatment onsite.
- Regional disposal at two or three sites to be selected after consultations with stakeholders from among the following six sites: Hanford, INEL, LANL, NTS, ORR, and SRS.

LLW Data and Major Assumptions:

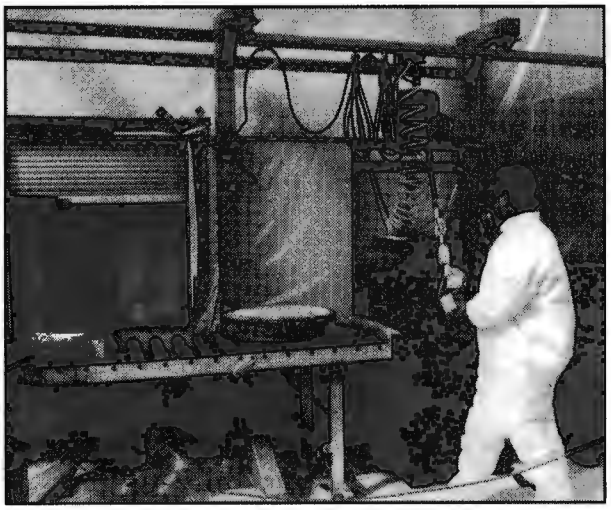
- LLW is currently generated, projected to be generated, or stored at 27 DOE sites.
- DOE will need to manage 1.5 million cubic meters of LLW over the next 20 years.
- New facilities would be constructed during a 10-year period; LLW currently in inventory and newly generated would be treated during the 10-year period following construction.
- Wastewater treatment would continue at every site.
- No waste acceptance criteria were imposed on disposal sites.

What Did We Learn from the Results?

- At a national level, costs, risks, and impacts would be greater for volume reduction than for minimum treatment.
- Centralized disposal would result in transportation of large amounts of waste with commensurately greater risk of both traffic accidents and radiation exposure. Rail transport has slightly lower risks than truck transport.
- Costs decrease as the number of treatment and disposal sites decreases.
- Radionuclide limits would be required for disposal at some sites.

5 Low-Level Waste

- *LLW is material that is not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct tailings.*
- *DOE will need to manage an estimated 1.5 million cubic meters of LLW over the next 20 years.*
- *LLW is currently generated, anticipated to be generated, or stored at 27 DOE sites as a result of nuclear weapons production and dismantlement, reactor operations, and research.*
- *DOE must select treatment and disposal sites for LLW.*



Some LLW can be compacted to 1/5th of its original size.

5.1 Analysis

The character of the waste is as important as waste volume in determining the potential impacts resulting from LLW management. LLW can contain many different radionuclides in many combinations and can exist in many forms, ranging from dilute liquids to activated metal equipment.

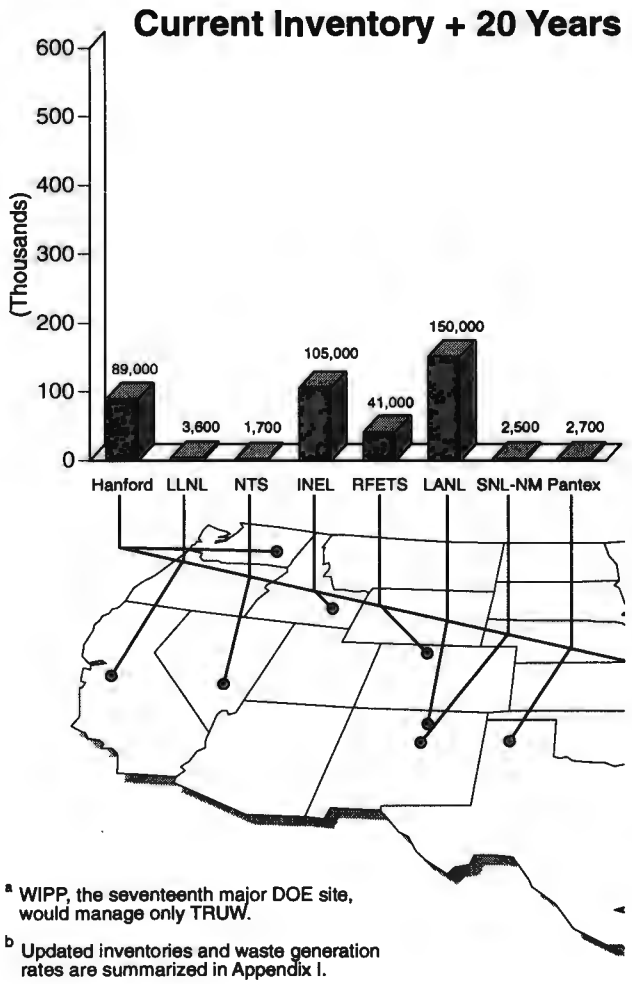
Approximately 1.5 million cubic meters of LLW is generated, anticipated to be generated, or stored at 27 DOE sites. Although 27 sites manage LLW, seven sites generate more than 80% of it—Hanford, INEL, LANL, ORR, PGDP, PORTS, and SRS. Figure 5.1-1 presents the total estimated volumes at all 27 sites. The distribution of LLW at the 16 major sites is illustrated by the bar chart and map.

DOE also has responsibility for two other types of LLW: commercially generated greater-than-Class-C (GTCC) waste and special-case waste. GTCC LLW is so named because it is more highly radioactive than Class C waste according to a classification system developed by the U.S. Nuclear Regulatory Commission; GTCC LLW is not suitable for near-surface disposal and will likely need to be disposed of in a geologic repository. Additionally, within the LLW (as well as LLMW and TRUW) category, there are wastes whose characteristics require special considerations and different management from that of most LLW. These wastes are special-case wastes. As detailed analyses are conducted, management plans for each waste stream would be established. These analyses could determine that some LLW streams currently managed as special cases meet the waste acceptance criteria for a disposal facility, and these waste streams would no longer be considered special case notwithstanding their earlier designation. Because programs for management of special-case and GTCC LLW have not been fully defined, these LLW groups are excluded from the WM PEIS analysis and will be addressed in separate NEPA reviews or in a supplement to the WM PEIS.

LLW Volumes

DOE Sites	Total Volumes (m^3)
1. Ames	110
2. ANL-E	6,700
3. Bettis	12,000
4. BNL	5,600**
5. Fermi	1,500
6. FEMP	0
7. Hanford	89,000
8. INEL	105,000
9. KCP	23
10. KAPL	19,000
11. LBL	1,300
12. LLNL	3,600
13. LANL	150,000

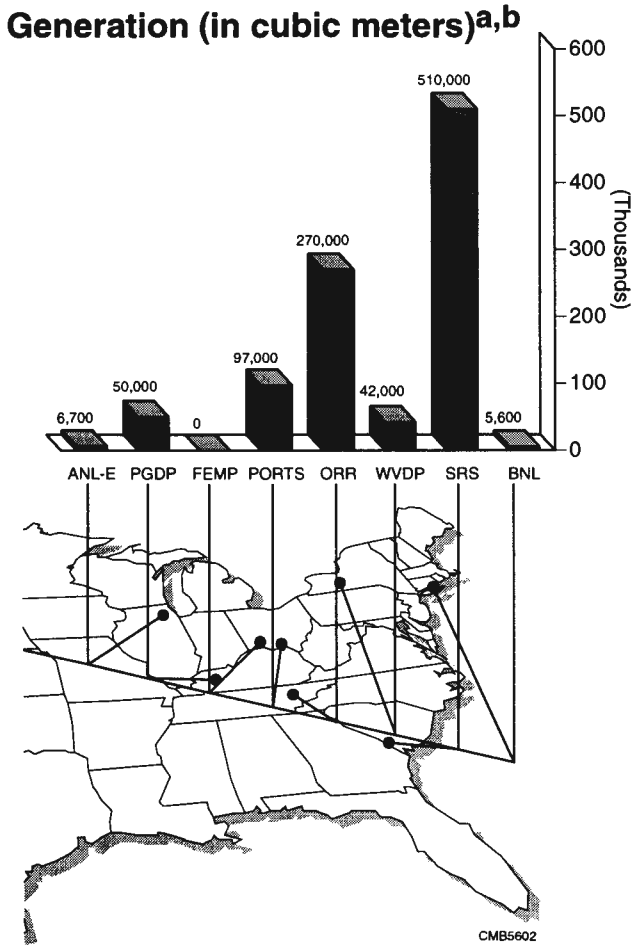
Figure 5.1-1. LLW Total



[a] WIPP, the seventeenth major DOE site, would manage only TRUW.

[b] Updated inventories and waste generation rates are summarized in Appendix I.

Volumes at the 16 Major Sites.



LLW Volumes (Continued)*

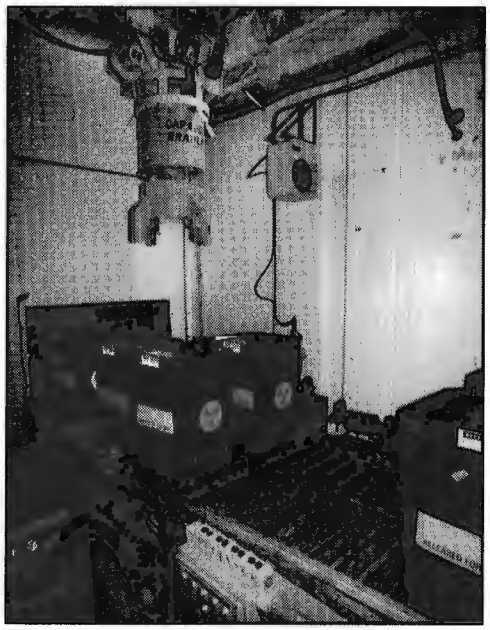
DOE Sites	Total Volumes (m^3)
14. Mound	38,000
15. NTS	1,700**
16. ORR	270,000**
17. PGDP	50,000
18. Pantex	2,700**
19. Pinellas	1,300
20. PORTS	97,000
21. PPPL	220
22. RMI	51,000
23. RFETS	41,000
24. SNL-NM	2,500
25. SRS	510,000
26. SLAC	2,500
27. WVDP	42,000**
Total	**1,500,000**

*Estimated LLW volumes from waste management activities include current inventory plus 20 years of anticipated generation. Waste volumes used in the WM PEIS analysis may vary from latest site estimates.

**Updated inventories and waste generation rates are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW."

DOE evaluated two treatment strategies for LLW:

- Minimum Treatment, defined as the least amount of treatment required prior to either onsite disposal or transport to another site for disposal. Minimum treatment includes solidification of liquids and fines (powdered material) and packaging.
- Volume Reduction, which reduces the overall volume of LLW by means of a variety of treatment techniques. Volume reduction can be achieved with several technologies, including thermal destruction, compaction or supercompaction, size reduction, evaporation and concentration. For disposal, DOE evaluated the impacts associated with both shallow land burial and engineered disposal facilities.



LLW in 270-liter, square cement-filled drums to be stored in specially designed aboveground vaults.

DOE analyzed transportation impacts associated with each alternative. Both truck and rail transportation were analyzed by using routing models that incorporate general principles of minimizing distance and transportation time. The routes were selected to be consistent with existing practices and all applicable regulations and guidelines; however, because the routes were determined for the purposes of risk assessment, they do not necessarily represent actual routes that DOE would use to transport waste in the future.

5.2 Alternatives

The WM PEIS considers 14 alternatives for treatment and disposal of LLW within the four categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. Treatment and disposal activities vary by alternative and by site. Each of the 14 alternatives was developed in order to estimate health risks, environmental impacts, and costs associated with the range of treatment and disposal options available to DOE and to provide information for decisions about where to locate LLW treatment and disposal facilities. Table 5.2–1 shows the sites where LLW would be treated and disposed of under each alternative.

5.2.1 No Action Alternative

The No Action Alternative provides a baseline for the analysis that approximates the current DOE program. Under the No Action Alternative, LLW would be treated at existing facilities and shipped to one of six DOE disposal sites. Today, most DOE LLW disposal occurs at NTS and Hanford. The six sites now operating have sufficient designated area for the proposed LLW disposal; thus, no new sites would be necessary.

5.2.2 DECENTRALIZED ALTERNATIVE

The Decentralized Alternative considers disposal of LLW at 16 sites following its minimum treatment at all 27 sites with LLW.

5.2.3 REGIONALIZED ALTERNATIVES

Regionalized Alternative 1 considers disposal at 12 sites, after minimum treatment at all sites. Regionalized Alternative 2 analyzes the impacts resulting from disposal at the same 12 sites after volume reduction at 11 of these sites. In addition to the Decentralized Alternative, Regionalized Alternatives 1 and 2 are the only alternatives that propose disposal at FEMP, LLNL, Pantex, and PGDP.

The remainder of the regionalized alternatives (Regionalized Alternatives 3 through 7) consolidate most LLW treatment and disposal at eight sites: Hanford, INEL, LANL, NTS, ORR, PORTS, RFETS, and SRS. Although the sites are the same for

Table 5.2–1. Low-Level Waste Alternatives

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	10*	6				TD	TD	D	T	D	TD	T			T		TD	
Decentralized		16	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Regionalized 1		12			D	D	D	D	D	D	D	D	D	D	D		D	
Regionalized 2	11	12			TD	TD	TD	TD	TD	D	TD	TD	TD	TD	TD		TD	
Regionalized 3		6				D	D	D		D	D						D	
Regionalized 4	7	6				TD	TD	TD		D	TD			T	T		TD	
Regionalized 5	4	6				TD	TD	D		D	TD						TD	
Regionalized 6		2				D											D	
Regionalized 7		2								D							D	
Centralized 1		1				D												
Centralized 2		1								D								
Centralized 3	7	1				TD	T	T			T			T	T		T	
Centralized 4	7	1				T	T	T		D	T			T	T		T	
Centralized 5	1	1				TD												

Notes: T = treat. "Treat" in the context of LLW means volume reduction by means of thermal organic destruction, size reduction, and compaction followed by solidification. Sites carry out "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. D = Dispose. Each of the 6-site disposal cases uses the same sites; each of the 12-site disposal cases uses the same 12 sites. A blank indicates that neither treatment nor disposal is proposed for this site under the alternative specified.
*Ten sites use existing facilities for volume reduction. Three sites (LBL, RMI, and Mound) not listed as major sites above include volume reduction facilities.

most of the regionalized alternatives, impacts at the sites vary because of the use of different treatment technologies and volumes of waste received from other sites. For example, Regionalized Alternatives 3 and 4 would dispose of waste at the same six sites. However, under Regionalized Alternative 3, DOE would conduct only minimum treatment before disposal, whereas under Regionalized Alternative 4, DOE would use volume reduction techniques in addition to minimum treatment prior to disposal. Because PORTS and RFETS would become waste consolidation sites for volume reduction before disposal under Regionalized Alternative 4, they would have a greater potential to impact the environment than they would under the minimum treatment proposed in Regionalized Alternative 3, although both alternatives propose the same six sites for disposal.

Regionalized Alternative 5 considers volume reduction at four sites and disposal at six, compared with volume reduction at seven sites under Regionalized Alternative 4. Regionalized Alternatives 6 and 7 each consider disposal at two sites after minimum treatment: Hanford and SRS under Regionalized Alternative 6, and NTS and SRS under Regionalized Alternative 7.

5.2.4 Centralized Alternatives

DOE analyzed disposal at one site under the centralized alternatives. Five alternatives were considered. Centralized Alternatives 1 and 2 would dispose of LLW at Hanford and NTS, respectively, after minimum at all DOE sites. Centralized Alternative 3 evaluates disposal at Hanford after volume reduction treatment at seven sites. In Centralized Alternative 4, NTS would be the single disposal site after volume reduction at the same seven sites considered under Centralized Alternative 3. Centralized Alternative 5 considers both the consolidation of LLW for volume reduction and disposal at Hanford.

NTS disposal facility.

5.2.5 Rationale for Defining Treatment and Disposal Alternatives

DOE generally identified sites as candidates for locating LLW treatment facilities if the sites had large volumes of LLW. In addition, the alternatives were formulated to consolidate LLW for treatment and disposal at locations that minimized transportation by shipping to the closest available treatment or disposal site. DOE used the same treatment (volume reduction) and disposal locations for LLW as those identified for the LLMW alternatives in Chapter 6 of Volume I.

The number of disposal sites considered covers a reasonable range of sites—from 1 to 16. The 16 candidates are those also under consideration for LLMW.

5.3 Impacts of Managing LLW

Some impacts illustrated clear trends across the alternatives; others reveal sensitivities at particular sites regardless of the alternative. The following discussion focuses on the impacts that would be affected by the management of LLW under the alternatives, identifying trends when appropriate and highlighting noteworthy findings at particular sites.

5.3.1 Health Risks

The greatest risk posed by the management of LLW is to workers involved in management activities, primarily as a result of physical hazards. Radiation exposure risks to noninvolved workers and the public are a function of the treatment technology and site characteristics. The highest risks to the public are projected to occur as a result of volume reduction treatment of tritium-contaminated waste at FEMP, Hanford, LLNL, ORR, and PORTS. The greatest potential consequences for facility accidents would occur at sites treating waste with higher concentrations of radionuclides; only LLNL, LANL and Hanford, however, have estimates of potential fatalities exceeding one under any alternative. Concentrations of radionuclides in the groundwater near disposal facilities might exceed applicable standards at several sites in the absence of waste acceptance criteria and other controls; accordingly, DOE would need to implement performance-based waste acceptance criteria at those sites if they were selected. Management of radionuclide concentrations and waste forms could be required to assure acceptable water quality and acceptable human health risks. Transportation risks from both traffic accidents and radiation exposure are estimated to be greatest under the centralized alternatives, which involve the largest number of vehicle miles traveled. Travel by rail rather than truck for bulk shipments could reduce transportation risk. Table 5.3–1 presents selected estimates of the risks of LLW management.

Table 5.3–1. Some of the Projected Risks to Workers and the Public From Managing LLW

Alternative	Number of Sites		Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Disposal Worker Physical Hazard Fatalities	Disposal Worker Cancer Fatalities	Truck[a] Radiation Fatalities	Truck[b] Non-Radiation Fatalities	Rail[a] Radiation Fatalities	Rail Non-Radiation Fatalities
	T	D									
No Action	10[c]	6	3	1	*	4	3	5	12	1	1
Decentralized		16	2	1	*	6	2	*	1	*	*
Regionalized 1		12	2	1	*	6	3	*	1	*	*
Regionalized 2	11	12	4	1	1	4	2	*	1	*	*
Regionalized 3		6	2	1	*	5	3	2	3	*	*
Regionalized 4	7	6	4	2	*	4	2	2	3	*	*
Regionalized 5	4	6	4	2	*	4	2	2	4	*	*
Regionalized 6		2	2	1	*	6	2	4	10	1	1
Regionalized 7		2	2	1	*	6	1	4	10	1	1
Centralized 1		1	2	1	*	1	3	16	37	2	3
Centralized 2		1	2	1	*	1	2	15	38	2	3
Centralized 3	7	1	4	1	*	1	2	15	35	2	3
Centralized 4	7	1	4	1	*	*	2	14	37	2	2
Centralized 5	1	1	4	2	*	1	2	15	37	2	3

Notes: T = treat; D = dispose; * = greater than 0 but less than 1. "Treat" in the context of LLW means volume reduction by means of thermal organic destruction, size reduction, and compaction followed by solidification. All sites do "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment.

[a] Fatalities are from radiation-induced cancer.

[b] Greatest number of fatalities are from physical hazards such as traffic accidents that occur within the 10-year analysis period (20-year analysis period for No Action).

[c] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above, also have volume reduction facilities.

5.3.2 Air Quality Impacts

The management of LLW would not cause the air quality standards to be approached or exceeded at most sites. However, decentralized treatment and disposal at BNL or centralized disposal at NTS could cause adverse air quality impacts (from construction equipment and vehicular emissions), thereby requiring additional control measures for criteria pollutants. Emissions of radionuclides were estimated to be below the applicable standards at every site.

5.3.3 Water Resources Impacts

Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL Site-300 and the WVDP. Potential water quality effects from disposal are discussed in Section 5.3.1.

5.3.4 Economic and Population Impacts

Total jobs in the regional economies for waste management activities could exceed 1% of the regional baseline at six of the 16 major sites under one or more alternatives, with the largest proportion at Hanford (approximately 3.3%) under Centralized Alternative 5. None of the alternatives would affect the national economy. Regions surrounding five sites would experience population increases exceeding 1%, with the largest being the region surrounding INEL with a 3% increase under Regionalized Alternative 5.

5.3.5 Infrastructure Impacts

Although proposed activities would affect the onsite infrastructure at 13 of the major sites, no infrastructure impacts are expected offsite. New requirements for wastewater treatment or electrical power for proposed LLW facilities would equal or exceed 5% of current system capacity at seven sites. The most significant increases would be at the WVDP under the Decentralized Alternative, at INEL under Regionalized Alternative 5 when volume reduction and disposal are consolidated at that site, and at Hanford (centralized alternatives). However, only Hanford and the WVDP would approach or exceed system capacity. Twelve sites would have site employment increases of 5% or more of current site employment during construction, which could lead to traffic increases that would affect the onsite transportation infrastructure.

Integration of remote sensing and computer technology is used for nonintrusive characterization of waste sites.

5.3.6 Costs

Costs decrease as the numbers of treatment and disposal sites decrease, ranging from approximately $16.8 to $11.1 billion for minimum treatment, and $19.8 to $15.3 billion for volume reduction. The increased cost of volume reduction more than offsets the cost savings from reducing the volume of waste disposed of. Transportation costs are substantially lower than facility costs, making shipment to available facilities at another site generally less expensive than building new onsite facilities. Table 5.3–2 provides the estimated costs to manage LLW under each of the WM PEIS alternatives over the 20-year analysis period.

Table 5.3–2. LLW Estimated Life-Cycle Costs (Billions of 1994 Dollars)

Alternatives	Number of Sites		Total (Including Truck Transportation)	Transport Costs	
	T	D		Truck	Rail
No Action	10*	6	18.1	0.07	0.14
Decentralized		16	16.8	0.05	0.02
Regionalized 1		12	16.4	0.06	0.02
Regionalized 2	11	12	19.5	0.06	0.02
Regionalized 3		6	14.9	0.23	0.07
Regionalized 4	7	6	19.8	0.22	0.07
Regionalized 5	4	6	19.7	0.34	0.08
Regionalized 6		2	13.0	0.65	0.17
Regionalized 7		2	13.9	0.67	0.18
Centralized 1		1	12.2	2.46	0.44
Centralized 2		1	11.1	2.25	0.43
Centralized 3	7	1	18.2	2.34	0.43
Centralized 4	7	1	17.3	2.15	0.43
Centralized 5	1	1	15.3	2.45	0.43

Notes: T = treat; D = dispose. "Treat" in the context of LLW means volume reduction by means of thermal organic destruction, size reduction, or compaction followed by solidification. All sites do "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.
* Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

5.3.7 Ecological Resources, Environmental Justice, Land Use, and Cultural Resources Impacts

The WM PEIS did not reveal significant differences among the alternatives in these four impact areas, nor did it reveal any major impacts under any alternative. However, impacts to ecological and cultural resources depend to a large degree on the technologies and the location of waste management activities at each site and would be evaluated after sites have been selected for LLW management. Assessment of potential environmental justice concerns from management of LLW indicated that, with the exception of low-income populations at PORTS, minority and low-income populations near the LLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the LLW alternatives. Land use is not a good criterion for differentiating among alternatives because the alternatives do not use much land when compared with the amount available at each site.

At a Glance: Transuranic Waste

No Action Alternative:

- Continue storage in existing facilities.

Decentralized Alternative:

- Sites with small amounts would transport to 10 largest sites for storage until disposal at WIPP.

Three Regionalized Alternatives:

- Contact-handled TRUW would be treated at three or five sites and remote-handled TRUW would be treated at two sites, and then transported to WIPP for disposal.
- Two levels of treatment are evaluated. One alternative examines treatment to an intermediate level and two to more stringent levels to meet RCRA land disposal restrictions (LDRs).

Centralized Alternative:

- Contact-handled TRUW would be transported to WIPP for treatment to meet LDRs and for disposal. Remote-handled TRUW would be transported to ORR and Hanford for treatment to meet LDRs and then to WIPP for disposal.

Preferred Alternative:

- Nine major sites would treat and store their own waste onsite.
- Regional treatment and storage at INEL, ORR, and SRS.

TRUW Data and Major Assumptions:

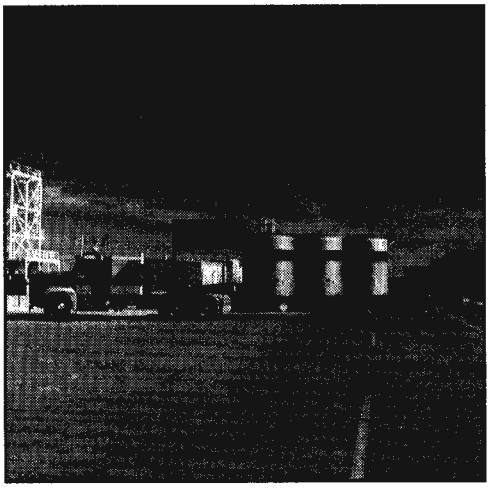
- TRUW is managed, or may be managed in the future, at 17 DOE sites, including WIPP.
- DOE will need to manage approximately 132,000 cubic meters of TRUW over the next 20 years.
- All TRUW is assumed to be mixed waste.
- For the transportation analysis, WIPP is assumed to be the geologic repository.
- Disposal impacts were not evaluated.
- New facilities would be constructed during a 10-year period; waste in storage and newly generated waste would be treated during the 10 years following construction.
- Characterization facilities would be constructed at each site before shipment.

What Did We Learn From the Results?

Transportation risks and costs were roughly equivalent for all alternatives involving shipment to WIPP.

6 Transuranic Waste

- *TRUW is generated during weapons and other research and development, nuclear weapons production and dismantlement, and fuel reprocessing. It contains elements with atomic numbers greater than that of uranium, which has an atomic number of 92.*
- *DOE will need to manage approximately 132,000 cubic meters of TRUW over the next 20 years.*
- *TRUW is managed, or may be managed in the future, at 13 of the major sites and at four other sites.*
- *Although approximately 60% of TRUW contains both radioactive and hazardous components, DOE assumes that all TRUW is mixed waste for purposes of the WM PEIS analysis.*
- *DOE must select sites for the treatment and storage of TRUW.*



TRUPACT-II demonstration containers show how transuranic wastes will be shipped.

6.1 Analysis

Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, per gram of waste, with half-lives greater than 20 years, except for (a) high-level radioactive waste; (b) waste that the Secretary has determined, with concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or (c) waste that NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61. The radioactive nuclides in TRUW emit alpha radiation, which can be contained by minimal shielding but can severely damage lung tissue if inhaled. TRUW requires long-term isolation from the environment. It is produced during research and development, nuclear weapons production, and fuel reprocessing. TRUW contains traces of plutonium, neptunium, americium, curium, and californium. For the purpose of analysis, DOE assumed that all TRUW is mixed waste (containing both radioactive and hazardous components), subject to both radioactive and hazardous waste regulations.

The radiological profiles at each site were assigned uniformly to each waste stream on the basis of the volume of the waste stream at the site. These radiological profiles identify the radionuclides likely to be encountered on the basis of a knowledge of the process that generates the waste and some limited sampling of stored TRUW. These profiles ultimately determine risk and impacts. TRUW is also categorized as either CH or RH. DOE analyzed CH and RH TRUW separately in the WM PEIS to account for their different handling and treatment requirements.

DOE plans to dispose of its TRUW generated by defense activities (and retrievably stored since 1970) at a geologic repository called WIPP, located near Carlsbad, New Mexico. TRUW generated and managed before 1970 is being addressed as part of DOE's environmental restoration program. Disposal of TRUW cannot begin until DOE

meets a series of regulatory requirements imposed under the Waste Isolation Pilot Plant Land Withdrawal Act. Before shipment for disposal, all TRUW will be required to meet waste acceptance criteria (WAC) that will be established by DOE in consultation with EPA and the State of New Mexico. The WAC for WIPP are not yet final, and treatment (such as reducing the potential for gas generation in the repository) could be required to dispose of waste at WIPP.

Table 6.1–1 lists the 13 major sites that have or are expected to generate or manage TRUW. Four other sites, ETEC, LBL, Mound, and UofMo, also have TRUW. The environmental impacts and costs for each waste management alternative considered in the WM PEIS were fully evaluated for all TRUW sites except ETEC, LBL, Mound, SNL-NM, UofMO, and WVDP. For these six sites, the volumes of TRUW were included in the estimated waste volumes for treatment or storage at regionalized or centralized facilities, but impacts were not analyzed because volumes were small. Since publication of the Draft WM PEIS, DOE issued updated information on TRUW volumes. Appendix I of the Final WM PEIS addresses how more recent TRUW data may affect the alternatives in the WM PEIS. Part of this more recent information is the addition of "small-quantity" sites that have or are expected to generate or store TRUW. The TRUW volumes at these small-quantity sites constitute less than 1% of the total TRUW inventory and would not affect the evaluation of the TRUW alternatives.

Figure 6.1–1 presents the estimated total volume of TRUW from waste management activities at the 16 sites that have TRUW currently. TRUW is not currently present at WIPP.

6.2 Alternatives

The TRUW analysis considered six alternatives for both CH TRUW and RH TRUW. Treatment and storage activities vary by alternative and by site. Table 6.1–1 shows the sites where TRUW would be treated and stored under each alternative.

Each of the alternatives was developed to evaluate the health risk, environmental impacts, and costs associated with the range of treatment and storage alternatives available to DOE and to provide input for a decision about where to locate TRUW treatment and storage facilities.

The analysis includes alternatives where TRUW would be treated to LDR levels. Although the WIPP

Table 6.1–1. Transuranic Waste Alternatives

Alternative	CH Treat	RH Treat	Treat Stand	ANL-E	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	RFETS	SNL-NM[d]	SRS	WIPP	WVDP[d]
No Action	11	5	WIPP-WAC	TS	TS	TS	TS	TS	S	TS	S	TS	S	TS		S
D	16	5	WIPP-WAC	TS	TS	TS	TS	TS	TS	TS	T	TS	T	TS		T
R-1	5	2	Reduced gas		TS[a]	TS	TS			TS[b]		TS		TS		
R-2	5	2	LDRs		TS[a]	TS	TS			TS[b]		TS		TS		
R-3	3	2	LDRs		TS[a]	TS				TS[b]				TS		
C	WIPP	2	LDRs		TS[c]					TS[b]					T	

Notes: D = Decentralized Alternative; R-1 = Regionalized Alternative 1; R-2 = Regionalized Alternative 2; R-3 = Regionalized Alternative 3; C = Centralized Alternative; T = treatment to one of three standards: process to current planning basis WIPP-WAC; shred and grout to reduce potential for gas generation in the repository (Reduced Gas); or treat to meet LDRs by means of thermal organic destruction and complete treatment train; S = storage after treatment under No Action and Decentralized Alternatives or storage of current inventory under No Action Alternative. A blank indicates that a site would not treat, store, or dispose of waste under the alternative specified.

[a] Hanford would treat both CH and RH waste.

[b] ORR would treat RH waste only.

[c] Hanford would treat RH waste only.

[d] Small waste volumes at SNL-NM and WVDP; impacts not analyzed.

Land Withdrawal Act amendments contained in the 1997 Defense Authorization Act render the RCRA LDRs inapplicable to waste to be disposed of at WIPP, LDR-treatment alternatives are reasonable alternatives for management activities and practices.

6.2.1 No Action Alternative

Under the No Action Alternative, DOE would continue to characterize, process, and package newly generated TRUW to meet current WIPP-WAC for storage at sites with existing or planned facilities. DOE would continue to store TRUW in existing storage facilities and would not ship TRUW for offsite storage or disposal. All sites are assumed to have adequate capabilities to package and store TRUW generated in the future. Eleven sites are projected to generate TRUW in the future, including five sites generating both CH and RH TRUW. The No Action Alternative does not assess the health risks, environmental impacts, or costs of removing TRUW from retrievable storage and repackaging it.

6.2.2 Decentralized Alternative

Under the Decentralized Alternative, DOE would, as needed, treat and package TRUW to meet the current planning basis WIPP-WAC at the 16 sites. After treatment, CH and RH TRUW would be shipped from the 6 sites with smallest amounts to the nearest of the 10 sites with the largest amounts of TRUW for storage prior to disposal. All TRUW would be shipped to WIPP for disposal.

6.2.3 Regionalized Alternatives

The regionalized alternatives consider the consolidation of TRUW for treatment and storage prior to its disposal at WIPP. Three regionalized alternatives were analyzed, with varying degrees of treatment at six and four sites and storage at those sites prior to disposal.

Under Regionalized Alternative 1, CH TRUW would be shipped from the 10 smallest generators to the 4 sites with the largest volumes of TRUW (Hanford, INEL, LANL, and SRS) for treatment and storage. In addition, RFETS would continue to treat its own waste, but would not receive waste from other sites. RH TRUW would be shipped from ANL-E, INEL, and LANL to Hanford or ORR for treatment and storage. At all six treatment sites, TRUW would be treated to an intermediate level to reduce its gas generation potential and shipped from those sites to WIPP for disposal. The six treatment sites proposed under this alternative have 95% of current and anticipated TRUW inventories.

Under Regionalized Alternative 2, DOE would use the same waste consolidation configuration as in Regionalized Alternative 1, except that TRUW would be treated to meet LDRs and then shipped to WIPP for disposal. With this alternative, DOE can compare the impacts of intermediate treatment under Regionalized Alternative 1 with the impacts of LDR treatment; the impacts from both Regionalized Alternatives 1 and 2 can be compared to the Decentralized Alternative to meet WIPP-WAC where 98% of the waste would be treated at the same six sites.

Regionalized Alternative 3 considers the consolidation of waste for treatment at four sites (Hanford, INEL, ORR, and SRS) where approximately 80% of the TRUW is already located or is expected to be generated. CH TRUW would be treated at Hanford, INEL, and SRS; RH TRUW would be treated at Hanford and ORR. Under this alternative, TRUW would be treated to meet LDRs and shipped to WIPP for disposal.

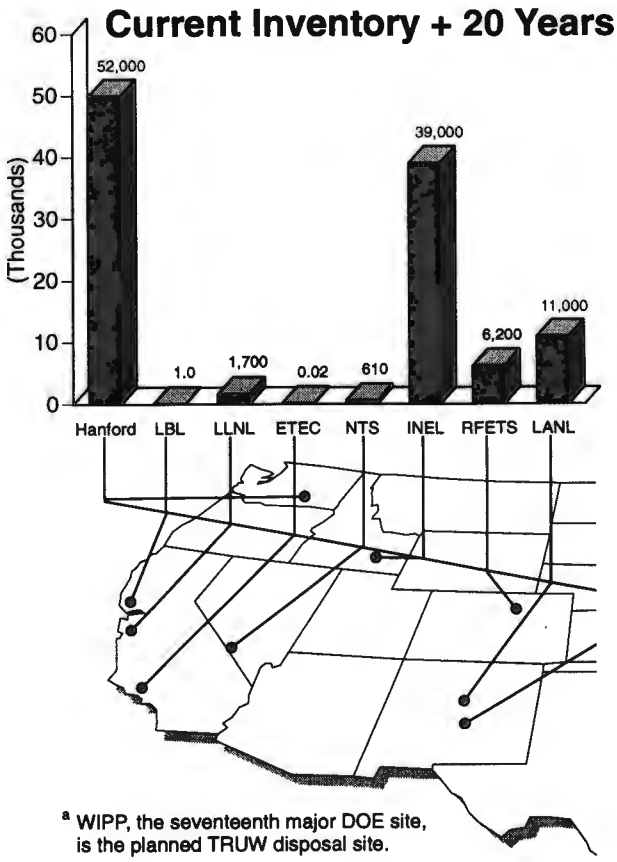
6.2.4 Centralized Alternative

Under the Centralized Alternative, DOE would ship all CH TRUW to WIPP for treatment to meet LDRs and for disposal. RH TRUW would be shipped to Hanford and ORR for treatment to meet LDRs and then shipped to WIPP for disposal.

TRUW Volumes

DOE Sites	Total Volumes (m^3)
1. ANL-E	1,300
2. ETEC	0.02
3. Hanford	52,000
4. INEL	39,000
5. LANL	11,000
6. LBL	1
7. LLNL	1,700
8. Mound	1,500
9. NTS	610

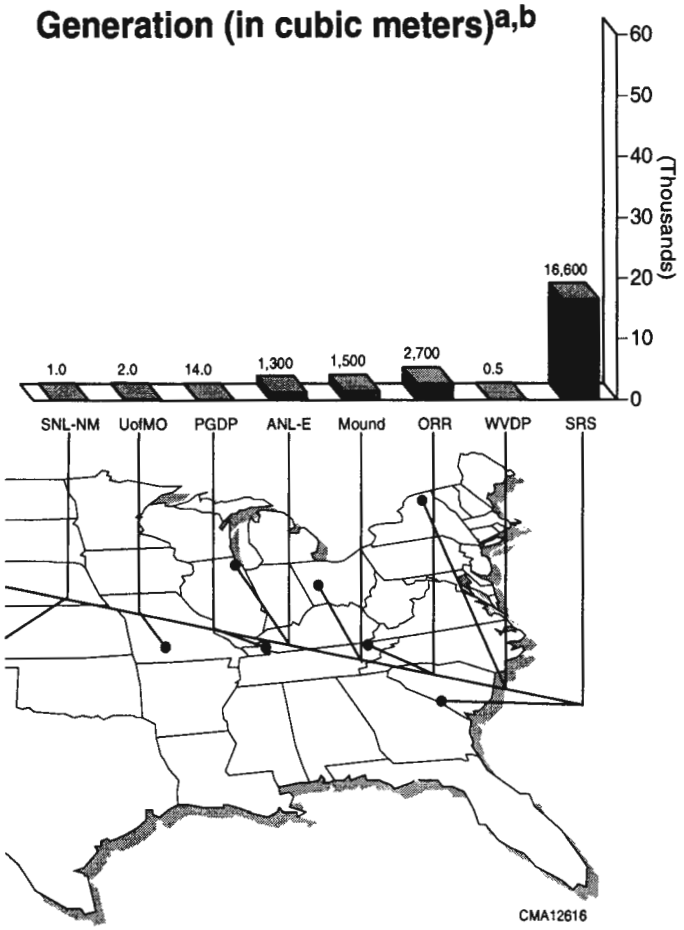
Figure 6.1–1. TRUW Total Volumes



[a] WIPP, the seventeenth major DOE site, is the planned TRUW disposal site.

[b] Updated inventories and waste generation rates are summarized in Appendix I. Different inventories provided in the WIPP SEIS II are also provided in Chapter 8.

at the 16 Major Sites.



*TRUW Volumes**
(Continued)

DOE Sites	Total Volumes (m^3)
10. ORR	2,700
11. PGDP	14
12. RFETS	6,200
13. SNL-NM	1
14. SRS	16,600
15. UofMO	2
16. WIPP	
17. WVDP	0.5
TOTAL	**132,000**

*Estimated TRUW volumes from waste management activities include current inventory plus 20 years of anticipated generation projected volume. Waste volumes used for the WM PEIS analysis may vary from latest site estimates. Updated inventories and waste generation rates are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW."

6.2.5 Rationale for Treatment and Storage Site Alternatives

TRUW alternatives were developed to cover the range of reasonable alternatives for treatment and storage sites. Thus, the Decentralized Alternative considers treatment and storage of TRUW at all 16 sites where TRUW is currently located, and the Centralized Alternative considers treatment and storage of all CH TRUW at one site and all RH TRUW at two sites. For the regionalized alternatives between these alternatives, DOE focused on the six sites where 95% of the waste is located or expected to be generated and on the four sites where approximately 80% of the waste is located or expected to be generated. Under these alternatives, DOE assumed that the waste from other generating sites would be shipped to the closest site for treatment.

In addition, DOE assumed that it would not be practical or reasonable for sites with small volumes of TRUW (number of sites having less than 15 cubic meters) to treat TRUW either to intermediate levels or to meet LDRs. Onsite treatment to meet current WIPP-WAC was considered feasible for all 16 sites, including the small-volume sites, under the Decentralized Alternative.

Most RH TRUW requires extensive treatment (but not necessarily to meet LDRs) before it can be shipped; therefore, consolidation of RH TRUW at one site for treatment was not considered. Thus, under the Centralized Alternative, DOE would treat RH TRUW at the two sites—Hanford and ORR—where approximately 85% of current and projected inventory would be located.

6.3 *Impacts of Managing TRUW*

Some impact areas illustrated clear trends across the alternatives, whereas others illustrated sensitivities at particular sites regardless of the alternative.

When reviewing the impacts and costs identified for the No Action Alternative, it is important to realize that the results for indefinite storage are based on the initial 20 years of that indefinite period. This is consistent with the period of analysis for all the alternatives; however, not shown are the impacts from storage expected beyond this 20-year time frame. The longer-term storage impacts and costs are likely to exceed those for the first 20 years, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of TRUW, where risks to workers and the offsite population, and other impacts and costs, are greatly reduced following disposal. The No Action Alternative does not reduce or avoid impacts and costs; rather it causes impacts and costs to be experienced every year for an indefinite period of time.

Mixed TRUW assay and shipping area.

The following discussion focuses on the impact areas that would be affected by the management of TRUW under the alternatives.

6.3.1 Health Risks

Facility health risks over 20 years are principally to workers, with approximately three-fourths from physical accidents and one-fourth from radiological exposures. Twenty-year risks to the offsite population are less than a single fatality, except for one fatality in one regionalized alternative to meet LDRs utilizing thermal treatment. Estimated transportation fatalities range from five to seven

Table 6.3–1. Some of the Projected Risks to Workers and the Public From Managing TRUW

Alternative	Number of Sites		Treatment Standard	Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Truck[a] Radiation Fatalities	Truck Non-Radiation Fatalities	Rail[a] Radiation Fatalities	Rail Non-Radiation Fatalities
	CH Treat	RH Treat								
No Action	11	5	WIPP-WAC	*	*	*	0	0	0	0
Decentralized	16	5	WIPP-WAC	2	1	*	4	3	1	*
Regionalized 1	5	2	Reduce Gas	3	1	*	3	3	1	*
Regionalized 2	5	2	LDRs	4	1	1	3	2	1	*
Regionalized 3	3	2	LDRs	3	1	*	3	3	1	*
Centralized	WIPP	2	LDRs	2	1	*	3	3	1	*

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs= land disposal restrictions; WIPP-WAC = Waste Isolation Pilot Plant Waste Acceptance Criteria; * = greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced cancer.
[b] Treatment results under the No Action Alternative include risks from only the first 20 years of indefinite storage of TRUW.

across all alternatives except for No Action, which does not involve transportation. Table 6.3–1 presents selected risk results for the TRUW alternatives.

6.3.2 Air Quality Impacts

The management of TRUW would not cause the air quality standards to be approached or exceeded at most sites; however, emissions of radionuclides were estimated to exceed applicable standards at LANL and WIPP in the alternatives involving thermal treatment to meet LDRs at these sites (Regionalized Alternative 2 and the Centralized Alternative). The exceedances at these sites could require additional control measures to reduce emissions to acceptable levels. Emissions of other hazardous air pollutants and criteria pollutants were estimated to be below the applicable standards and guidelines at all sites.

6.3.3 Economic and Population Impacts

The greatest benefit to the region surrounding any site occurs when TRUW is managed at that site. The most jobs as a percent of overall regional employment would occur in regions surrounding INEL and WIPP under Regionalized Alternative 3 and the Centralized Alternative, respectively. None of the TRUW alternatives would substantially affect the national economy, although some 1,900 to 12,000 jobs would be directly or indirectly created. No regions would experience population increases of 1% or more.

6.3.4 Infrastructure Impacts

No offsite infrastructure impacts are expected. Onsite infrastructure impacts on water use, wastewater treatment, and electrical power are comparable for the Decentralized and Regionalized

Alternatives, but are much greater at WIPP under the Centralized Alternative. Impacts generally increase as the intensity of treatment increases, with the greatest impacts at WIPP under the Centralized Alternative.

In addition, increases in site employment at Hanford, INEL, LANL, and WIPP could lead to traffic increases sufficient to affect onsite transportation infrastructure.

6.3.5 Costs

Costs increase as the level of treatment increases. Processing to meet WIPP-WAC and treatment to reduce gas generation cost about the same. Treatment to meet LDRs costs approximately 22% more except for the Centralized Alternative, which treats RH TRUW at only two sites. Transportation costs are substantially lower than facility costs, making shipment to available facilities at another site generally less expensive than building a new facility onsite. Table 6.3–2 provides the estimated costs to manage TRUW under each of the alternatives over 20 years.

6.3.6 Water Resources, Ecological Resources, Environmental Justice, Land Use, and Cultural Resources Impacts

Major impacts to these resources at the sites are unlikely from treatment of TRUW under any of the alternatives. However, ecological and cultural resources impacts would receive further site-specific studies prior to the siting of new facilities. Assessment of potential environmental justice concerns associated with TRUW management indicated no substantial potential for disproportionately high and adverse health risks or environmental impacts to minority and low-income groups living near INEL and WIPP. The potential at both sites could be mitigated by selection of an alternative treatment technology or employment of more efficient emissions controls.

Table 6.3–2. TRUW Estimated Life-Cycle Costs (Billions of 1994 Dollars)

Alternative	Number of Sites		Treatment Standard	Total (Including Truck Transport)	Transportation Costs	
	CH Treat	RH Treat			Truck	Rail
No Action	11	5	WIPP-WAC	1.7	0	0
Decentralized	16	5	WIPP-WAC	7.4	0.56	1.44
Regionalized 1	5	2	Reduce Gas	7.7	0.51	1.40
Regionalized 2	5	2	LDRs	9.0	0.45	1.24
Regionalized 3	3	2	LDRs	8.5	0.49	1.29
Centralized	WIPP	2	LDRs	7.9	0.51	1.33

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = land disposal restrictions; WIPP-WAC = Waste Isolation Pilot Plant waste acceptance criteria.
[a] Costs under the No Action Alternative include those from only the first 20 years of indefinite storage. The costs of storage beyond 20 years are analyzed as part of the No Action Alternatives in the WIPP SEIS-II.

At a Glance:
High-Level Waste

No Action Alternative:

- HLW canisters would be stored at Hanford, SRS, and WVDP until shipment to a geologic repository.

Decentralized Alternative:

- HLW canisters would be stored at all four sites generating canisters until shipment to a geologic repository.

Two Regionalized Alternatives:

- Canisters from WVDP would be transported to SRS or Hanford; canisters would be stored at Hanford, SRS, and INEL until shipment to a geologic repository.

Centralized Alternative:

- Canisters would be transported from WVDP, INEL, and SRS to Hanford; canisters would be stored at Hanford until shipment to a geologic repository.

Preferred Alternative:

- Each site would store its own immobilized waste onsite.

HLW Data and Major Assumptions:

- HLW is currently stored at Hanford, INEL, SRS, and WVDP.
- Approximately 378,000 cubic meters of HLW have been or will be generated. Treated HLW will require an estimated 21,600 canisters for packaging.
- The Glass Waste Storage Building for SRS (2,286 canisters) is the model used to analyze storage at Hanford and INEL.
- For transportation impacts analysis, DOE assumed the repository would be Yucca Mountain.
- The repository could accept 800 canisters per year.
- The WM PEIS evaluates canister storage. Treatment and disposal of HLW are not analyzed.
- Two sets of timing assumptions are analyzed—acceptance of canisters at the repository beginning in 2015 and acceptance beginning at some later date.

What Did We Learn From the Results?

- Although costs and risks are slightly higher for centralized storage at Hanford, differences from costs and risks at other sites are not significant. Alternatives are roughly equivalent from the standpoint of environmental impacts and costs.
- The acceptance rate of canisters by the repository controls the length of storage time.

7 High-Level Waste

- *HLW is highly radioactive waste that results from the reprocessing of spent nuclear fuel and of targets irradiated in nuclear defense, research, and production activities.*
- *Approximately 378,000 cubic meters of HLW have been or will be generated. Treated HLW will require an estimated 21,600 canisters for packaging.*
- *HLW will be treated and packaged for disposal in a licensed geologic repository.*
- *The WM PEIS analyzes the impacts of storing vitrified HLW.*
- *HLW is currently stored at Hanford, INEL, SRS, and WVDP.*
- *DOE must decide where to store the HLW canisters.*

7.1 Analysis

High-level waste is the highly radioactive material from the chemical reprocessing of spent nuclear fuel and of irradiated targets that contain fission products in concentrations sufficient to require permanent isolation.

Government operations from 1944 to the present have generated approximately 357,000 cubic meters of HLW with approximately 21,000 cubic meters to be generated in the future. Only four sites manage HLW—Hanford, INEL, SRS, and WVDP.

DOE is proceeding with plans to treat HLW by processing it into a solid form that cannot be readily dispersed into air, groundwater, or surface water. This process is called vitrification. When the existing inventory of HLW is vitrified, the vitrified material will fill an estimated 21,600 canisters. The WM PEIS only analyzes the impacts of storing this vitrified HLW.

Table 7.1–1. High-Level Waste Volumes and Projected Number of HLW Canisters

Site	HLW Volume (m^3)	Estimated Total Number of Canisters to Be Generated
Hanford	213,000	15,000
INEL	10,400	1,700
SRS	152,000	4,600
WVDP	2,200	340
Total	378,000	21,600

Table 7.1–1 shows the HLW inventory at Hanford, INEL, SRS, WVDP, and the projected total of vitrified HLW canisters that will be generated as a result of treating the entire HLW inventory.

Analysis of the impacts of HLW disposal in a repository is not within the scope of this WM PEIS, but those impacts will be analyzed in NEPA reviews relating to the geologic repository. Because Yucca Mountain is the only candidate repository site for HLW being studied at this time, DOE assumed this location in its analysis of the impacts of transporting HLW to a disposal facility.

Each alternative considered in this WM PEIS for storage of HLW canisters involves three major facilities and features: the canisters, the facilities for storage of canisters, and packages for transporting canisters to a geologic repository.

7.2 Alternatives

DOE analyzed five alternatives for HLW. Each of the alternatives was developed in order to estimate health risks, other environmental impacts, and

cost associated with the range of storage options and to provide information for a decision about where to store HLW. For each of the five alternatives, DOE assumed that a geologic repository would begin accepting DOE's HLW in 2015 at the rate of 800 canisters per year. For purposes of this analysis, DOE also evaluated an alternative that assumed that there would be a delay in acceptance of DOE's HLW by the repository until some time later than 2015, but at the same rate of acceptance of 800 canisters per year. Table 7.2–1 presents the alternatives in tabular form. Figure 7.2–1 shows the location of the HLW sites.

7.2.1 No Action Alternative

Under the No Action Alternative, only existing and approved HLW storage facilities would be used. Each site would store only those canisters produced at that site. Under this alternative, Hanford would run out of canister storage capacity before canisters could be sent to a geologic repository in 2015. Therefore, production of HLW canisters under the No Action Alternative would be phased because of both the lack of existing storage capacity at most of the sites and the assumed repository acceptance rate of 800 canisters per year.

7.2.2 Decentralized Alternative

Under the Decentralized Alternative, storage capacity equal to the anticipated total production of HLW canisters would be constructed at each site. This would allow each site to start vitrifying HLW as soon as treatment facilities were available. On the basis of the assumption that storage capacity at all four sites would be adequate until canister acceptance begins at the candidate repository in 2015, no delays in the vitrification of HLW would occur.

Table 7.2–1. High-Level Waste Alternatives

Alternative	Number of Storage Sites	Hanford	INEL	SRS	WVDP
No Action	4	S	S	S	S
Decentralized	4	S	S	S	S
Regionalized 1	3	S	S	S	
Regionalized 2	3	S	S	S	
Centralized[a]	1	S			

Note: S = storage. A blank cell indicates that there was no storage at a site under the specified alternative.

[a] Canisters generated at WVDP, SRS, and INEL prior to acceptance at the candidate repository in 2015 would be shipped to Hanford for storage. Canisters generated at SRS and INEL after 2015 would be shipped directly to the candidate repository. If acceptance of the DOE-managed HLW is delayed past 2015, then all HLW canisters would be shipped to Hanford for storage.

Typical high-level waste canister.

Figure 7.2–1. HLW Sites.

7.2.3 Regionalized Alternatives

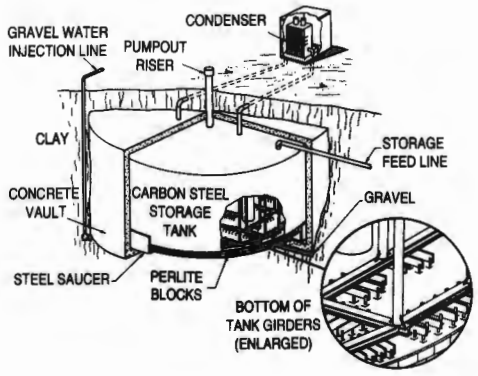
Two regionalized alternatives were analyzed for managing HLW canisters. Under Regionalized Alternative 1, the HLW canisters generated at WVDP would be taken in approved transportation casks to SRS for storage. Adequate storage capacity for HLW canisters would be provided at Hanford, INEL, and SRS until canisters were accepted at a geologic repository.

Under Regionalized Alternative 2, the canisters produced at WVDP would be transported to Hanford in approved transportation casks. Adequate storage capacity for HLW canisters would be provided at Hanford, INEL, and SRS until HLW canisters were accepted at a geologic repository.

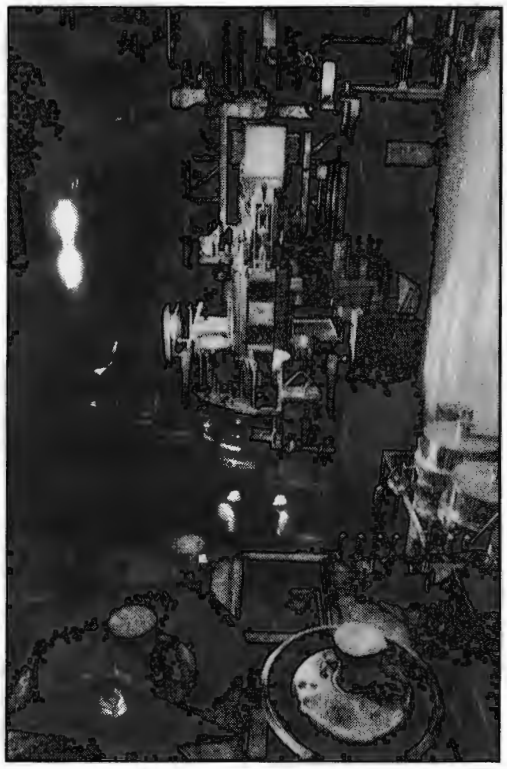
7.2.4 Centralized Alternative

Under the Centralized Alternative, the canisters produced at INEL, SRS, and WVDP would be transported to Hanford in approved transportation casks for storage until a geologic repository began to accept the canisters.

Because the WM PEIS analyzed two different assumptions about when canisters would be accepted at a geologic repository, the alternative has two subalternatives. The WM PEIS assumed that HLW canisters generated before the repository would begin accepting HLW in 2015 would be shipped to Hanford for centralized storage. The remaining canisters generated at SRS and INEL after 2015 would be shipped directly to the repository. Because WVDP



HLW storage tank design.



Vitrification facility at SRS.

would generate all of its canisters before 2015, all 340 canisters would be shipped to Hanford.

For the second subalternative, in which acceptance at a geologic repository would be delayed beyond 2015, all canisters generated at WVDP, SRS, and INEL would be shipped to Hanford for storage before shipment to a geologic repository once it began accepting HLW.

7.2.5 Rationale for Storage Alternatives

The five storage alternatives were developed to cover the range of reasonable alternatives. From one to four sites are available for storage of HLW (the Centralized Alternative and Decentralized Alternative, respectively). DOE identified two intermediate alternatives, in which the relatively small amount of WVDP HLW is transported to either Hanford or SRS. To define the regionalized alternatives, DOE selected the site with the largest amount of HLW (Hanford) and the site where transportation would be minimized (SRS). INEL was eliminated from consideration as a Regionalized Alternative site because it has no existing or approved storage facilities.

Under the Centralized Alternative, all HLW would be shipped to Hanford for storage. Hanford was proposed because it has the greatest volume of HLW. The major variable is the total miles for transportation between HLW sites, the central storage site, and the geologic repository. Consolidating all HLW canisters at Hanford minimizes the transportation impacts required for Centralized storage, because the largest number of canisters (those produced at Hanford) would be shipped directly to the repository. WVDP was eliminated from consideration for the Centralized Alternative because it has the smallest volume of HLW (only 1.6% of the total HLW) and because storage of canisters from other sites would be inconsistent with the West Valley Demonstration Project Act.

Table 7.3–1. Some of the Projected Risks to Workers and the Public From Managing HLW

Alternative	Number of Sites Storing	Worker Physical Hazard Fatalities	Worker Cancer Fatalities	Truck Radiation Fatalities	Truck Non-Radiation Fatalities	Rail Radiation Fatalities[a]	Rail Non-Radiation Fatalities
No Action	4	1	2	3	2	*	*
Decentralized	4	1	3	3	2	*	*
Regionalized 1	3	1	3	3	2	*	*
Regionalized 2	3	2	3	3	2	*	*
Centralized	1	2	3	3	2	*	*

Notes: * = greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced cancer.

7.3 Impacts of Managing HLW

The impacts were evaluated across all of the alternatives to identify trends, compare alternatives, and help select DOE's preferred alternative. The following discussion focuses on the impact areas that would be affected by the management of HLW canisters under the alternatives.

It should be noted that the No Action Alternative for HLW does not provide enough canister storage capacity for all of the canisters that would be produced after treatment of HLW. Provision of adequate storage would lead to costs and impacts as great as shown for the other HLW alternatives.

7.3.1 Health Risks

Both fatalities and incidences of cancer for waste management workers are comparable under the Decentralized, Regionalized, and Centralized Alternatives and do not favor one alternative over another (see Table 7.3–1). Estimates of worker cancer fatalities from radiation exposure exceed fatalities from physical hazards. Transportation risks are approximately the same for all alternatives. Fatalities from facility accidents are less than one under each of the HLW alternatives.

7.3.2 Economic and Population Impacts

HLW storage facility construction and operations expenditures would minimally benefit the localeconomy at the four HLW sites because estimated job and personal income growth are well below 1% at all sites under all the alternatives. None of the HLW alternatives would affect the national economy, although 300 to 1,200 jobs would be directly or indirectly created. The regional population would remain relatively constant under all proposed alternatives and would not incur a major increase at any site.

7.3.3 Infrastructure Impacts

Proposed HLW activities have the potential for affecting the onsite infrastructure only at the Hanford Site, although the effects would be minor. No offsite infrastructure impacts are expected at any other site. Estimated new requirements for wastewater treatment at Hanford would increase current demand under all alternatives, except No Action. Employment increases

would not approach or exceed 5% of current site employment at any site. Traffic increases would be minimal during construction and would not affect the onsite transportation infrastructure.

7.3.4 Costs

The costs of storage and transportation remain relatively constant, at approximately $3 billion, under all alternatives except No Action. Costs do rise slightly when storage is centralized. Delay in disposing of the waste in a geologic repository causes the life-cycle costs to increase at a rate of 0.2% per year of delay. Table 7.3–2 presents the estimated costs for each of the alternatives.

7.3.5 Air Quality, Water Resources, Ecological Resources, Environmental Justice, Land Use, and Cultural Resources Impacts

The management of HLW canisters would not appreciably affect the air quality or water resources at any site. Operation of HLW storage facilities should not affect ecological resources because airborne emissions, liquid effluents, and loss of habitat are expected to be negligible. Additionally, no impacts to current land uses would result because under all alternatives, no site would need to use more than 1% of its suitable lands for storage facilities. Assessment of potential environmental justice concerns from management of HLW indicated that minority and low-income populations near the HLW sites would not experience disproportionately high adverse health risks or environmental impacts under any of the HLW alternatives. DOE would conduct additional site-specific analyses to assess cultural resource impacts.

Table 7.3–2. HLW Estimated Life-Cycle Costs (Billions of 1994 Dollars)

Alternatives	Number of Sites Storing	Total Cost (Including Transportation Costs)	Transportation Cost	
			Truck	Rail
No Action	4	1.5	0.4	0.6
Decentralized	4	2.7	0.4	0.6
Regionalized 1	3	2.7	0.4	0.6
Regionalized 2	3	2.7	0.4	0.6
Centralized	1	2.9	0.5	0.7

Hazardous Waste

At a Glance:
Hazardous Waste

No Action Alternative:

- Nonwastewater HW would continue to be transported to commercial facilities. Two DOE sites would treat organic materials.

Decentralized Alternative:

- Nonwastewater HW would continue to be transported to commercial facilities. Three DOE sites would treat organic materials.

Two Regionalized Alternatives:

- 50% of nonwastewater HW would be treated at five DOE sites; 50% would be treated at commercial facilities.
- 90% of nonwastewater HW would be treated at two DOE sites; 10% would be treated at commercial facilities.

Centralized Alternative:

- None.

Preferred Alternative:

- No Action (continue use of commercial facilities for nonwastewater HW treatment).

HW Data and Major Assumptions:

- HW is generated or exists at most sites.
- DOE will need to manage 69,000 cubic meters of RCRA-regulated hazardous waste over the next 20 years. Totals do not include wastewater.
- An analysis of RCRA HW shipped to commercial treatment from the 11 sites with the most HW in fiscal year 1992 provides a representative sample for comparing onsite DOE treatment with offsite commercial treatment.
- Wastewater HW will continue to be treated onsite.

What Did We Learn From the Results?

- Risks and impacts are similar for each alternative.
- Costs favor commercial treatment.

8 Hazardous Waste

- *HW is nonradioactive chemical waste.*
- *HW is generated or exists at about 45 sites.*
- *HW is generated as a result of research and development and as a byproduct of nuclear weapons production and dismantlement.*
- *Most nonwastewater DOE HW is treated commercially.*
- *DOE must decide whether to develop additional capacity of its own to treat HW.*

8.1 Analysis

Hazardous waste consists of nonradioactive chemical waste generated as a result of nuclear weapons production and other research and development activities. HW has been generated, or is anticipated to be generated, at most DOE sites. Although HW generation from the production of nuclear weapons has essentially stopped, many chemicals and chemical residues were left in containers and process lines. These wastes must be properly treated and disposed of to manage existing and future inventories.

Most of DOE's HW consists of wastewater, which by definition contains less than a 1% concentration of organic HW materials. Hazardous wastewater is generated as a result of operations such as metal cleaning, etching, and plating. Hazardous wastewater requires treatment before it can be safely discharged to the environment. DOE currently treats its hazardous wastewater at the sites that generate it and will continue to do so in the future because wastewater is not difficult to treat but is difficult and expensive to transport.

Nonwastewater HW consists of sludges, solids, and organic liquids (liquids containing higher concentrations of organic chemicals than wastewater). DOE currently ships most of this HW off site to commercial facilities for treatment, although two sites (ORR and INEL) have the capability to treat nonwastewater HW by thermal treatment. DOE needs to decide the extent to which it should continue its reliance on the commercial treatment of nonwastewater HW.

DOE estimates that more than 90% of the total HW (wastewater and nonwastewater) in a given year is generated by 11 DOE sites. Table 8.1-1 shows the quantities of HW at the 11 sites that generate the most HW. Table 8.1-1 shows waste volume generation per year. The focus of the alternatives is on these RCRA-defined wastes which total approximately 3,440 metric tons annually, and 69,000 for a 20-year period.

8.2 Alternatives

The WM PEIS considered four alternatives for treatment facilities within three general categories of alternatives: no action, decentralized, and regionalized (see Table 8.2-1). No centralized alternative was analyzed because DOE determined it would be an unreasonable alternative in light of the cost, risk, regulatory constraints, and practical considerations of attempting to centrally manage all of DOE's diverse HW.

Each of the alternatives was developed in order to estimate the human health risks, other environmental impacts, and costs associated with the range of HW treatment options available to DOE and to provide input for a decision about whether to continue to rely on offsite treatment of HW.

Table 8.1–1. Waste Management of HW at DOE's 11 Largest Generators (metric tons[a]/year)

DOE Site	Wastewater Treated Onsite[b]	Onsite Thermal Treatment and Fuel Burning[b]	Other Onsite Treatment[b]	Offsite Commercial Treatment[c]
ANL-E	0	0	2	206
Fermi	0	0	12	49
Hanford	0	0	140	303
INEL	33,000	35	80	160
KCP[d]	343,000	0	80	601
LANL	0	0	40	246
LLNL	250	0	230	629
ORR	624,000	66	14,600	207
Pantex	3,000	0	2,700	512
SNL-NM	130,000	0	0	153
SRS[d]	59,000	0	50	273
Total	1,192,250	101	17,934	3,339

[a] Metric ton = 1,000 kilograms = 2,205 lb. One metric ton of HW is approximately one cubic meter in volume.
[b] Based on 1991 data taken from biennial and annual reports (includes temporary storage volumes).
[c] Based on fiscal year (FY) 1992 manifests. Includes only RCRA-defined waste; an additional 6,600 metric tons of Toxic Substances Control Act (TSCA)-regulated HW, State-regulated HW, and environmental-restoration-generated HW was shipped to commercial treatment in FY 1992.
[d] Excludes wastewater treatment of groundwater at KCP and SRS.

Table 8.2–1. Hazardous Waste Alternatives

Alternative	Number of Sites Treating	ANL-E	Hanford	INEL	LANL	LLNL	ORR	Pantex	SNL-NM	SRS
No Action	2			T			T			
Decentralized	3			T			T			T
Regionalized 1	5		T	T	T		T			T
Regionalized 2	2			T			T			

Notes: T = treatment. A blank indicates that a site does not treat waste under the alternative specified.

8.2.1 No Action Alternative

Under this alternative, current operations would continue. Some of the HW that is currently being treated onsite at DOE facilities (i.e., thermal treatment of organic materials at ORR and INEL) would continue to be treated onsite, and other HW would continue to be treated at commercial facilities.

8.2.2 Decentralized Alternative

Under this alternative, DOE would continue thermal treatment at existing facilities at INEL, ORR, and SRS. In addition, the use of commercial facilities would continue as needed. Most wastes generated at the other major sites would also be sent to commercial facilities, except for wastes thermally treated or used as fuel at INEL, ORR, and SRS.

8.2.3 Regionalized Alternatives

Under Regionalized Alternative 1, 50% of the HW generated by the 11 major HW sites would be treated at five onsite treatment centers or "hubs" (Hanford, INEL, LANL, ORR, and SRS). Each regional hub would be permitted under RCRA, and onsite treatment facilities would be constructed for thermal treatment and organic removal and recovery. The hub sites would treat two-thirds of the HW received from other sites and send the other one-third to a commercial facility. For HW that could be thermally treated, two-thirds would be sent to the regional hubs from the generating sites, and the other third would be sent directly to commercial treatment facilities. Approximately 50% of the estimated 3,440 metric tons considered for onsite thermal treatment or offsite commercial treatment of HW would be treated at DOE HW facilities.

Under Regionalized Alternative 2, DOE would build facilities at INEL and ORR for organic treatment and deactivation/neutralization. Metal recovery and recycling, battery recycling, stabilization, and land disposal would continue to be provided by offsite commercial establishments. Approximately 90% of HW would be treated at DOE HW facilities.

8.2.4 Rationale for Treatment Alternatives

The alternatives selected were developed to cover the range of reasonable alternatives on the basis of three primary criteria: (1) the site's experience with HW treatment technologies, (2) the location of the site, and (3) the volume of the HW generated by site. As it was in the case of evaluating alternatives for the management of the radioactive waste types, consideration was given to avoiding the shipment of HW to DOE sites that do not generate HW. These criteria and considerations served to minimize the costs and impacts associated with the alternatives and sites selected.

The technologies evaluated for onsite treatment of HW are thermal treatment, burning as fuel, and deactivation. Of all the sites evaluated in the No Action Alternative, five of the sites—Hanford, INEL, LANL, ORR, and SRS—have operated or plan to operate thermal treatment units.

Regionalized Alternative 1 uses the five DOE sites with thermal treatment units, satisfying the criterion for technology experience. The location criterion is addressed in that the five sites are regionally distributed, which serves to minimize transportation of HW and its associated risks.

Regionalized Alternative 2 is based on using two sites for HW treatment. The two proposed sites, INEL and ORR, satisfy the technology experience criterion as discussed above, and their locations (western and eastern United States) require the least transportation of HW when compared with other two-site combinations. Onsite deactivation, or neutralization, also considered in this alternative, is planned for the two hubs.

8.3 *Impacts of Managing HW*

Impacts were evaluated across all of the alternatives to identify trends and compare alternatives. Some impact areas illustrated clear trends across the alternatives, whereas others illustrated sensitivities at particular sites regardless of the alternative.

The following discussion focuses on the impact areas that would be affected by the management of HW under the alternatives, identifying trends when appropriate and highlighting noteworthy findings at particular sites.

Interior of 709-G hazardous waste storage facility at SRS.

8.3.1 Health Risks

Incidences of cancer among the public for both routine operations at DOE facilities and facility accidents were found to be less than one for all alternatives. Noncancer risks to the offsite population and noninvolved workers were also low. However, noncancer risks for WM workers may be of concern under each of the alternatives evaluated.

Waste oil shipment to TSCA incinerator at ORR.

Although DOE would treat more of its HW under the regionalized alternatives and send less to commercial facilities, DOE believes that worker risk is similar under treatment by DOE and commercial facilities. Therefore, there is no significant difference among the alternatives with regard to HW worker risk.

Although HW can be transported both by truck and rail, truck transportation is the predominant method for shipping HW. The risk estimates include a fraction of a single fatality for each of the proposed HW alternatives from vehicle accidents and exposures associated with HW transportation.

8.3.2 Air Quality Impacts

The management of HW would not cause air quality standards to be approached or exceeded at most sites. No criteria pollutants would exceed standards at any site. However, regionalization of treatment facilities

at LANL and ORR would cause adverse air impacts that would require additional control measures for vinyl chloride. The exceedances at LANL and ORR primarily result from emissions from thermal treatment.

8.3.3 Costs

The No Action Alternative is the least costly of the alternatives, at an estimated $144 million, followed by the Decentralized Alternative at $183 million. Regionalized Alternative 1 is the most expensive, at $376 million, closely followed by Regionalized Alternative 2, at a cost of $318 million. Conversely, commercial treatment costs are highest under the No Action Alternative and lowest under Regionalized Alternative 2.

The fundamental differences among the alternatives involve transportation and costs. Table 8.3–1 presents a summary of the transportation and cost differences among the alternatives over the 20-year period of analysis.

8.3.4 Water Resources, Ecological Resources, Economic Impacts, Environmental Justice, Infrastructure, Land Use, and Cultural Resources

The impacts analyses for water, ecological, economic, population, infrastructure, cultural, and land use resources did not indicate significant impacts under any of the HW alternatives; therefore, these analyses do not reveal significant differences among alternatives. Assessment of potential environmental justice concerns from management of HW indicated that minority and low-income populations near the HW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HW alternatives.

Table 8.3–1. Summary Comparison of the HW Alternatives

Alternative	Sites	Shipments		Costs[c]		
		Mileage[a]	Number[b]	Transport	Project Life-Cycle	Total
No Action	2	20	34	49	95	144
Decentralized	3	19	41	49	134	183
Regionalized 1	5	35	50	87	289	376
Regionalized 2	2	19	34	47	271	318

[a] Mileage in millions.
[b] Number of shipments in thousands.
[c] Cost in millions of dollars.

9.1 Analysis

Cumulative impacts are those impacts that result from the incremental impact of an action added to other past, present, and reasonably foreseeable actions in the future. Examples of impacts from past and present actions include those from contaminated sites, ongoing activities that result in waste generation, and waste management activities outside the scope of the WM PEIS. Both Council on Environmental Quality regulations and DOE regulations for implementing NEPA require DOE to assess cumulative impacts because significant impacts can result from several smaller actions that individually might not have significant impacts.

To conduct the cumulative impacts analysis, DOE first examined the combined impacts of siting waste management facilities for more than one waste type at each of the 17 major sites. **Combined impacts** are the subset of cumulative impacts resulting from the siting of multiple facilities for managing more than one waste type at a site. DOE then added the impacts of existing site conditions and reasonably foreseeable future actions at a site or in an area to these combined impacts to assess the cumulative impacts.

The combined and cumulative analysis considers the following impacts:

- Offsite population health risks
- Offsite MEI health risks
- Worker health risks
- Air quality exceedances
- Groundwater quality exceedances
- Impacts on resources and infrastructure
- Socioeconomic impacts

In addition, an analysis of both combined and cumulative transportation impacts is presented.

Impacts that are not considered for combined and cumulative effects include:

- Risks from accidents, because accidents are not certain to occur and, even if they were to occur, event-initiating accidents for each waste type would be independent of each other.
- Risks to individual waste management workers, because it is assumed that each waste-type worker is dedicated to that waste type and would not work simultaneously in another waste-type facility.
- Impacts to surface water resources, ecological resources, and cultural resources, because they are dependent on facility location and location-specific environmental factors.

Because the alternatives for the five waste types can be combined in many ways (for some sites there are thousands of possible combinations of alternatives), the combined impacts of placing multiple facilities at each site are presented in the form of minimum and maximum values for each of the combined impacts for each waste type. The values are then summed for each category of impacts to determine the combined minimum and maximum impacts for each site. Following the combined impacts analysis, the minimum and maximum impacts are considered together with the impacts of existing site actions, and reasonably foreseeable future actions at and near each of the 17 major sites. The cumulative impact assessment for these sites includes consideration of actions that DOE is taking or considering for spent nuclear fuel management, tritium supply and recycling, and the consolidation of nonnuclear functions. Other site-specific projects, such as vitrification of HLW at Hanford and SRS and the operation of WIPP, are also discussed for each of the 17 major sites where applicable.

Chapter 11 of the WM PEIS contains tables of combined and cumulative impacts showing the impact categories and the major elements that constitute the cumulative impacts (i.e., combined, existing, and other reasonably foreseeable future actions) for each

of the 17 major sites and for transportation impacts. These data allow the decision maker, when evaluating alternatives for a specific waste type such as LLMW, to consider the range of impacts that might occur at any site caused by implementation of alternatives for other waste types and other activities.

9.2 Results

The following discussion briefly summarizes the key results of the cumulative impacts analysis:

- Even though locating waste management facilities at sites would result in an increase in dose to offsite populations surrounding the sites, cumulative atmospheric radiological releases are not projected to exceed EPA standards except at LANL, as a result of treatment under Regionalized Alternative 2 for TRUW, and at WIPP, as a result of treatment under the Centralized Alternative for TRUW. The exceedance of the EPA standard for the Regionalized 2 and Centralized Alternatives for TRUW indicates that mitigation measures could be needed to achieve compliance if either of these two alternatives is chosen.

- Seven of the 17 sites (BNL, Hanford, INEL, LANL, NTS, ORR, and RFETS) could exceed one or more air pollutant standards as a result of maximum combined atmospheric emissions. Selection of waste management alternatives that result in locating waste management activities at these sites could require mitigation measures.

- Nine of the 17 sites (FEMP, Hanford, LANL, ORR, PGDP, PORTS, RFETS, SNL-NM, and SRS) could exceed one or more drinking water standards in groundwater as a result of disposal of LLMW or LLW on the site. Selection of alternatives for these two waste types at these sites would need to take into consideration potential cumulative groundwater quality impacts as well as potential mitigation measures.

- Nine of the 17 sites could require improvements to onsite water, wastewater, or electric power systems to accommodate requirements for increased capacity. At two sites (Hanford and WIPP), the increases are caused by waste management activities, while at three sites (INEL, NTS, and WVDP), either waste management or other planned future activities could require additional infrastructure. At four additional sites (ANL-E, FEMP, SNL-NM, and SRS), the requirements for additional infrastructure result from future activities other than waste management.

- Eight sites (Hanford, INEL, LANL, NTS, ORR, Pantex, SRS, and WIPP) could require mitigation measures to reduce offsite infrastructure and institution demands caused by possible employment increases resulting from waste management and other actions considered in the cumulative impacts analysis.

- The largest number of shipments to or from a single site would occur at NTS as a result of the shipments of LLMW and LLW and of shipments of HLW if Yucca Mountain is found to be suitable as a repository for HLW. A combined total of more than 295,000 truck shipments or more than 106,000 rail shipments of waste could occur at NTS, or about 118 truck shipments or 42 rail shipments per day (assuming receipt of shipments during 250 days per year).

- The transport of waste by truck is expected to result in a combined total of between 11 and 69 fatalities for the shipment of all waste types. Of these fatalities, about 6 to 23 would result from exposure of transport crew members and the population along transportation routes to the radioactive components in the waste. The remaining fatalities from truck transport would result from emissions and accidents independent of the waste cargo.

- The transport of LLMW, LLW, TRUW, and HLW by rail and HW by trucks is expected to result in a combined total of between two and six fatalities over the periods of analyses for these waste types. Of these fatalities, about one to three would result from the exposure of the train crew and the public to the radioactive components in the waste. The remaining fatalities for rail transport would result from train emissions and accidents independent of the waste cargo.

- Maximum combined health risks from the routine operation of waste management facilities are estimated to range from 0 to 6 worker radiation cancer fatalities and less than one radiation cancer fatality in the offsite populations at the 17 major sites.

- Maximum cumulative health risks from the routine operation of waste management facilities and other facilities at the sites are estimated to range from 0 to 12 worker radiation cancer fatalities and less than two radiation cancer fatalities in the offsite populations at the 17 major sites.

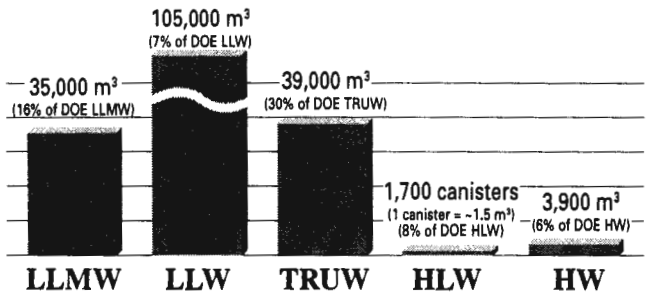
Site Summary

Idaho National Engineering Laboratory

Idaho National Engineering Laboratory (INEL) has been a major Department of Energy (DOE) site for more than 40 years, building, testing and operating various nuclear facilities; managing the resulting radioactive and hazardous waste; and performing a variety of missions related to research and development for advanced reactors, naval nuclear propulsion systems, and waste disposal technologies. INEL occupies 890 square miles in the southeastern portion of Idaho, approximately 42 miles west of Idaho Falls.

INEL is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), high-level waste (HLW), and hazardous waste (HW) and, in some alternatives, other sites' LLMW, LLW, TRUW and HW. The WM PEIS includes waste volumes from Argonne National Laboratory-West and the Naval Reactor Facility in its evaluation of INEL as a candidate site for waste management facilities.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the five waste types at INEL, are shown in the following chart. Also, how INEL relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at INEL include the treatment and storage of LLMW on site, treatment and disposal of LLW on site, storage of TRUW on site, storage of HLW on site pending disposal in a geologic repository, and the transport of HW off site for treatment. A waste minimization and pollution prevention awareness plan has been developed and is being implemented at INEL to reduce waste volumes.

Waste Management Alternatives at INEL

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site	Treatment On Site	*3 subalternatives:* **Treatment On Site** (including offsite shipments); **Disposal On Site**	Treatment Off Site (except RH)
	Storage On Site	Disposal On Site	*1 subalternative:* **Treatment On Site** (including offsite shipments); **Disposal Off Site**	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*4 subalternatives:* **Treatment On Site** (minimum treatment in 2 subalternatives); **Disposal On Site**; *1 subalternative:* **Treatment On Site** (including offsite shipments)	*2 subalternatives:* **Minimum Treatment On Site**; **Disposal Off Site**; *2 subalternatives:* **Treatment On Site**
	Disposal On Site	Disposal On Site	**Disposal On Site**; *2 subalternatives:* **Minimum Treatment On Site**; **Disposal Off Site**	**Disposal Off Site**; *1 subalternative:* **Treatment Off Site**; **Disposal Off Site**
TRUW	Treatment On Site	Treatment On Site	**Treatment On Site** (CH only, including offsite shipments); **Treatment Off Site** (RH only)	Treatment Off Site
	Storage On Site	Storage On Site	**Storage On Site** (CH only); **Storage Off Site** (RH only)	Storage Off Site
HLW	Storage On Site	Storage On Site	Storage On Site	Storage On Site
	Pending Disposal Off Site (geologic repository)	*Pending* Disposal Off Site (geologic repository)	*Pending* Disposal Off Site (geologic repository)	*Pending* Disposal Off Site (geologic repository)
HW	Treatment On Site (organic only); Treatment Off Site (commercial facilities)	Treatment Off Site (commercial facilities)	*1 subalternative:* **Treatment On Site** (organic only); **Treatment Off Site** (commercial facilities); *1 subalternative:* **Treatment On Site** (organic only, including offsite shipments); **Treatment Off Site**	Not Analyzed

RH = Remote-handled TRUW. CH = Contact-handled TRUW.

= DOE's preferred alternatives. DOE does not yet have site preferences for LLMW or LLW disposal.

Hanford

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, Hanford's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which Hanford fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers regionalized treatment of LLMW at Hanford. This alternative includes onsite treatment of Hanford's LLMW and could include treatment of some LLMW generated at other sites. LLMW activities at Hanford would be conducted in accordance with the Hanford Site's Tri-Party Agreement with the State of Washington and U.S. Environmental Protection Agency. Hanford could be selected as one of the regional disposal sites for LLMW.

Low-Level Waste: DOE prefers to treat Hanford's LLW on site. Hanford could be selected as one of the regional disposal sites for LLW.

Transuranic Waste: DOE prefers onsite treatment and storage of Hanford's TRUW.

High-Level Waste: DOE prefers onsite storage of Hanford's immobilized HLW pending disposal in a geologic repository.

Hazardous Waste: DOE prefers the No Action Alternative where Hanford would continue to use commercial facilities for HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated Hanford for potential impacts under all of the alternatives that identified a role for this site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for Hanford under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Health risks are principally to workers and could include physical hazard and latent cancer fatalities from waste management activities over the 20-year period of analysis. Collective worker health risk estimates are one fatality for LLMW, three fatalities for HLW, and up to four fatalities for LLW, depending on whether Hanford is selected as a disposal site. Less than one latent cancer fatality is estimated among the offsite population.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. To meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW and LLW. No major impacts to ecological resources, land use, or environmental justice are expected. Increases to requirements for wastewater treatment under the preferred alternatives could lead to requirements for additional capacity and corresponding costs; no other major impacts to the infrastructure are estimated. Expenditures for WM activities could cause socioeconomic effects that include the benefits of increased regional employment and income as well as regional population growth that could alter community structure and stress available housing and community services. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the maximum total number of shipments of TRUW and HLW is estimated to be 18,400 truck or 8,140 rail shipments. The total number of shipments of LLMW and LLW to and from Hanford is dependent upon DOE's final selection of disposal sites for these wastes. Centralized disposal of LLW, which was analyzed in the WM PEIS, could result in approximately 242,000 to 257,000 truck shipments or 91,000 to 97,000 rail shipments to a single site; centralized disposal of LLMW could result in 7,500 to 9,600 truck shipments or 3,300 to 3,700 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 3,659 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Wastewater treatment capacity could be exceeded, and the regional employment and community structure could be affected, as noted above. In addition, to meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW and LLW. Waste management activities could greatly increase waste shipments entering or leaving the site.

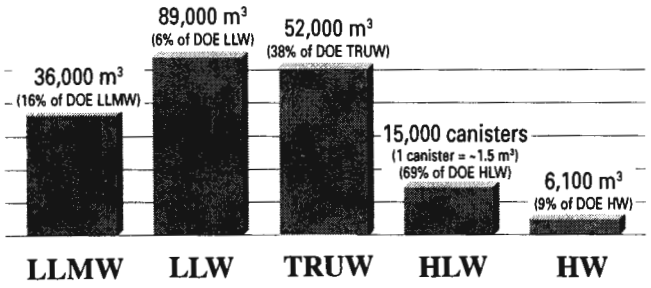
Site Summary

Hanford

The Hanford Site has played a major role in national security for more than 40 years, producing nuclear materials (primarily plutonium) for weapons manufacture, managing the resulting radioactive and hazardous waste, and performing a variety of missions related to research and development for advanced reactors, energy technologies, basic sciences, and waste disposal technologies. Today, Hanford is no longer a production facility but instead focuses solely on waste management and environmental restoration guided by the Hanford Federal Facilities Agreement and Consent Order (Tri-Party Agreement). Hanford encompasses about 560 square miles within the Columbia River Basin in southeastern Washington.

Hanford is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own and, in some alternatives, other sites' low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), high-level waste (HLW), and hazardous waste (HW).

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the five waste types at Hanford, are shown in the following chart. Also, how Hanford relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at Hanford include the storage of LLMW with the treatment of wastewater only, treatment and disposal of LLW on site, storage of TRUW on site, storage of HLW on site pending disposal in a geologic repository, and the transport of HW off site for treatment. A waste minimization and pollution prevention plan has been developed and is being implemented at Hanford to reduce waste volumes.

Waste Management Alternatives at Hanford

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site (including some offsite shipments)	*3 subalternatives:* **Treatment On Site** (including offsite shipments) / **Disposal On Site** / *1 subalternative:* **Treatment On Site** (including offsite shipments) / **Disposal Off Site**	Treatment On Site (including shipments from all DOE sites) / Disposal On Site
	Storage On Site	Disposal On Site		
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*3 subalternatives:* **Treatment On Site** (minimum treatment in 2 subalternatives) / **Disposal On Site** / *2 subalternatives:* **Treatment On Site** (including offsite shipments) / **Disposal On Site** / *1 subalternative:* **Minimum Treatment On Site** / **Disposal On Site** (including shipments from all western DOE sites) / *1 subalternative:* **Minimum Treatment On Site** / **Disposal Off Site**	*2 subalternatives:* **Treatment On Site*** / **Disposal On Site** (including shipments from all DOE sites) / *2 subalternatives:* **Treatment On Site*** / **Disposal Off Site** / *1 subalternative:* **Treatment On Site** (including shipments from all DOE sites) / **Disposal On Site**
	Disposal On Site (including offsite shipments)	Disposal On Site		
TRUW	Treatment On Site	Treatment On Site	Treatment On Site (including offsite shipments)	**Treatment On Site** (RH only, including offsite shipments) / **Treatment Off Site** (CH to WIPP, N.M.)
	Storage On Site	Storage On Site	Storage On Site	**Storage On Site** (RH only)
HLW	Storage On Site	Storage On Site	**Storage On Site** (possibly including offsite shipments)	**Storage On Site** (including offsite shipments)
	Pending Disposal Off Site (geologic repository)	*Pending* Disposal Off Site (geologic repository)	*Pending* **Disposal Off Site** (geologic respository)	*Pending* **Disposal Off Site** (geologic repository)
HW	Treatment Off Site (commercial facilities)	Treatment Off Site (commercial facilities)	*1 subalternative:* **Treatment On Site** (organic only, including offsite shipments) / **Treatment Off Site** (commercial facilities) / *1 subalternative:* **Treatment Off Site** (DOE and commercial facilities)	Not Analyzed

*Minimum treatment in one subalternative, offsite shipments included in other subalternative.
RH = Remote-handled TRUW. CH = Contact-handled TRUW.
= DOE's preferred alternatives. DOE does not yet have site preferences for LLMW or LLW disposal.

FEMP

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, FEMP's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which FEMP fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat FEMP's LLMW on site consistent with FEMP's site treatment plan. DOE prefers to ship FEMP's LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: All LLW at FEMP is currently managed under the Environmental Restoration Program and was not analyzed in the WM PEIS.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for FEMP under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for FEMP under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Latent cancer fatalities among the offsite population are estimated to be essentially zero, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at FEMP.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW shipments from FEMP is estimated to be 110 truck or 50 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 212 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded.

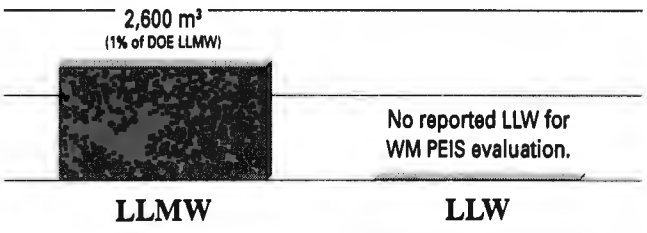
Site Summary

Fernald Environmental Management Project

The Fernald Environmental Management Project (FEMP) has been a major Department of Energy (DOE) site for more than 40 years, producing nuclear materials (primarily uranium metal and uranium compounds) for use at other DOE facilities. Since the late 1980s, the site's mission has focused on environmental restoration. FEMP is located on approximately 1.6 square miles, 17 miles northwest of Cincinnati, Ohio.

FEMP is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), and, in some alternatives, other sites' LLMW and LLW. FEMP is not considered a major generator of hazardous waste. FEMP currently does not have an inventory of transuranic waste or high-level waste and is not expected to manage these waste types in the future.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the two waste types at FEMP, are shown in the following chart. Also, how FEMP relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at FEMP include the storage of LLMW with the treatment of wastewater only. FEMP has no LLW at this time. A waste minimization and pollution prevention plan has been developed and is being implemented at FEMP to reduce waste volumes.

Waste Management Alternatives at FEMP

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	*1 subalternative:* Treatment On Site (including shipments from offsite facilities); Disposal On Site (FEMP LLMW only); Disposal Off Site	Treatment Off Site
LLMW	Storage On Site	Disposal On Site	*3 subalternatives:* Treatment Off Site; Disposal Off Site	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*2 subalternatives:* Treatment On Site (Minimum treatment in 1 subalternative); Disposal On Site; *3 subalternatives:* Minimum Treatment On Site	*2 subalternatives:* Minimum Treatment On Site; Disposal Off Site
LLW	Disposal Off Site	Disposal On Site	Disposal Off Site; *2 subalternatives:* Treatment Off Site; Disposal Off Site	*3 subalternatives:* Treatment Off Site; Disposal Off Site

= DOE's preferred alternatives.

BNL

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, BNL's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which BNL fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat BNL's LLMW under the Regionalized Alternative and consistent with BNL's proposed site treatment plan. Under this alternative, BNL's LLMW would be shipped off site for treatment. DOE prefers to ship BNL's LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat BNL's LLW on site. DOE prefers to ship BNL's LLW to one of 2 or 3 regional disposal sites.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for BNL under all of the alternatives that identified a role for this site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for BNL under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Latent cancer fatalities among the offsite population are estimated to be essentially zero, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at BNL.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW and LLW shipments from BNL is estimated to be 1,370 truck or 530 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 41 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

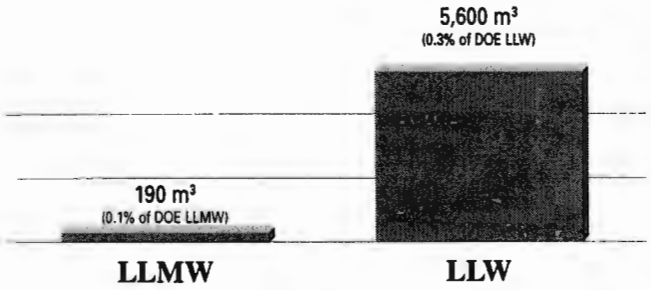
Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Waste management activities could substantially increase waste shipments leaving the site.

Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) was established in 1946 to provide a multipurpose research and development laboratory capable of supporting the design and operation of large, complex research projects for fundamental scientific studies and basic and applied research. The laboratory provides research capabilities in the physical, biomedical, and environmental sciences and energy technologies for hundreds of users from universities, industry, and other government laboratories. BNL is located in New York on approximately 8.2 square miles, 60 miles east of New York City.

BNL is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW) and low-level waste (LLW). BNL is not considered a major generator of hazardous waste. BNL currently does not have an inventory of transuranic waste or high-level waste and is not expected to manage these waste types in the future.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the two waste types at BNL, are shown in the following chart. Also, how BNL relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at BNL include the storage of LLMW with the treatment of wastewater only and the preparation of LLW for shipment off site for disposal. A waste minimization and pollution prevention plan has been developed and is being implemented at BNL to reduce waste volumes.

Waste Management Alternatives at BNL

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	Treatment Off Site	Treatment Off Site
LLMW	Storage On Site	Disposal On Site	Disposal Off Site	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*4 subalternatives:* Minimum Treatment On Site	*2 subalternatives:* Minimum Treatment On Site
LLW			Disposal Off Site	Disposal Off Site
LLW	Disposal Off Site	Disposal On Site	*3 subalternatives:* Treatment Off Site	*3 subalternatives:* Treatment Off Site
LLW			Disposal Off Site	Disposal Off Site

= DOE's preferred alternatives.

ANL-E

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, ANL-E's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which ANL-E fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat ANL-E's LLMW on site under the Decentralized Alternative and consistent with ANL-E's proposed site treatment plan. DOE prefers to ship ANL-E's LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat ANL-E's LLW on site. DOE prefers to ship ANL-E's LLW to one of 2 or 3 regional disposal sites.

Transuranic Waste: DOE prefers the Decentralized Alternative for onsite treatment and storage of ANL-E's TRUW.

Hazardous Waste: DOE prefers the No Action Alternative, where ANL-E would continue to use commercial facilities for HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for ANL-E under all of the alternatives that identified a role for this site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for ANL-E under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Latent cancer fatalities among the offsite population are estimated to be essentially zero, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at ANL-E.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW, LLW, and TRUW shipments from ANL-E is estimated to be 1,660 truck or 710 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 132 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Waste management activities could substantially increase waste shipments leaving the site.

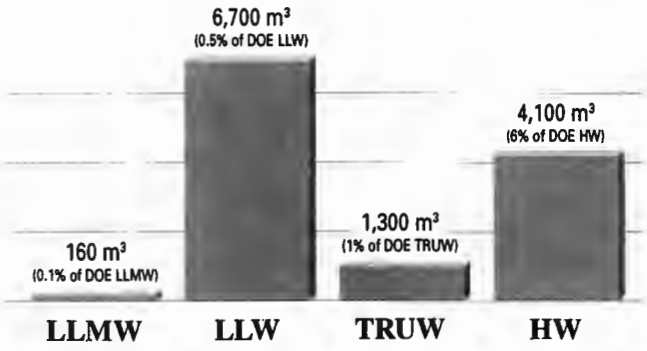
Site Summary

Argonne National Laboratory-East

Argonne National Laboratory-East (ANL-E) is an outgrowth of the Metallurgical Laboratory established in 1942 as part of the Manhattan Project. This laboratory conducts research and development studies of nuclear and non-nuclear energy sources. ANL-E is located on 2.7 square miles, 22 miles southwest of Chicago in northeast Illinois.

ANL-E is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), and hazardous waste (HW) and, in some alternatives, LLMW and LLW from small sites. ANL-E currently does not have an inventory of high-level waste and is not expected to manage this waste type in the future.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the four waste types at ANL-E, are shown in the following chart. Also, how ANL-E relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at ANL-E include the storage of LLMW with the treatment of wastewater only; preparation of LLW for shipment off site for disposal; storage of TRUW; and the transport of HW off site for treatment. A waste minimization and pollution prevention strategic plan has been developed and is being implemented at ANL-E to reduce waste volumes.

Waste Management Alternatives at ANL-E

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	Treatment Off Site	Treatment Off Site
	Storage On Site	Disposal On Site (including shipments from small offsite facilities)	Disposal Off Site	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*4 subalternatives:* Minimum Treatment On Site	*2 subalternatives:* Minimum Treatment On Site
			Disposal Off Site	Disposal Off Site
	Disposal Off Site	Disposal On Site (including shipments from small offsite facilities)	*3 subalternatives:* Treatment Off Site	*3 subalternatives:* Treatment Off Site
			Disposal Off Site	Disposal Off Site
TRUW	Treatment On Site	Treatment On Site	Treatment Off Site	Treatment Off Site
	Storage On Site	Storage On Site	Storage Off Site	Storage Off Site
HW	Treatment Off Site (commercial facilities)	Treatment Off Site (commercial facilities)	Treatment Off Site (DOE and commercial facilities)	Not Analyzed

= DOE's preferred alternatives

Site Summaries

INEL

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, INEL's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which INEL fits within each preferred waste management alterative are as follows.

Low-Level Mixed Waste: DOE prefers regionalized treatment of LLMW at INEL. This alternative includes onsite treatment of INEL's LLMW and could include treatment of LLMW generated at other sites. LLMW activities at INEL would be conducted in accordance with INEL's site treatment plan. INEL could be selected as one of the regional disposal sites for LLMW.

Low Level Waste: DOE prefers to treat INEL's LLW on site. INEL could be selected as one of the regional disposal sites for LLW.

Transuranic Waste: DOE prefers the Regionalized Alternative for treatment and storage of INEL's TRUW. This alternative could include treatment of TRUW received from RFETS.

High-Level Waste: DOE prefers onsite storage of INEL's immobilized HLW pending disposal in a geologic repository.

Hazardous Waste: DOE prefers the No Action Alternative where organic HW at INEL would continue to be treated on site. INEL would continue to use commercial facilities for all other HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated INEL for potential impacts under all of the alternatives that identified a role for this site. These impacts are discussed in Chapters 6 though 11. Results of the analyses for INEL under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Health risks are principally to workers and could include fatalities from waste management activities over the 20-year period of analysis. Collective worker health risk estimates are one fatality each for LLMW and LLW depending on whether INEL is selected as a disposal site, one fatality for HLW, and two fatalities for TRUW. Less than one latent cancer fatality is estimated among the offsite population for waste management activities under the preferred alternatives for all waste types at INEL.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air or groundwater quality standards. No major impacts to ecological resources, land use, or infrastructure are expected. The assessment of environmental justice impacts associated with treatment of TRUW at INEL identified a potential for disproportionately high and adverse health risks to low-income groups, which could require mitigation measures. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the maximum total number of LLMW, LLW, TRUW, and HLW shipments to and from INEL is estimated to be 23,670 truck or 9,770 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 1,913 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risks are primarily caused by waste management activities; however, the maximum cumulative increase in radiation dose to the offsite population is estimated to be well below the EPA standard of 10 millirems per year to the maximally exposed individual. Cumulative environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Waste management activities could substantially increase waste shipments entering or leaving the site.

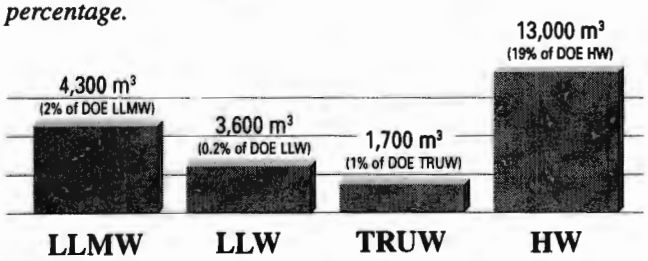
Site Summary

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL), established in 1952 by the Atomic Energy Commission, has been a major Department of Energy (DOE) site for more than 40 years in nuclear weapons research. Today, its major programs include defense and related programs, laser fusion, laser isotope separation, human genome study, supercomputation, and environmental restoration and waste management. LLNL and its components occupy approximately 12.8 square miles east of San Francisco, California. The laboratory includes Site 300, located near Tracy, California, and Sandia National Laboratories-California.

LLNL is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), and hazardous waste (HW) and, in some alternatives, other sites' LLMW and LLW. LLNL currently does not have an inventory of high-level waste and is not expected to manage this waste type in the future. The WM PEIS includes waste volumes for SNL-CA in its evaluation of LLNL as a candidate for waste management facilities.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the four waste types analyzed at LLNL, are shown in the following chart. Also, how LLNL relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at LLNL include the storage of LLMW with the treatment of wastewater only, preparation of LLW for shipment off site for disposal, storage of TRUW on site, and the transport of HW off site for treatment. A waste minimization and pollution prevention program has been developed and is being implemented at LLNL to reduce waste volumes.

Waste Management Alternatives at LLNL

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	*1 subalternative:* Treatment On Site (including shipments from offsite facilities)	Treatment Off Site
		Disposal On Site (LLNL waste only)	Disposal On Site	
			Disposal Off Site (TRU-contaminated LLMW)	
	Storage On Site	Disposal Off Site (TRU-contaminated LLMW)	*3 subalternatives:* Treatment Off Site	Disposal Off Site
			Disposal Off Site	
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*2 subalternatives:* Treatment On Site*	*2 subalternatives:* Minimum Treatment On Site
			Disposal On Site (including shipments from offsite facilities)	Disposal Off Site
			3 subalternatives: Minimum Treatment On Site	*3 subalternatives:* Treatment Off Site
	Disposal Off Site	Disposal On Site (including shipments from offsite facilities)	Disposal Off Site	
			2 subalternatives: Treatment Off Site	Disposal Off Site
			Disposal Off Site	
TRUW	Treatment On Site	Treatment On Site	Treatment Off Site	Treatment Off Site
	Storage On Site	Storage On Site	Storage Off Site	Storage Off Site
HW	Treatment Off Site (commercial facilities)	Treatment Off Site (commercial facilities)	Treatment Off Site (DOE and commercial facilities)	Not Analyzed

* Minimum treatment in one subalternative.

= DOE's preferred alternatives.

LLNL

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, LLNL's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which LLNL fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat LLNL's LLMW on site consistent with LLNL's site treatment plan. DOE prefers to ship LLNL's LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat LLNL's LLW on site. DOE prefers to ship LLNL's LLW to one of 2 or 3 regional disposal sites.

Transuranic Waste: DOE prefers the Decentralized Alternative for onsite treatment and storage of LLNL's TRUW.

Hazardous Waste: DOE prefers the No Action Alternative where LLNL would continue to use commercial facilities for HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for LLNL under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for LLNL under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Less than one latent cancer fatality is estimated among the offsite population, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at LLNL.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. This assumes that any new water requirements at Site-300 would be provided through a municipal system rather than by groundwater. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW, LLW, and TRUW shipments from LLNL is estimated to be 1,010 truck or 430 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 387 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risks are primarily caused by waste management activities; however, the maximum cumulative increase in radiation dose to the offsite population is estimated to be below the EPA standard of 10 millirems per year to the maximally exposed individual. Cumulative environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Waste management activities could substantially increase waste shipments leaving the site.

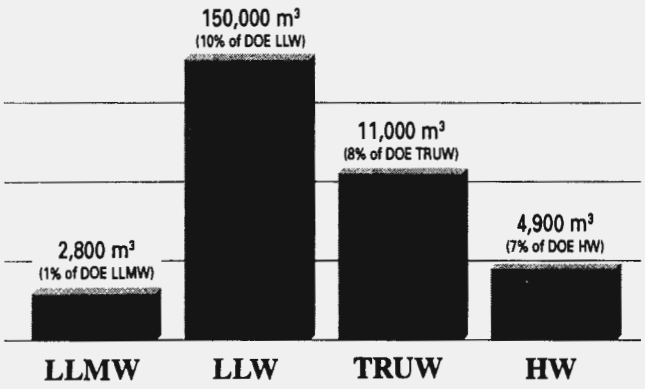
Site Summary

Los Alamos National Laboratory

Los Alamos National Laboratory (LANL) has been a major Department of Energy (DOE) site since 1943, providing nuclear weapons research and development and related projects. LANL is located on 43 square miles, 25 miles north of Santa Fe in north central New Mexico.

LANL is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own, and in some alternatives, other sites' low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), and hazardous waste (HW). LANL currently does not have an inventory of high-level waste and is not expected to manage this waste type in the future.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the four waste types at LANL, are shown in the following chart. Also, how LANL relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at LANL include the storage of LLMW with the treatment of wastewater only; treatment and disposal of LLW on site; storage of TRUW on site; and the transport of HW off site for treatment. A pollution prevention program has been developed and is being implemented at LANL to reduce waste volumes.

Waste Management Alternatives at LANL

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	*2 subalternatives:* **Treatment On Site** (including offsite shipments); **Disposal On Site**	Treatment Off Site
	Storage On Site	Disposal On Site	*1 subalternative:* **Treatment On Site** (including offsite shipments); **Disposal Off Site**	Disposal Off Site
			1 subalternative: **Treatment Off Site**; **Disposal Off Site**	
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*5 subalternatives:* **Treatment On Site** (minimum treatment in 2 subalternatives); **Disposal On Site** (including offsite shipments)	*2 subalternatives:* **Minimum Treatment On Site** (including offsite shipments); **Disposal Off Site**
	Disposal On Site	Disposal On Site	*2 subalternatives:* **Minimum Treatment On Site**; **Disposal Off Site**	*2 subalternatives:* **Treatment On Site** (including offsite shipments); *1 subalternative:* **Treatment Off Site**; **Disposal Off Site**
TRUW	Storage On Site	Treatment On Site	*2 subalternatives:* **Treatment On Site** (CH only, including offsite shipments); **Treatment Off Site** (RH only); **Storage On Site** (CH only)	Treatment Off Site
		Storage On Site	**Storage Off Site** (RH only); *1 subalternative:* **Treatment Off Site**; **Storage Off Site**	Storage Off Site
HW	Treatment Off Site (commercial facilities)	Treatment On Site (organic HW only)	*1 subalternative:* **Treatment On Site** (organic HW only, including offsite shipments); **Treatment Off Site** (non-organic HW to commercial facilities)	Not Analyzed
		Treatment Off Site (non-organic HW to commercial facilities)	*1 subalternative:* **Treatment Off Site** (DOE and commercial facilities)	

RH = Remote-handled TRUW. CH = Contact-handled TRUW.

= DOE's preferred alternatives. DOE does not yet have site preferences for LLMW and LLW disposal.

LANL

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, LANL's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which LANL fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat LANL's LLMW on site consistent with LANL's site treatment plan. LANL could be selected as one of the regional disposal sites for LLMW.

Low-Level Waste: DOE prefers to treat LANL's LLW on site. LANL could be selected as one of the regional disposal sites for LLW.

Transuranic Waste: DOE prefers the Decentralized Alternative for onsite treatment and storage of LANL's TRUW. This alternative could include treatment of TRUW received from SNL-NM.

Hazardous Waste: DOE prefers the No Action Alternative where LANL would continue to use commercial facilities for HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for LANL under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for LANL under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Health risks are principally to workers and could include physical hazard and latent cancer fatalities from waste management activities over the 20-year period of analysis. Collective worker health risk estimates are two fatalities for LLW depending on whether LANL is selected as a disposal site, one fatality for TRUW, and less than one fatality for LLMW. Less than one latent cancer fatality is estimated among the offsite population for waste management activities under the preferred alternatives for all waste types at LANL.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air or groundwater quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the maximum total number of LLMW, LLW and TRUW shipments to and from LANL is estimated to be 20,170 truck or 7,810 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 1,012 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Waste management activities could greatly increase waste shipments leaving the site.

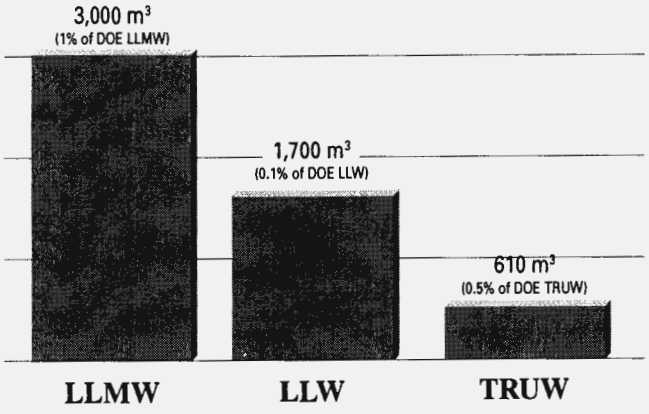
Site Summary

Nevada Test Site

The Nevada Test Site (NTS) has been the primary location for testing nuclear explosive devices since 1957. NTS is also a low-level waste disposal site. NTS occupies 1,350 square miles of desert valley and mountain terrain, 65 miles northwest of Las Vegas in southern Nevada.

NTS is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), and transuranic waste (TRUW) and, in some alternatives, other sites' LLMW and LLW. NTS does not have an inventory of high-level waste and is not considered a major generator of hazardous waste.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the three waste types at NTS, are shown in the following chart. Also, how NTS relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at NTS include the storage of LLMW with the treatment of wastewater only, treatment and disposal of LLW on site, and storage of TRUW on site. A waste minimization and pollution prevention plan has been developed and is being implemented at NTS to reduce waste volumes.

Waste Management Alternatives at NTS

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	*3 subalternatives:* Treatment Off Site / Disposal Off Site	Treatment Off Site
LLMW	Storage On Site	Disposal On Site (including shipments from offsite facilities)	*1 subalternative:* Treatment Off Site / Disposal On Site (including shipments from all DOE facilities)	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*2 subalternatives:* Minimum Treatment On Site / Disposal On Site	*1 subalternative:* Minimum Treatment On Site / Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*3 subalternatives:* Minimum Treatment On Site (including offsite shipments) / Disposal On Site	*1 subalternative:* Minimum Treatment On Site / Disposal On Site (including shipments from all DOE facilities)
LLW	Disposal On Site (including shipments from offsite facilities)	Disposal On Site	*1 subalternative:* Minimum Treatment On Site / Disposal Off Site	*2 subalternatives:* Treatment Off Site / Disposal Off Site
LLW	Disposal On Site (including shipments from offsite facilities)	Disposal On Site	*1 subalternative:* Minimum Treatment On Site / Disposal On Site (including shipments from all western DOE sites)	*1 subalternative:* Treatment Off Site / Disposal On Site
TRUW	Storage On Site	Treatment On Site / Storage On Site (including small quantities of offsite TRUW)	Treatment Off Site / Storage Off Site	Treatment Off Site / Storage Off Site

= DOE's preferred alternatives. DOE does not yet have site preferences for LLMW and LLW disposal.

NTS

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, NTS's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which NTS fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers regionalized treatment of NTS' LLMW. Under this alternative, NTS' LLMW would be shipped off site for treatment. NTS could be selected as one of the regional disposal sites for LLMW.

Low-Level Waste: DOE prefers to treat NTS' LLW on site. NTS could be selected as one of the regional disposal sites for LLW.

Transuranic Waste: DOE prefers the Decentralized Alternative for onsite treatment and storage of NTS' TRUW.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated NTS for potential impacts under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for NTS under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Health risks are principally to workers and could include physical hazard and latent cancer fatalities from waste management activities over the 20-year period of analysis. Collective worker health risk estimates are one fatality for LLMW and three fatalities for LLW, depending on whether NTS is selected as a disposal site, and less than one fatality for TRUW. Among the offsite population latent cancer fatalities are estimated to be essentially zero for waste management activities under the preferred alternatives for all waste types at NTS.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of groundwater quality standards. Equipment and vehicular emissions could require mitigative measures to meet air quality standards for nonattainment areas in the region. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the maximum total number of shipments of TRUW is estimated to be 90 truck or rail shipments. The total number of shipments of LLMW and LLW to and from NTS is dependent upon DOE's final selection of disposal sites for these wastes. Centralized disposal of LLW, which was analyzed in the WM PEIS, could result in approximately 242,000 to 257,000 truck shipments or 91,000 to 97,000 rail shipments to a single site; centralized disposal of LLMW could result in 7,500 to 9,600 truck shipments or 3,300 to 3,700 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 1,535 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded, except for air quality criteria air pollutants (CO). Waste management activities could greatly increase waste shipments entering or leaving the site.

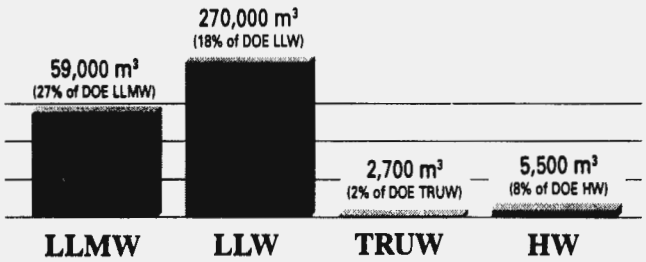
Site Summary

Oak Ridge Reservation

For the past 50 years, the U.S. Department of Energy's (DOE's) mission has involved weapons production, uranium enrichment, and energy research — all of which have contributed to the legacy of complex environmental cleanup challenges at the Oak Ridge Reservation (ORR). The Reservation consists of three separate sites, situated on 54.7 square miles in eastern Tennessee: a national laboratory, a manufacturing and developmental engineering plant, and a former gaseous diffusion plant. Presently, ORR's mission includes environmental restoration, waste management, energy and medical research, defense programs, and technology transfer.

ORR is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own and, in some alternatives, other sites' low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), and hazardous waste (HW). ORR currently does not have an inventory of high-level waste and is not expected to manage this waste type in the future.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the four waste types analyzed at ORR, are shown in the following chart. Also, how ORR relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at ORR include the treatment and storage of LLMW on site, treatment and disposal of LLW on site, storage of TRUW on site, treatment of organic HW on site, and the transport of remaining HW off site for treatment. A pollution prevention program has been developed and is being implemented at ORR to reduce waste volumes.

Waste Management Alternatives at ORR

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site	Treatment On Site	*1 subalternative:* **Treatment On Site** **Disposal On Site** *2 subalternatives:* **Treatment On Site** (including shipments from offsite facilities) **Disposal On Site**	Treatment Off Site
LLMW	Storage On Site	Disposal On Site	*1 subalternative:* **Treatment On Site** (including shipments from offsite facilities) **Disposal Off Site**	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*2 subalternatives:* **Treatment On Site*** **Disposal On Site** *3 subalternatives:* **Treatment On Site*** (including shipments from offsite facilities) **Disposal On Site** (including shipments from offsite facilities)	*2 subalternatives:* **Minimum Treatment On Site** **Disposal Off Site** *2 subalternatives:* **Treatment On Site** (including shipments from offsite facilities) **Disposal Off Site**
LLW	Disposal On Site	Disposal On Site	*2 subalternatives:* **Minimum Treatment On Site** **Disposal Off Site**	*1 subalternative:* **Treatment Off Site** **Disposal Off Site**
TRUW	Treatment On Site	Treatment On Site	Treatment On Site (RH only, including shipments from offsite facilities) Treatment Off Site (CH only)	Treatment On Site (RH only, including shipments from offsite facilities) Treatment Off Site (CH only)
TRUW	Storage On Site	Storage On Site (including shipments from offsite facilities)	Storage On Site (RH only) Storage Off Site (CH only)	Storage On Site (RH only) Storage Off Site (CH only)
HW	Treatment On Site (organic HW only)	Treatment On Site (organic HW only)	**Treatment On Site** (organic HW only, including shipments from offsite facilities)	Not Analyzed
HW	Treatment Off Site (commercial facilities)	Treatment Off Site (commercial facilities)	**Treatment Off Site** (commercial facilities)	

* Minimum treatment in one subalternative.

RH = Remote-handled TRUW. CH = Contact-handled TRUW.

= DOE's preferred alternatives. DOE does not yet have site preferences for LLMW and LLW disposal.

ORR

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, ORR's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which ORR fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers regional treatment of LLMW at ORR consistent with ORR's site treatment plan. This alternative could include treatment of LLMW generated at other sites. ORR could be selected as one of the regional disposal sites for LLMW.

Low-Level Waste: DOE prefers to treat ORR's LLW on site. ORR could be selected as one of the regional disposal sites for LLW.

Transuranic Waste: DOE prefers the Regionalized Alternative for onsite treatment and storage of ORR's remote-handled TRUW. This alternative could include treatment and storage of some remote-handled TRUW received from SRS. Also, under this alternative, DOE could ship ORR's contact-handled TRUW to SRS for treatment and storage.

Hazardous Waste: DOE prefers the No Action Alternative where organic HW at ORR would continue to be treated on site. ORR would continue to use commercial facilities for all other HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for ORR under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for ORR under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Health risks are principally to workers and could include physical hazard and latent cancer fatalities from waste management activities over the 20-year period of analysis. Collective worker health risk estimates are one fatality each for LLMW and LLW, depending on whether ORR is selected as a disposal site, and less than one fatality for TRUW. Among the offsite population latent cancer fatalities are estimated to be essentially zero for waste management activities under the preferred alternatives for all waste types at ORR.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. To meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the maximum total number of LLMW, LLW and TRUW shipments to and from ORR is estimated to be 69,130 truck or 26,490 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 1,658 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. However, to meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW. Waste management activities could greatly increase waste shipments entering or leaving the site.

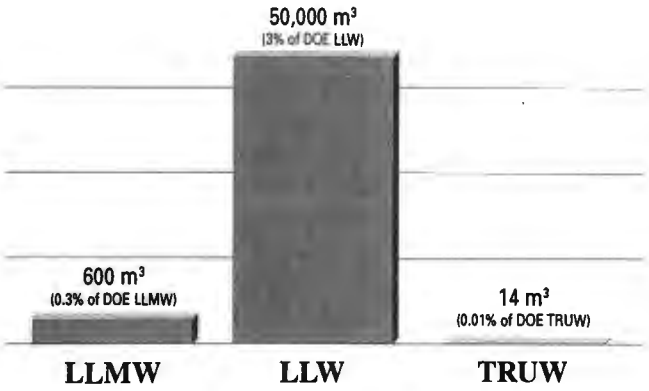
Site Summary

Paducah Gaseous Diffusion Plant

The Paducah Gaseous Diffusion Plant (PGDP) has been a major Department of Energy (DOE) site for more than 40 years, producing enriched uranium for commercial nuclear power reactors in the United States and overseas. PGDP is located on 5.4 square miles in western Kentucky.

PGDP is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), and transuranic waste (TRUW) and, in some alternatives, other sites' LLMW and LLW. PGDP currently does not have an inventory of high-level waste and is not expected to manage this waste type in the future. In addition, PGDP is not considered a major generator of hazardous waste.

The estimated total waste inventories, including current inventory and 20 years of generation for the three waste types at PGDP, are shown in the following chart. Also, how PGDP relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at PGDP include the storage of LLMW with the treatment of wastewater only, preparation of LLW for shipment off site for disposal, and storage of TRUW on site. A waste minimization and pollution prevention program has been developed and is being implemented at PGDP to reduce waste volumes.

Waste Management Alternatives at PGDP

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	*1 subalternative:* Treatment On Site (including shipments from offsite facilities); Disposal On Site	Treatment Off Site
LLMW	Storage On Site	Disposal On Site (including shipments from offsite facilities)	*3 subalternatives:* Treatment Off Site; Disposal Off Site	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*2 subalternatives:* Treatment On Site* (including shipments from offsite facilities); Disposal On Site	*2 subalternatives:* Minimum Treatment On Site; Disposal Off Site
LLW	Disposal Off Site	Disposal On Site (including shipments from offsite facilities)	*3 subalternatives:* Minimum Treatment On Site; Disposal Off Site; *2 subalternatives:* Treatment Off Site; Disposal Off Site	*3 subalternatives:* Treatment Off Site; Disposal Off Site
TRUW	Storage On Site	Treatment On Site	Treatment Off Site	Treatment Off Site
TRUW	Storage On Site	Storage** Off Site	Storage Off Site	Storage Off Site

*Minimum treatment in one subalternative.

** The WM PEIS analyses assumed offsite storage; however, DOE prefers onsite decentralized storage.

= DOE's preferred alternatives.

PGDP

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, PGDP's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which PGDP fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat most of PGDP's LLMW at an offsite regional treatment facility, although some LLMW would be treated on site, consistent with PGDP's site treatment plan. DOE prefers to ship PGDP's LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat PGDP's LLW on site. DOE prefers to ship PGDP's LLW to one of 2 or 3 regional disposal sites.

Transuranic Waste: DOE prefers onsite treatment and storage of PGDP's TRUW.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for PGDP under all of the alternatives that identified a role for this site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for PGDP under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Latent cancer fatalities among the offsite population are estimated to be essentially zero, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at PGDP.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW, LLW, and TRUW shipments from PGDP is estimated to be 6,330 truck or 2,410 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 157 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Waste management activities could substantially increase waste shipments leaving the site.

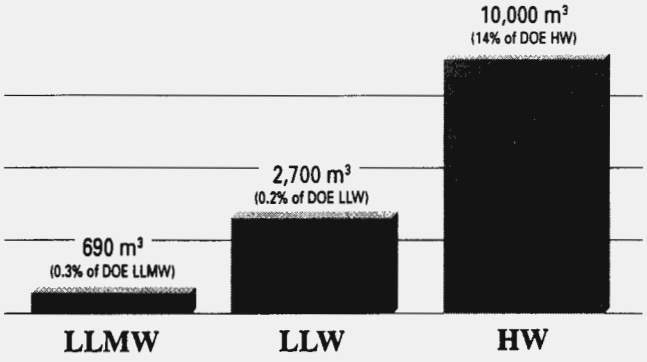
Site Summary

Pantex Plant

The Pantex Plant has been a major Department of Energy (DOE) site for more than 40 years, providing nuclear weapons assembly facilities. The mission of the Pantex Plant includes disassembly, assembly, quality evaluation, and maintenance of the U.S. nuclear weapons stockpile. The site is also a candidate for tritium supply and recycling. The Pantex Plant, consisting of 15.8 square miles of DOE-owned land and 9.2 square miles of land leased from Texas Tech University, is located about 17 miles northeast of Amarillo, Texas.

The Pantex Plant is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), and hazardous waste (HW). The Pantex Plant currently has a very small amount of transuranic waste (TRUW). The Pantex Plant currently does not have an inventory of high-level waste and is not expected to manage this waste type in the future.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the three waste types at the Pantex Plant, are shown in the following chart. Also, how Pantex relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at the Pantex Plant include the storage of LLMW with the treatment of wastewater only, preparation of LLW for shipment off site for disposal, and the transport of HW off site for treatment. A pollution prevention and waste minimization program has been developed and is being implemented at the Pantex Plant to reduce waste volumes.

Waste Management Alternatives at Pantex

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	**Treatment On Site**	*1 subalternative:* Treatment On Site / Disposal On Site	Treatment Off Site
LLMW	Storage On Site	Disposal On Site	*3 subalternatives:* Treatment Off Site / **Disposal Off Site**	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*2 subalternatives:* **Treatment On Site** (minimum treatment in one subalternative) / **Disposal On Site** / *3 subalternatives:* **Minimum Treatment On Site** / **Disposal Off Site**	Treatment Off Site (minimum treatment in 2 subalternatives)
LLW	Disposal Off Site	Disposal On Site	*2 subalternatives:* Treatment Off Site / Disposal Off Site	Disposal Off Site
HW	**Treatment Off Site (commercial facilities)**	Treatment Off Site (commercial facilities)	Treatment Off Site (DOE and commercial facilities)	Not Analyzed

Bold = DOE's preferred alternatives.

Pantex

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, Pantex's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which Pantex fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat LLMW generated at Pantex on site consistent with Pantex's site treatment plan. DOE prefers to ship Pantex's LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat LLW generated at Pantex on site. DOE prefers to ship Pantex's LLW to one of 2 or 3 regional disposal sites.

Transuranic Waste: DOE prefers offsite treatment and storage of Pantex's very small amount of TRUW.

Hazardous Waste: DOE prefers the No Action Alternative where Pantex would continue to use commercial facilities for HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for Pantex under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for Pantex under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Latent cancer fatalities among the offsite population are estimated to be essentially zero, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at Pantex.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW and LLW shipments from the Pantex Plant is estimated at 460 truck or 190 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 102 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risks are primarily caused by waste management activities; however, the maximum cumulative increase in radiation dose to the offsite population is estimated to be well below the EPA standard of 10 millirems per year to the maximally exposed individual. Cumulative environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded.

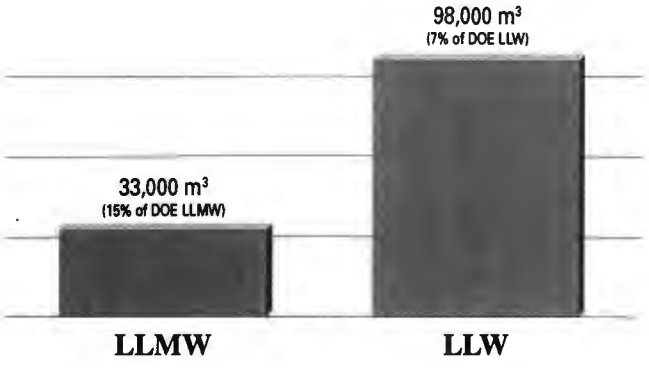
Site Summary

Portsmouth Gaseous Diffusion Plant

The Portsmouth Gaseous Diffusion Plant (PORTS) has been a major Department of Energy (DOE) site for more than 40 years, producing enriched uranium. PORTS is located on 6.3 square miles, about 22 miles northeast of Portsmouth, Ohio.

PORTS is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW) and low-level waste (LLW) and, in some alternatives, other sites' LLMW and LLW. PORTS currently does not have an inventory of transuranic waste or high-level waste and is not expected to manage these waste types in the future. In addition, PORTS is not considered a major generator of hazardous waste.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the two waste types at PORTS, are shown in the following chart. Also, how PORTS relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at PORTS include the storage of LLMW with the treatment of wastewater only and preparation of LLW for shipment off site for disposal. A waste minimization and pollution prevention program has been developed and is being implemented at PORTS to reduce waste volumes.

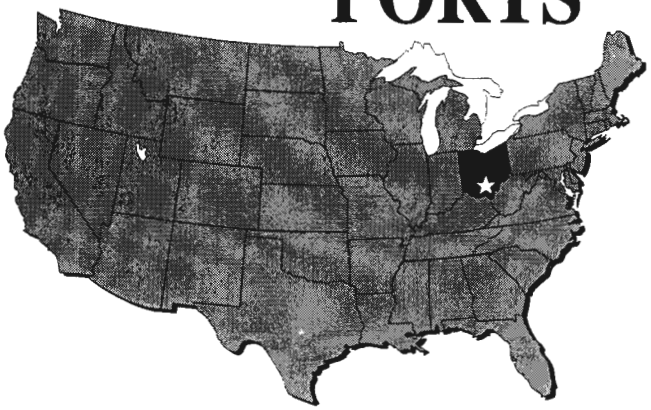
Waste Management Alternatives at PORTS

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	*1 subalternative:* Treatment On Site (including shipments from offsite facilities) Disposal On Site (including shipments from offsite facilities) *2 subalternatives:* Treatment On Site (including shipments from offsite facilities) Disposal Off Site	Treatment Off Site
LLMW	Storage On Site	Disposal On Site (including shipments from offsite facilities)	*1 subalternative:* Treatment Off Site Disposal Off Site	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*2 subalternatives:* Treatment On Site* (including shipments from offsite facilities) Disposal On Site (including shipments from offsite facilities) *3 subalternatives:* Minimum Treatment On Site Disposal Off Site	*2 subalternatives:* Minimum Treatment On Site Disposal Off Site *2 subalternatives:* Treatment On Site (including shipments from offsite facilities)
LLW	Disposal Off Site	Disposal On Site (including shipments from offsite facilities)	*1 subalternative:* Treatment On Site (including shipments from offsite facilities) Disposal Off Site *1 subalternative:* Treatment Off Site Disposal Off Site	Disposal Off Site *1 subalternative:* Treatment Off Site Disposal Off Site

*Minimum treatment in one subalternative.

= DOE's preferred alternatives.

PORTS



DOE's Preferred Alternatives

In the development of a national strategy for each waste type, PORTS's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which PORTS fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat PORTS' LLMW on site consistent with Portsmouth's site treatment plan. DOE prefers to ship PORTS' LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat PORTS' LLW on site. DOE prefers to ship PORTS' LLW to one of 2 or 3 regional disposal sites.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for PORTS under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for PORTS under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Latent cancer fatalities among the offsite population are estimated to be essentially zero, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at PORTS.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW and LLW shipments from PORTS is estimated to be 34,090 truck or 13,000 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 399 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Waste management activities could greatly increase waste shipments leaving the site.

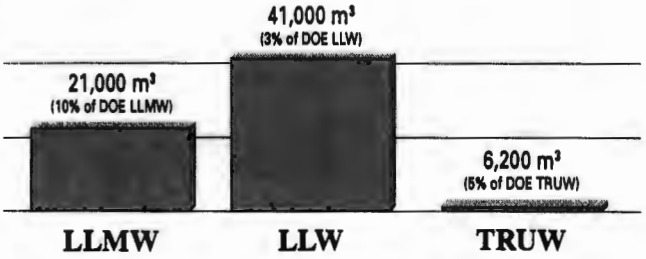
Site Summary

Rocky Flats Environmental Technology Site

The Rocky Flats Environmental Technology Site (RFETS) has been a major Department of Energy (DOE) site for more than 40 years, producing nuclear weapons components from plutonium and other metals. In 1992, its mission changed to environmental restoration and decontamination and decommissioning. RFETS occupies 11 square miles, approximately 16 miles northwest of Denver, Colorado.

RFETS is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), and transuranic waste (TRUW) and, in some alternatives, other sites' LLMW and LLW. RFETS currently does not have an inventory of high-level waste and is not expected to manage this waste type in the future. In addition, RFETS is not considered a major generator of hazardous waste.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the three waste types at RFETS, are shown in the following chart. Also, how RFETS relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at RFETS include the storage of LLMW with the treatment of wastewater only, preparation of LLW for shipment off site for disposal, and storage of TRUW on site. A waste minimization program has been developed and is being implemented at RFETS to reduce waste volumes.

Waste Management Alternatives at RFETS

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	*1 subalternative:* Treatment On Site (including shipments from offsite facilities)	Treatment Off Site
			Disposal On Site	
	Storage On Site	Disposal On Site (including shipments from offsite facilities)	*2 subalternatives:* Treatment On Site (including shipments from offsite facilities)	Disposal Off Site
			Disposal Off Site	
			1 subalternative: Treatment Off Site	
			Disposal Off Site	
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*2 subalternatives:* Treatment On Site*	*2 subalternatives:* Minimum Treatment On Site
			Disposal On Site	
			1 subalternative: Treatment On Site (including shipments from offsite facilities)	Disposal Off Site
			Disposal Off Site	*2 subalternatives:* Treatment On Site (including shipments from offsite facilities)
	Disposal Off Site	Disposal On Site	*1 subalternative:* Treatment Off Site	
			Disposal Off Site	Disposal Off Site
			2 subalternatives: Minimum Treatment On Site	*1 subalternative:* Treatment Off Site
			Disposal Off Site	Disposal Off Site
TRUW	Treatment On Site	Treatment On Site	*2 subalternatives:* Treatment On Site	Treatment Off Site
			Storage On Site	
	Storage On Site	Storage On Site	*1 subalternative:* Treatment Off Site	Storage Off Site
			Storage Off Site	

*Minimum treatment in one subalternative.

= DOE's preferred alternatives.

RFETS

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, RFETS's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which RFETS fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat RFETS' LLMW on site consistent with RFETS' site treatment plan. DOE prefers to ship RFETS' LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat RFETS' LLW on site. DOE prefers to ship RFETS' LLW to one of 2 or 3 regional disposal sites.

Transuranic Waste: DOE prefers the Decentralized Alternative for onsite treatment and storage of some of RFETS' TRUW. Some of RFETS' TRUW could be treated at INEL.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for RFETS under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for RFETS under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

The largest estimated health risks are to workers and are related to the waste volumes being handled. Physical accidents typically result in a higher potential for fatalities than exposure to radiation. One worker fatality could occur for the preferred treatment alternative for LLMW. Among the offsite population, latent cancer fatalities are estimated to be essentially zero for waste management activities under the preferred alternatives for all waste types at RFETS.

Environmental Effects

Under the preferred alternatives, equipment and vehicular emissions could require mitigative measures to meet air quality standards for nonattainment areas in the region. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW, LLW and TRUW shipments from RFETS is estimated to be 6,920 truck or 2,690 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 774 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risks are primarily caused by waste management activities; however, the maximum cumulative increase in radiation dose to the offsite population is estimated to be below the EPA standard of 10 millirems per year to the maximally exposed individual. Cumulative environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded, except for air quality criteria air pollutants (CO and NO_2). Waste management activities could greatly increase waste shipments leaving the site.

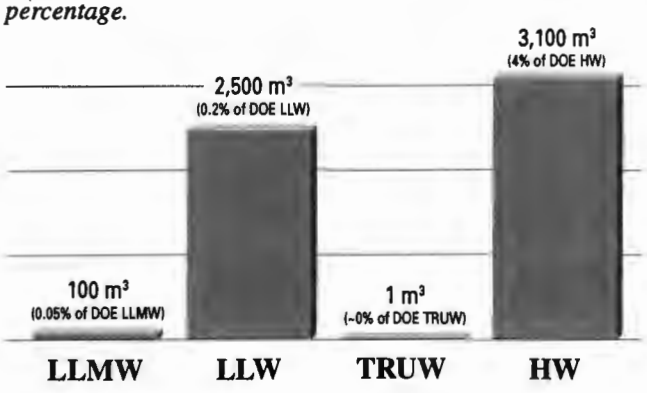
Site Summary

Sandia National Laboratories

Sandia National Laboratories-New Mexico (SNL-NM) is a major Department of Energy (DOE) research and development laboratory with a primary mission of developing, engineering, and testing non-nuclear components of nuclear weapons. SNL-NM is located on 4.4 square miles southeast of Albuquerque, New Mexico, on the Kirtland Air Force Base.

SNL-NM is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), and hazardous waste (HW). SNL-NM currently does not have an inventory of high-level waste and is not expected to manage this waste type in the future. The WM PEIS includes waste volumes for ITRI in its evaluation of SNL-NM as a candidate site for waste management facilities.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the four waste types at SNL-NM, are shown in the following chart. Also, how SNL-NM relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at SNL-NM include the storage of LLMW with the treatment of wastewater only, preparation of LLW for shipment off site for disposal, storage of TRUW on site, and the transport of HW off site for treatment. A waste minimization and pollution prevention plan has been developed and is being implemented at SNL-NM to reduce waste volumes.

Waste Management Alternatives at SNL-NM

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	Treatment Off Site	Treatment Off Site
	Storage On Site	Disposal On Site	Disposal Off Site	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*3 subalternatives:* Treatment Off Site / Disposal Off Site	*2 subalternatives:* Minimum Treatment On Site / Disposal Off Site
	Disposal Off Site	Disposal On Site	*4 subalternatives:* Minimum Treatment On Site / Disposal Off Site	*3 subalternatives:* Treatment Off Site / Disposal Off Site
TRUW	Storage On Site	Treatment On Site	Treatment Off Site	Treatment Off Site
		Storage Off Site	Storage Off Site	Storage Off Site
HW	Treatment Off Site (commercial facilities)	Treatment Off Site (commercial facilities)	Treatment Off Site (DOE and commercial facilities)	Not Analyzed

= DOE's preferred alternatives.

SNL-NM

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, SNL-NM's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which SNL-NM fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat SNL-NM's LLMW on site consistent with SNL-NM's site treatment plan. DOE prefers to ship SNL-NM's LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat SNL-NM's LLW on site. DOE prefers to ship SNL-NM's LLW to one of 2 or 3 regional disposal sites.

Transuranic Waste: DOE prefers the offsite treatment and storage of SNL-NM's TRUW.

Hazardous Waste: DOE prefers the No Action Alternative where SNL-NM would continue to use commercial facilities for HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for SNL-NM under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for SNL-NM under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Latent cancer fatalities among the offsite population are estimated to be essentially zero, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at SNL-NM.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW, LLW, and TRUW shipments from SNL-NM is estimated to be 370 truck or 180 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 46 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Waste management activities could greatly increase waste shipments leaving the site.

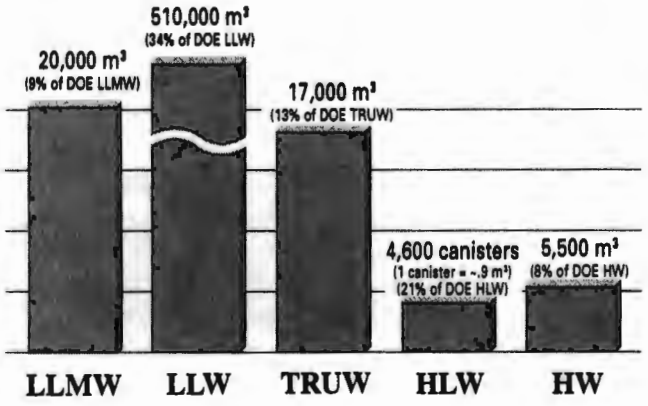
Site Summary

Savannah River Site

The Savannah River Site (SRS) has played a major role in national security for more than 40 years, producing nuclear materials (primarily plutonium and tritium) for weapons, managing the resulting radioactive and hazardous waste, and performing a variety of missions related to energy research and nuclear materials management. SRS is located on approximately 310 square miles, about 20 miles south of Aiken, South Carolina, and 25 miles southeast of Augusta, Georgia.

SRS is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), high-level waste (HLW), hazardous waste (HW), and, in some alternatives, other sites' LLMW, LLW, TRUW and HLW.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the five waste types at SRS, are shown in the following chart. Also, how SRS relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at SRS include the treatment and storage of LLMW, treatment and disposal of LLW on site, storage of TRUW on site, storage of HLW on site pending disposal in a geologic repository, and the transport of HW off site for treatment. A waste minimization and pollution prevention plan has been developed and is being implemented at SRS to reduce waste volumes.

Waste Management Alternatives at SRS

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site	Treatment On Site	*3 subalternatives:* Treatment On Site (including offsite shipments); Disposal On Site	Treatment On Site (RH only); Treatment Off Site; Disposal Off Site
LLMW	Storage On Site	Disposal On Site (including offsite shipments)	*1 subalternative:* Treatment On Site (including offsite shipments); Disposal Off Site	
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*5 subalternatives:* Treatment On Site*; Disposal On Site (including offsite shipments)	*4 subalternatives:* Treatment On Site* (including offsite shipments); Disposal Off Site
LLW	Disposal On Site (including offsite shipments)	Disposal On Site (including offsite shipments)	*2 subalternatives:* Minimum Treatment On Site; Disposal On Site (including shipments from all eastern sites)	*1 subalternative:* Treatment Off Site; Disposal Off Site
TRUW	Treatment On Site	Treatment On Site	Treatment On Site (including offsite CH)	Treatment Off Site
TRUW	Storage On Site	Storage On Site	Storage On Site	Storage Off Site
HLW	Storage On Site	Storage On Site; *Pending* Disposal Off Site (geologic repository)	Storage On Site (possibly including offsite shipments); *Pending* Disposal Off Site (geologic repository)	Storage Off Site
HW	Treatment Off Site (commercial facilities)	Treatment On Site (organic only)	*1 subalternative:* Treatment On Site (organic only); Treatment Off Site (commercial facilities)	Not Analyzed
HW		Treatment Off Site (commercial facilities)	*1 subalternative:* Treatment Off Site (DOE and commercial facilities)	

* Minimum treatment in 2 subalternatives.
RH = Remote-handled TRUW. CH = Contact-handled TRUW.
= DOE's preferred alternatives. DOE does not yet have site preferences for LLMW and LLW disposal.

SRS

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, SRS' future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which SRS fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers regionalized treatment of LLMW at SRS. This alternative includes onsite treatment of SRS's LLMW and could include treatment of LLMW generated at other sites. LLMW activities at SRS would be conducted in accordance with SRS's site treatment plan. SRS could be selected as one of the regional disposal sites for LLMW.

Low-Level Waste: DOE prefers to treat SRS' LLW on site. SRS could be selected as one of the regional disposal sites for LLW.

Transuranic Waste: DOE prefers the Regionalized Alternative for onsite treatment and storage of SRS' contact-handled TRUW. Under this alternative, some contact-handled TRUW could be received from ORR for treatment and storage. Also, DOE could ship SRS' remote-handled TRUW to ORR for treatment and storage.

High-Level Waste: DOE prefers onsite storage of SRS' immobilized HLW pending disposal in a geologic repository.

Hazardous Waste: DOE prefers the No Action Alternative where SRS would continue to use commercial facilities for HW treatment.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for SRS under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for SRS under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Health risks are primarily to workers and could include fatalities from waste management activities over the 20-year period of analysis. Collective worker health risk estimates are one fatality for LLMW and five fatalities for LLW, depending on whether SRS is selected as a disposal site, one fatality for HLW, and less than one fatality for TRUW. Less than one latent cancer fatality is estimated among the offsite population for waste management activities under the preferred alternatives for all waste types at SRS.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. To meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW. Expenditures for WM activities could cause socioeconomic effects that include the benefits of increased regional employment and income as well as regional population growth that could alter community structure and stress available housing and community services. No major impacts to ecological resources, land use, infrastructure, or environmental justice are expected. The programmatic analyses did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the maximum total number of LLMW, LLW, TRUW, and HLW shipments to and from SRS is estimated to be 74,862 truck or 27,275 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 2,406 workers. This could include workers currently employed for existing waste management operations.

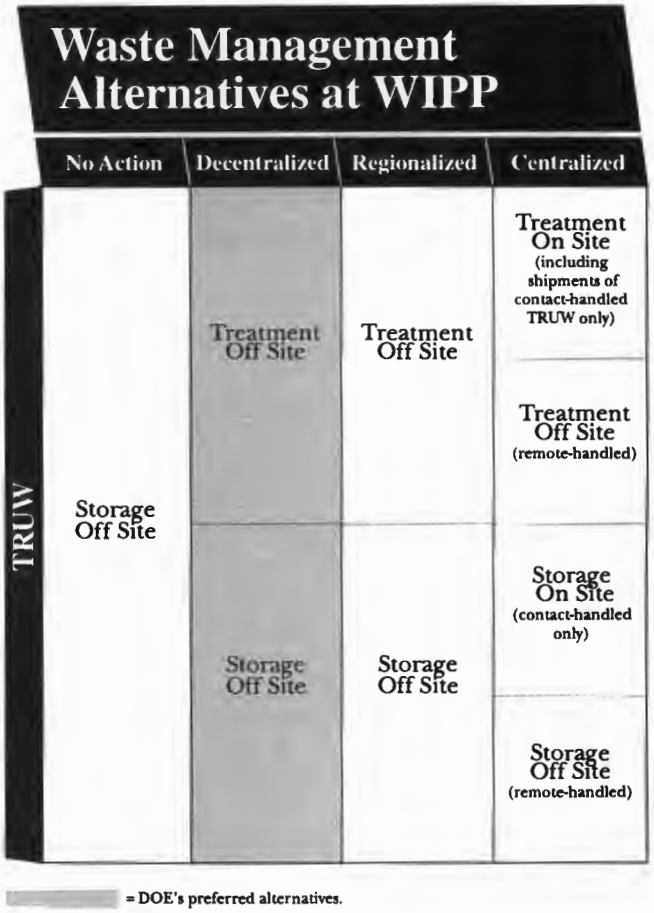
Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. However, to meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW and LLW. Waste management activities could greatly increase waste shipments entering or leaving the site.

Site Summary

Waste Isolation Pilot Plant Site

The Waste Isolation Pilot Plant (WIPP) is a Department of Energy (DOE) research and development facility for the safe and permanent disposal of defense-generated transuranic waste (TRUW). WIPP will become a permanent disposal site for TRUW if it meets all regulatory requirements and DOE decides to open it. The WIPP site is located on 16 square miles in southeastern New Mexico, approximately 25 miles from Carlsbad.



WIPP is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential geologic disposal site for TRUW from other DOE sites. The WIPP site does not currently manage or contain waste.

In 1981, DOE issued a Record of Decision for the phased development of WIPP. In 1990, a subsequent Record of Decision was issued that called for the continuation of the phased development of WIPP. To support a decision on whether to proceed to disposal, DOE prepared a second Supplemental EIS (SEIS II) to evaluate impacts associated with disposal at the site. Also, a number of regulatory and legislative requirements must be met before shipments of TRUW for disposal at WIPP could begin.

DOE's current strategy is to have all TRUW meet the WIPP waste acceptance criteria established by DOE in consultation with the Environmental Protection Agency (EPA) and the State of New Mexico. These criteria are not yet final and may be modified to require more extensive treatment of TRUW before disposal. The WM PEIS only analyzes the role of the WIPP site with respect to the treatment of TRUW. The environmental impacts of TRUW disposal at WIPP are evaluated in the WIPP SEIS II mentioned above. If certified as a TRUW disposal site by EPA, WIPP will operate as a repository, accepting TRUW for approximately 35 years (under the Proposed Action in the WIPP SEIS II). At the end of that time, DOE will backfill and permanently seal the facility.

WIPP

DOE's Preferred Alternative

In the development of a national strategy for each waste type, WIPP's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS, the WIPP SEIS II, and regulatory requirements. Although the site's role will not be determined until the Records of Decision are issued and other requirements are met, the way in which WIPP fits within the preferred waste management alternative for TRUW is as follows.

Transuranic Waste: DOE prefers the Decentralized Alternative in which all DOE-generated TRUW would be treated and stored at the sites where it is generated and then shipped to WIPP for disposal. Although the FFC Act's requirement for a Site Treatment Plan would not apply to WIPP, DOE did include management plans for mixed TRUW in the proposed site treatment plans of the sites where mixed TRUW is currently being managed.

Potential Impacts of Preferred Alternative

The WM PEIS evaluated WIPP only under the Centralized Alternative, in which treatment of TRUW would occur at WIPP. These impacts are discussed in Chapter 8. However, in the preferred Decentralized Alternative, treatment of TRUW would occur elsewhere. The potential impacts of TRUW disposal have been assessed in previous EISs and the WIPP SEIS II.

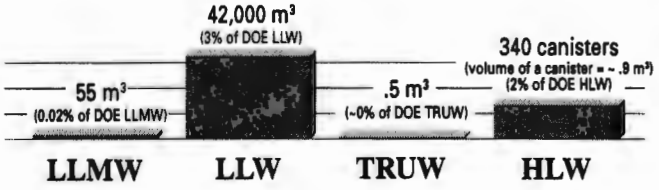
Site Summary

West Valley Demonstration Project

The West Valley Demonstration Project (WVDP) is located on the site of the only U.S. commercial nuclear fuel reprocessing plant, which recycled fuel from commercial and federally owned reactors until 1972. Under the WVDP Act, a Public Law enacted by Congress in 1980, the Department of Energy (DOE) is required to develop and demonstrate a technology for solidifying high-level waste in preparation for disposal. Other WVDP activities include programs for waste management and decontamination and decommissioning. The WVDP is located on 0.3 square mile in West Valley, approximately 31 miles south of Buffalo, New York.

WVDP is considered in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) as a potential waste management site for its own low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), and high-level waste (HLW). WVDP currently does not have a large inventory of hazardous waste and is not expected to manage large quantities of this waste type in the future.

The estimated total waste inventories, consisting of current inventory and 20 years of generation for the four waste types at WVDP, are shown in the following chart. Also, how WVDP relates to DOE's entire 20-year projected inventory for each waste type is provided below as a percentage.



Current waste management activities at WVDP include the storage of LLMW with the treatment of wastewater only, preparation of LLW for shipment off site for disposal, storage of TRUW on site, and the storage of HLW on site pending disposal in a geologic repository. A waste minimization/pollution prevention program has been developed and is being implemented at WVDP to reduce waste volumes.

Waste Management Alternatives at WVDP

	No Action	Decentralized	Regionalized	Centralized
LLMW	Treatment On Site (wastewater only)	Treatment On Site	Treatment Off Site	Treatment Off Site
	Storage On Site	Disposal On Site	Disposal Off Site	Disposal Off Site
LLW	Minimum Treatment On Site	Minimum Treatment On Site	*3 subalternatives:* Treatment Off Site / Disposal Off Site	*2 subalternatives:* Minimum Treatment On Site / Disposal Off Site
	Disposal Off Site	Disposal On Site	*4 subalternatives:* Minimum Treatment On Site / Disposal Off Site	*3 subalternatives:* Treatment Off Site / Disposal Off Site
TRUW	Storage On Site	Treatment On Site	Treatment Off Site	Treatment Off Site
		Storage* Off Site	Storage Off Site	Storage Off Site
HLW	Storage On Site	Storage On Site	Storage Off Site	Storage Off Site
		Pending Disposal Off Site (geologic repository)		

* Although the WM PEIS analyses assumed offsite storage, DOE prefers onsite decentralized storage of WVDP transuranic waste.

= DOE's preferred alternatives.

WVDP

DOE's Preferred Alternatives

In the development of a national strategy for each waste type, WVDP's future role will be shaped in part by DOE's preferred alternatives, along with decision criteria discussed in Section 1.7.3 of the WM PEIS. Although the site's role will not be determined until the Records of Decision for each waste type are issued, the ways in which WVDP fits within each preferred waste management alternative are as follows.

Low-Level Mixed Waste: DOE prefers to treat WVDP's LLMW according to the Regionalized Alternative and consistent with WVDP's site treatment plan. Under this alternative, WVDP's LLMW would be shipped off site for treatment. DOE prefers to ship WVDP's LLMW to one of 2 or 3 regional disposal sites.

Low-Level Waste: DOE prefers to treat WVDP's LLW on site. DOE prefers to ship WVDP's LLW to one of 2 or 3 regional disposal sites.

Transuranic Waste: DOE prefers the onsite treatment and storage of WVDP's TRUW.

High-Level Waste: DOE prefers onsite storage of WVDP's immobilized HLW pending disposal in a geologic repository.

Potential Impacts of Preferred Alternatives

The WM PEIS evaluated potential impacts for WVDP under all of the alternatives that identified a role for the site. These impacts are discussed in Chapters 6 through 11. Results of the analyses for WVDP under DOE's preferred alternatives are highlighted for the following impacts.

Health Effects

Latent cancer fatalities among the offsite population are estimated to be essentially zero, and collective physical hazard and latent cancer risks to workers are less than one fatality, for waste management activities under the preferred alternatives for all waste types at WVDP.

Environmental Effects

The preferred alternatives are not expected to cause exceedances of air quality standards. No major impacts to ecological resources, land use, or environmental justice are expected; moderate increases to requirements for wastewater treatment and power for activities under the preferred alternatives could lead to requirements for additional capacity and corresponding costs for these systems. The programmatic analysis did not select exact locations for facilities within site boundaries; some location-specific impacts, such as to cultural and sensitive ecological resources, could require impacts assessment when exact locations are determined.

Transportation

Under the preferred alternatives, the total number of LLMW, LLW, TRUW, and HLW shipments from WVDP is estimated to be 6,990 truck or 2,578 rail shipments.

Site Employment

Under the preferred alternatives, the annual workforce required for waste management operations is estimated to average 142 workers. This could include workers currently employed for existing waste management operations.

Cumulative Effects

Cumulative health risk and environmental impacts are primarily caused by existing conditions and other actions at the site. Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded. Wastewater and power requirements could cause current capacities to be exceeded. Waste management activities could substantially increase waste shipments leaving the site.